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Effect of foliar potassium application and irrigation scheduling on growth, yield, nutrient uptake and nutrient use efficiency of *Summer* mungbean

Shivashankar K and Adesh Singh

Abstract
Scheduling irrigation is the major factor in producing higher yields of summer crops. Inadequate moisture during the sensitive stages will cause substantial reduction in yield. Potassium (K+) is an important element in reducing the ill effects of soil water stress on crop. Foliar application of potassium increases the drought tolerance in mungbean. Keeping this in view, a field experiment was carried out to study the "Effect of foliar potassium application and irrigation schedules on growth, yield, nutrient uptake and nutrient use efficiency of *summer* mungbean" during 2018 at SVPUA&T, Meerut (U.P). It included 12 treatment combinations comprised of 2 irrigation schedules (0.6 and 0.4 IW/CPE ratio) and 6 foliar potassium application treatments (1% spray of K through KNO_3 and/or KCl at flowering, flowering and pod development stage including control), replicated thrice and were tested under a split-plot design. The results indicated that, the growth parameters, yield of mungbean were significantly higher under 0.6 IW/CPE ratio as compared to 0.4 IW/CPE ratio. Irrigation scheduled at 0.6 IW/CPE ratio (I_1) recorded the highest nitrogen, phosphorous and potassium uptake by grains, straw as well as total, respectively which were significantly superior over 0.4 IW/CPE ratio irrigation schedule. The increment in nitrogen, phosphorus and potassium uptake by grains in I_1 over I_2 was 32.9, 50.0 and 34.8 per cent, respectively. Among the foliar application of potassium treatments, the growth attributes and yield were significantly increased by foliar application of 1% K through KNO_3/KCl at flowering and pod development stage. Significantly highest nitrogen, phosphorous and potassium uptake by grains, straw and total, respectively were recorded with the foliar application of 1% K as KNO_3 (one at flowering and another at pod development stage) over rest of the treatments. The increase in nitrogen phosphorus and potassium uptake by grains under treatment with 1% K by KNO_3 spray at flowering and pod development stage (T_6) over 1% K spray through KNO_3 only at flowering (T_3) was 24.4, 34.6 and 29.2%, respectively. The interaction effect between irrigation regimes and potassium foliar levels was non-significant for most of the parameters.

Keywords: Summer Mungbean, KCl, KNO_3, foliar spray, nutrient uptake, use efficiency, 0.4 and 0.6 IW/CPE ratio

Introduction
The main source of protein for vegetarians is considered to be pulses, which are a rich source of protein. After cereals, pulses are regarded as the second most important component of the Indian diet. Pulses not only improve the soil by fixing nitrogen from the air, but they also add organic matter. Pulses generally contain 22-25 percent protein, compared to 8-10 percent in grains. Green gram (*Vigna radiata* L. Wilczek), also known as mungbean in some regions, belongs to the fabaceae family. On a dry weight basis, its grains contain roughly 22-25% protein, 1% oil, 3.5-4.5% ash and 62-65% carbohydrates. Lysine-rich in mungbean makes its protein an amazing addition to rice in terms of a balanced diet for people [1]. It is a crop that is grown annual in nature, short durated and is drought tolerant crop. It is an annual plant that is often short-lived, drought-resistant and able to fix atmospheric nitrogen (58-109 kg/ha) into the soil through its roots [2]. Mungbean can be grown both in kharif and in the summer. Due to its rapid growth, it is also grown as a catch crop. Mungbean was produced on 4.58 million hectares in the 2019-20 growing season, producing 2.508 million tonnes at an average productivity of 548 kg/ha [3]. Moisture stress occurs at several growth stages during the summer as a result of the high temperature, high transpiration rate and low water availability. Irrigation emerged as the most significant element among agricultural production tools in the context of a changing world. Mungbean plants need water at all growth phases, but during the flowering and pod-filling periods they are more prone to water stress.

Water shortages during these critical stages will significantly lower the production. Numerous plant functions, such as photosynthesis, transpiration, evaporation, and others are adversely affected by water stress [4], which also significantly reduces the accumulation of dry matter [5]. Utilizing water efficiently during the summer will increase production, productivity of pulses and water use efficiency. Scheduling of irrigation at right time *i.e.* use of meteorological approach based pan evaporation method is one of the simplest, reliable and economical method. Foliar application of nutrients in mungbean is in limited use currently for increase of stress resistance mechanism. Spray of nutrients on foliage also results in less ground water pollution. When grown as relay crops, where pulses are planted before the first crop is harvested, there is no time for pulses to get a basal application of nutrients. Foliar application of fertilizers was considered to be more appropriate, effective, and cost-effective than soil application [6]. 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 [7]. In general, Indian soils are rich in potassium, but the amount that is made available to crops is insufficient. High yielding varieties respond well to various potassium doses, and intensive cropping and intercropping are now becoming more important in India. Potassium is one of the macro nutrient, which is important for plant growth and sustainable crop production. It involves the activation of more than 60 plant enzymes [8]. It gives plants resilience to insect and disease attack. Additionally, it aids in maintaining the cell's turgor pressure, which is essential for cell development. It supports the opening and closing mechanisms of stomata and aids in the osmo-regulation of plant cells [9]. When considered as a whole, potassium is an enzyme activator, aids in the synthesis of starch and protein, aids in metabolism, significantly regulates stomata and also plays a role in the generation of chlorophyll 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 development, which subsequently explores more soil water. Therefore, providing potassium nutrition externally is crucial to promoting overall plant growth and production. The negative consequences of water stress can be mitigated by potassium application during the vegetative and reproductive stages. It was discovered that foliar application of macronutrients like potassium and nitrogen was just as effective as soil application [10]. According to Thalooth *et al.* [11], foliar potassium application enhances the water content of broad bean leaves. The Foliar application of potassium increases the drought tolerance in mungbean plant [12]. Potassium application during flowering had a positive impact on all growth characteristics [13]. By taking into account the aforementioned information, a study titled "Response of Summer Mungbean (*Vigna radiata* L. Wilczek) to Foliar Potassic Fertilization under Different Moisture Regimes" was conducted in the summer of 2018 at the Technology Park of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, (U.P.).

Materials and Methods

The experiment was conducted at Technology Park, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) during 2018. The soil of the experimental field was well drained, sandy loam in texture and slightly alkaline in reaction (7.73). It was low in organic carbon (0.46%) and available nitrogen (176.3 kg ha^{-1}), medium in available phosphorus (16.4 kg ha^{-1}) and potassium (149.2 kg ha^{-1}). The treatments consisted of 2 levels of irrigation I_1 (0.6 IW/CPE) and I_2 (0.4 IW/CPE ratio) in main plots and six levels of foliar potassium application *viz.*, T_1-control, T_2-1% K by KCl at flowering stage, 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 stage, T_6-1% K by KNO_3 at flowering and pod development stage, were tested in split plot design and replicated thrice. Seed rate of 25 kg ha^{-1} of Pant Mung-5 variety was used for sowing with a row spacing of 30 cm and 10 cm per plant to plant. Recommended dose of fertilizer was applied @ 20 kg N ha^{-1} and 40 kg P_2O_5 ha^{-1} to all the treatments. The full dose of nitrogen and phosphorous were given through DAP (18% N and 46% P_2O_5) and urea (46% N) as basal dose *i.e.* at the time of sowing and foliar potassium fertilizers were given as per treatments to each plot. During crop period, the irrigations were given based on climatological approach, at IW/CPE ratio of 0.6 and 0.4, as per treatments. The evaporation was recorded every day from USWB (United States Weather Bureau) Class A open pan evaporimeter installed at IIFSR, Modipuram. In totality five irrigations were scheduled to the treatment with 0.6 IW/CPE (on 6th April, 22nd April, 2nd May, 19th May and 28th May) and 3 irrigations were scheduled to the treatment with 0.4 IW/CPE ratio (on 16th April, 2nd May and 24th May). The data recorded during the course of investigation were subjected to statistical analysis as per method of analysis of variance.

Results and Discussion

Effect of irrigation regimes on growth, yield, nutrient uptake and potassium use efficiency of mungbean

Growth parameters: Growth parameters like plant height, plant spread and crop growth rate (g/plant/day) generally increased with increase in number of irrigations given during the crop growth period. Significantly taller plants (55.1 cm) and wider plant spread (33.2 cm) were recorded with the application of irrigation at 0.6 IW/CPE (I_1) as compared to 0.4 IW/CPE (I_2). This might be due to good establishment of roots, 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 [14] and Patel *et al.* [15] in mungbean. Significantly higher crop growth rate between 25 to 50 DAS (0.172 g/plant/day) was recorded under 0.6 IW/CPE ratio over 0.4 IW/CPE irrigation schedule. Between 50 DAS to harvest stage, the highest crop growth rate was recorded under 0.6 IW/CPE ratio irrigation schedule (0.122 g/plant/day), but did not differ significantly with 0.4 IW/CPE (0.120 g/plant/day). This was mainly due to the 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 and crop growth rate. These results are in line with the findings of Dabhi *et al.* [16], Yadav and Singh [14], Chaudhary *et al.* [17] and Mondal *et al.* [18] in mungbean.

Irrigation schedules did not show any significant variation in days taken to flowering. Although, mungbean took 41.5 to 44.2 days to attain the flowering, being highest under 0.6

IW/CPE ratio moisture regime. On the other hand, Irrigation scheduled at 0.6 IW/CPE ratio delayed the maturity (77.4 days) significantly as compared to 0.4 IW/CPE ratio (72.2 days) by 5 days. It was probably due to that sufficient moisture condition throughout the growth period leading to higher plant water status which might have delayed the physiological maturity and continued vegetative growth for longer period of time. Similar results were also found by Mekonnen [19] in haricot bean. Mondal *et al.* [20] observed that under adequate availability of water during mungbean growth period encouraged the vegetative growth that led to delay in maturity.

Table 1: Effect of irrigation schedules and foliar potassium management on growth parameters and number of days taken to flowering and maturity of mungbean

Treatments	Plant height (cm)	Plant spread (cm)	CGR (g/plant/day)		Number of days taken to	
			25 to 50 DAS	50 DAS to Harvest	Flowering	Maturity
A. Irrigation schedules (IW/CPE)						
I_1-0.6 IW/CPE ratio	55.1	33.2	0.172	0.122	44.2	77.4
I_2-0.4 IW/CPE ratio	47.7	27.4	0.146	0.120	41.5	72.2
S.Em. (±)	0.7	0.7	0.004	0.002	0.4	0.7
C.D. (P=0.05)	4.7	4.5	0.028	NS	NS	4.7
B. Foliar potassium management						
T_1-water spray	44.4	26.1	0.127	0.103	41.8	71.7
T_2-1%K by KCl at flowering	50.4	29.4	0.157	0.104	42.7	73.3
T_3-1%K by KNO_3 at flowering	51.6	30.2	0.169	0.106	43.8	73.8
T_4-1%K by ($KCl+KNO_3$) at flowering	52.0	31.4	0.179	0.112	42.3	75.2
T_5-1%K by KCl at flowering and pod development	53.9	32.1	0.161	0.150	43.3	77.2
T_6-1%K by KNO_3 at flowering and pod development	56.0	32.7	0.163	0.152	43.0	78.0
S.Em. (±)	1.3	0.9	0.007	0.004	1.1	2.3
C.D. (P=0.05)	4.0	2.6	0.021	0.013	NS	NS

Yield: Irrigation scheduled at 0.6 IW/CPE ratio (I_1) recorded significantly higher grain yield (1100 kg ha^{-1}), straw yield (2381 kg ha^{-1}), biological yield (3489 kg ha^{-1}) and harvest index (31.5%) over 0.4 IW/CPE ratio (I_2) (Table-2). This might be due to adequate water supply under 0.6 IW/CPE ratio (I_1) which resulted in increasing uptake of water and nutrients, which helped in keeping larger photosynthetic green surface and provided the longer reproductive phase which in turn improved storage and translocation capacity to attain higher allocation of drymatter in grains. This led to the increase in yield attributing characters and finally the yield. Similar observations were also made by Yadav and Singh [14] and Patel *et al.* [15] in mungbean and Deewan *et al.* [21] in clusterbean.

Table 2: Effect of irrigation schedules and foliar potassium management on yields (grain, straw and biological) and harvest index of mungbean

Treatment	Yields (kg/ha)			Harvest Index (%)
	Grain	Straw	Biological	
A. Irrigation schedules (IW/CPE)				
I_1-0.6	1100	2381	3489	31.5
I_2-0.4	878	2183	3061	28.7
S.Em. (±)	19	26	35	0.1
C.D. (P=0.05)	122	169	227	0.8
B. Foliar potassium management				
T_1-water spray	805	1917	2744	29.2
T_2-1%K by KCl at flowering	932	2209	3141	29.6
T_3-1%K by KNO_3 at flowering	957	2246	3203	29.8
T_4-1%K by ($KCl+KNO_3$) at flowering	990	2299	3290	30.0
T_5-1%K by KCl at flowering and pod development	1098	2478	3577	30.6
T_6-1%K by KNO_3 at flowering and pod development	1152	2544	3696	31.1
S.Em. (±)	35	51	50	0.7
C.D. (P=0.05)	103	153	150	NS

Nutrient uptake: The data showed that irrigation schedules had a significant effect on nitrogen, phosphorus and potassium uptake (grains, straw and total) by mungbean. Irrigation scheduled at 0.6 IW/CPE ratio (I_1) recorded the highest nitrogen uptake (43.2, 17.7 and 60.9 kg/ha), highest phosphorous uptake (3.3, 5.0 and 8.3 kg/ha) and potassium uptake (5.8, 29.9 and 35.8 kg/ha) by grains, straw as well as total, respectively which were significantly superior over 0.4 IW/CPE ratio irrigation schedule (Table-3). The increment in nitrogen, phosphorus and potassium uptake by grains in I_1 over I_2 was 32.9, 50.0 and 34.8 per cent, respectively. This increase was 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 [22] in mungbean and Lakshmi *et al.* [23] in urdbean. Mandal *et al.* [24] also found that N, P and K uptake was higher with three irrigations (at branching, pre-flowering and pod development stages) than only two irrigations in mungbean crop.

Quality aspects: The results indicated that significantly higher protein content (24.5%) was noted under 0.6 IW/CPE ratio (I_1) over 0.4 (I_2) where the lowest protein content was recorded (23.1%) (Table-4). The higher protein content in grains was mainly due to the adequate moisture content in soil has led to the higher nutrient uptake and higher N content in grains which resulted in higher protein content, besides grain yield under 0.6 IW/CPE ratio irrigation schedule led to higher protein yield. Our results are in close conformity with the findings of Borse *et al.* [25] in mungbean and Singh *et al.* [26] in french bean.

Potassium use efficiency: Partial factor productivity (PFP) showed significant difference in Potassium Use Efficiency (PUE). Irrigation scheduling at 0.6 IW/CPE ratio recorded significantly higher partial factor productivity (638.7 kg grain yield/kg of potassium applied) than 0.4 IW/CPE ratio (513.8 kg grain yield/kg of potassium applied) over 0.4 IW/CPE ratio. Similarly, the highest Physiological efficiency was recorded with the 0.6 IW/CPE ratio irrigation schedule, while Agronomic and Recovery efficiency was maximum at 0.4 IW/CPE ratio but didn't differ significantly.

Effect of foliar potassium nutrition on growth, yield, nutrient uptake and potassium use efficiency of mungbean

Growth parameter: Significantly higher values of growth parameters like plant height (56.0 cm) and plant spread (32.7 cm) were recorded under foliar applied 1% K through KNO_3 at flowering and pod development stage (T_6) and remained on par with 1% K spray through KCl at flowering and pod development stage (T_5) and the lowest was recorded under control treatment (T_1) (Table-1). This might be due to the involvement of potassium in 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, plant spread and higher dry matter accumulation. These results are in close conformity with those of Govind and Thirumurugan [27] in mungbean, Goud *et al.* [28] in chickpea and Sanjay [29] in mungbean. Significantly higher crop growth rate (0.163 and 0.152 g/plant/day between 25 to 50 DAS and 50 DAS to Harvest, respectively) was recorded under foliar applied 1% K through KNO_3 at flowering and pod development stage (T_6) and remained on par with 1% K spray through KCl at flowering and pod development stage (T_5) and the lowest was recorded under control treatment (T_1). The increase in crop growth rate might be due to the fact that potassium nitrate provides potassium as well as nitrogen, both influences the crop growth through its 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 the more biomass production/plant. Our results are in close conformity with the findings of Chandrasekar and Bangarusamy [30] in mungbean, Vekaria *et al.* [31] in mungbean, Sanjay [29] in mungbean and Lakshmi *et al.* [23] in urdbean.

The foliar application of potassium did not brought any significant variation in number of days taken to flowering and maturity, though the increase in the number of potassium sprays delayed the days taken to flowering and maturity in mungbean as compared to control. However, the minimum (71.7) and maximum (78.0) days were taken to attain maturity with control and 1%K through KNO_3 sprayed at flowering and pod development stage, respectively.

Table 3: Effect of irrigation schedules and foliar potassium management on nitrogen, phosphorus and potassium uptake (kg/ha) of mungbean

Treatment	N uptake (Kg/ha)			P uptake (Kg/ha)			K uptake (Kg/ha)		
	Grains	Straw	Total	Grains	Straw	Total	Grains	Straw	Total
A. Irrigation schedules (IW/CPE)									
I_1-0.6	43.2	17.7	60.9	3.3	5.0	8.3	5.8	29.9	35.8
I_2-0.4	32.5	12.5	44.9	2.2	4.1	6.3	4.3	25.5	29.8
S.Em. (±)	0.5	0.5	1.1	0.1	0.1	0.2	0.2	0.5	0.5
C.D. (P=0.05)	3.6	3.1	6.6	0.6	0.2	0.9	1.3	3.2	3.3
B. Foliar potassium management									
T_1-water spray	29.8	10.1	39.8	2.1	3.6	5.6	3.8	22.1	25.9
T_2-1%K by KCl at flowering	35.2	14.0	49.2	2.5	4.3	6.8	4.6	26.6	31.2
T_3-1%K by KNO_3 at flowering	36.4	14.2	50.6	2.6	4.4	7.0	4.8	27.3	32.1
T_4-1%K by (KCl+KNO_3) at flowering	37.8	15.2	53.0	2.7	4.6	7.3	5.0	28.0	33.1
T_5-1%K by KCl at flowering and pod development	42.6	17.9	60.5	3.2	5.1	8.3	5.8	30.7	36.5
T_6-1%K by KNO_3 at flowering and pod development	45.3	19.0	64.3	3.5	5.3	8.8	6.2	31.6	37.9
S.Em. (±)	1.5	1.2	2.1	0.1	0.2	0.2	0.3	0.6	0.7
C.D. (P=0.05)	4.6	3.6	6.3	0.4	0.6	0.6	0.8	1.8	2.2

Yield: The higher values of grain yield (1152 kg ha^{-1}), straw yield (2544 kg ha^{-1}), biological yield (3696 kg ha^{-1}) and harvest index (31.1%) were recorded with the foliar application of 1% K through KNO_3 at flowering and pod development stage (T_6) followed by 1% K by KCl sprayed at flowering and pod development stage (T_5) than the control (T_1) (Table-2). This increase might be due to the increase in sink size and increase in the fruit setting, diversion of energy towards sink followed by efficient transfer of metabolites and subsequent accumulation of these metabolites in the grains, which results in increase in yield attributes finally resulted into higher grain and straw yields. These results are in close proximity with the findings of Govindan and Thirumurugan [27] in mungbean, Beg *et al.* [13] in black gram and Lakshmi *et al.* [23] in urdbean.

Nutrient uptake: Significantly highest nitrogen uptake (45.3, 19.0 and 64.3 kg/ha), phosphorous uptake (3.5, 5.3 and 8.8 kg/ha) and potassium uptake (6.2, 31.6 and 37.9 kg/ha) by grains, straw and total, respectively were recorded with the foliar application of 1%K as KNO_3 (one at flowering and another at pod development stage) over rest of the treatments (Table-3). However, it remained *on par* with 1%K as KCl spray (one at flowering and another at pod development). The increase in nitrogen phosphorus and potassium uptake by grains under treatment with 1%K by KNO_3 spray at flowering and pod development stage (T_6) over 1%K spray through KNO_3 only at flowering (T_3) was 24.4, 34.6 and 29.2%, respectively. This increase might be due to favorable influence of potassium on plant metabolism, 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 which might have led to the higher nutrient content in 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.* [28] in chick pea. Kurhade *et al.* [33] also reported that N, P and K content in grains, straw and their uptake were higher with the foliar application of 1.5% KCl at flowering and 15 days after first spray along with RDF than control.

Quality aspects: Foliar potassium application also had positive effect on protein content of mungbean. The maximum protein content (24.5%) in mungbean grains was recorded with the foliar application of 1%K through KNO_3 spray at flowering and pod development stage (T_6) and minimum protein content was recorded under control (Table-4). Though, the difference between control and other potassium sprays was found to be non-significant. This might be due to the favorable influence of potassium on plant metabolism and its stimulating effects on photosynthetic pigments and enzyme activity. As potash has synergistic effect on nitrogen uptake, facilitates protein synthesis and activates different enzymes which in turn increases yield of plants and consequently protein content. The higher nitrogen content resulted in higher protein content and higher grain yield resulted into higher protein yield. Our results are in close proximity with Thalooth *et al.* [12] in mungbean, Goud *et al.* [28] in chick pea and Rao *et al.* [34] in mungbean. Kurhade *et al.* [33] recorded that protein content in grains and protein yield/ha were higher with the foliar application of 1.5% KCl at flowering and 15 days after first spray along with RDF than control.

Potassium use efficiency: Significantly highest partial factor productivity was recorded with the foliar application of 1%K through KCl at flowering followed by application of 1%K as (KCl+KNO_3) spray at flowering (931.7 and 853.0 kg grain yield/kg of potassium applied, respectively) over control (Table-4). Foliar application of 1% KNO_3/KCl (once/twice) significantly increased the potassium use efficiency (Agronomic, Recovery and Physiological efficiency etc.) as compared to control. Goud *et al.* [28] reported that higher agronomic efficiency and apparent recovery in chick pea was recorded with the application of 30 kg K_2O/ha than lower/higher doses.

Table 4: Influence of irrigation schedules and foliar potassium management on quality parameter (protein content (%) and protein yield (kg/ha)) potassium use efficiency (partial factor productivity, agronomic, recovery and physiological efficiency) in mungbean

Treatment	Quality parameter		Potassium use efficiency			
	Protein content (%)	Protein yield (kg/ha)	PFP	AE	RE	PE
A. Irrigation schedules (IW/CPE)						
I_1-0.6	24.5	270.1	23.0 (638.7)	9.0 (106.0)	17.3 (369.3)	4.6 (25.3)
I_2-0.4	23.1	203.0	20.7 (513.8)	10.0 (117.6)	20.2 (487.4)	4.4 (21.3)
S.Em. (±)	0.2	3.4	0.2	1.5	1.5	0.3
C.D. (P=0.05)	1.4	22.3	1.3	NS	NS	NS
B. Foliar potassium management						
T_1-water spray	23.0	186.1	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)
T_2-1%K by KCl at flowering	23.5	220.0	30.5 (931.7)	10.9 (126.7)	22.2 (530.3)	5.2 (27.0)
T_3-1%K by KNO_3 at flowering	23.7	227.7	26.4 (701.2)	10.3 (111.2)	20.9 (454.8)	5.1 (26.1)
T_4-1%K by (KCl+KNO_3) at flowering	23.8	236.2	29.2 (853.0)	11.6 (159.4)	24.5 (616.3)	5.0 (29.0)
T_5-1%K by KCl at flowering and pod development	24.2	266.3	23.4 (549.2)	12.1 (146.7)	22.9 (530.3)	5.4 (29.1)
T_6-1%K by KNO_3 at flowering and pod development	24.5	283.1	20.5 (422.3)	11.1 (127.1)	20.9 (438.2)	5.4 (28.5)
S.Em. (±)	0.3	9.7	0.4	1.2	1.5	0.6
C.D. (P=0.05)	NS	28.8	1.2	3.5	4.3	1.8

Original values are in parenthesis and transformed values are as $\sqrt{(x+1)}$.
(PFP: Partial factor productivity; AE: Agronomic efficiency; RE: Recovery efficiency; PE: Physiological efficiency)

Conclusion
From the results, it may be concluded that foliar application of 1%K through KNO_3/KCl at flowering and pod development stages under 0.6 IW/CPE ratio irrigation schedule gave best results in terms of growth parameters and yield, besides proved to be beneficial for *summer* mungbean in terms of NPK uptake, protein content and nutrient use efficiency.

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