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INFLUENCE OF POTASSIUM ON GROWTH, YIELD AND NUTRIENT UPTAKE ON BLACK GRAM (VBN-3)

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Abstract

A field experiment was conducted at farmer's field in Sivapuri village, Chidambaram taluk, Cuddalore district, Tamilnadu, to study the effect of different levels of potassium on growth, yield, available nutrient and uptake in black gram. The treatments were T_1 - Absolute control, T_2 - Control (K), T_3 - 12.5 kg of K_2O ha^{-1}, T_4 - 25 kg of K_2O ha^{-1}, T_5 -37.5 kg of K_2O ha^{-1}, T_6 - 50 kg of K_2O ha^{-1}, T_7 - 62.5 kg of K_2O ha^{-1}, T_8 - 75 kg of K_2O ha^{-1}. The results of the experiment indicated that application of T_6 - 50 kg ha^{-1} of K_2O significantly increased the growth characters, nutrient uptake, yield and yield attributes of black gram.

Key Words: Blackgram, Yield attributes, Nutrient uptake, K_2O.

Introduction

Black gram (*Vigna mungo* L. Hepper), commonly called as urdbean, is an ancient and well-known leguminous crop. It occupies about 3.25 million ha area in the country producing 1.5 million tons of seed with average productivity of 462 kg/ha (AICRP, 2013). Kota district of Rajasthan occupies 13441 ha area with average productivity of 800 kg/ha of urd which is slightly higher against the Rajasthan average productivity of 516 kg/ha (GOR, 2012) .In Tamil Nadu, it is cultivated in 4.56 lakh hectares of area with a production of 2.36 lakh tonnes and the average productivity is 518 kg ha^{-1}. The average productivity of pulses in Tamilnadu is very low when compared to India's average of 610 kg ha^{-1}. Production of black gram is low in general due to poor management and low soil fertility status. Madhya Pradesh, Maharashtra, Uttar Pradesh, Tamil Nadu, Orissa and Gujarat are the main black gram growing states of India. Black gram is highly priced pulse, rich in phosphoric acid. The productivity potential of pulses is not realized and the reasons for low productivity of black gram are large scale cultivation under rainfed and marginal lands and may be under low input conditions (Anon, 2015). The productivity of pulse crops including black gram is not sufficient enough to meet the domestic demand of the population. Hence, there is need for enhancement of the productivity of black gram by proper practices. Among all the yield limiting factors, fertility management is imperative to ensure better crop production on exhausted soils as nutrients play a vital role in increasing the seed yield in pulses (Chandrasekhar and Bangarusamy, 2003). The productivity potential of pulses is not realized and the reasons for low productivity of black gram are large scale cultivation under rainfed and marginal lands and may be under low input conditions (Rathore, 2002). Among all the yield limiting factors, fertility management is imperative to ensure better crop production on exhausted soils as nutrients play a vital role in increasing the seed yield in pulses (Chandrasekhar and Bangarusamy, 2003). Potassium application has been neglected in many developing countries, including India, which has resulted in soil K depletion in agricultural ecosystems and a decline in crop yields (Regmi *et al*., 2002; Panaullah *et al*., 2006). Higher yields and crop quality can be obtained at optimal N:K nutritional ratios. Potassium is an essential macronutrient required for proper development of plants.

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Materials and Methods

Field experiment was conducted in the farmer's field at Sivapuri village near Chidambaram, Cuddalore district, Tamil Nadu. The experimental farm is geographically

situated at 12°38' North latitude and 80°70' East longitude and at an altitude of ±5.79 m above mean sea level and 6 km away from Bay of Bengal. It is characterized by tropical climate with a mean annual rainfall of 1500 mm distributed over 57 rainy days. Out of these, 22.97 percent (344.55 mm) is received during South-West monsoon (June-September), 69.13 percent (1036.95 mm) during North-East monsoon (October-December), 3.9 percent (58.50 mm) during winter season (January- February) and the remaining 4 percent (60.00 mm) during summer months (March-April). The maximum temperature ranges from 30.1°C to 39.2°C with a mean of 34.2°C, the minimum temperature ranges from 18.9°C to 28.6°C with a mean of 24.2°C and relative humidity ranges from 79 to 90 percent. The experimental design adopted in the study was randomized block design with three replications and eight treatments. The treatments were T_1 - Absolute control, T_2 - Control (-K), T_3 - 12.5 kg of K_2O ha^{-1}, T_4 - 25 kg of K_2O ha^{-1}, T_5 - 37.5 kg of K_2O ha^{-1}, T_6 - 50 kg of K_2O ha^{-1}, T_7 - 62.5 kg of K_2O ha^{-1}, T_8 - 75 kg of K_2O ha^{-1}. The soils of Sivapuri village was found to contain soil separates of 29.2, 39.4, 30.5 percent sand, silt and clay respectively. The soils are classified under the textural class clay loam. The bulk density, particle density, pH, electrical conductivity and cation exchange capacity of the soil were 1.38 Mg m^{-3}, 2.50 Mg m^{-3}, 7.50 dsm^{-1}, 0.81 dsm^{-1} and 21.8 c mol (p^+) kg^{-1} respectively. Organic carbon content of the soil was 3.5 g kg^{-1}. Available N, P and K content of the soil were 187.0, 9.8 and 118 kg ha^{-1} respectively, available sulphur content was 4.8 mg kg^{-1} and the exchangeable calcium, magnesium, potassium and sodium contents were 7.6, 8.2, 3.8 and 0.9 c mol (p^+) kg^{-1} respectively. The data recorded pertaining to growth, grain yield, nutrient uptake and quality parameters were analyzed statistically for interpreting the results. In order to know the nutrient status of the experimental site, the soil samples to the depth of 0-30 cm were randomly collected from the experimental site before sowing and after harvesting of crop.

Table 1: Effect of graded levels of potassium on growth parameters in black gram.

Treatments	Growth attributes		
	Plant height (cm)	No.of branches $plant^{-1}$	Leaf area index
T_1 - Absolute Control	20.2	6.76	1.96
T_2 - control (- K)	24.5	7.97	2.23
T_3 - 12.5 kg of K_2O ha^{-1}	28.8	9.93	2.37
T_4 - 25 kg of K_2O ha^{-1}	32.5	10.8	2.46
T_5 - 37.5 kg of K_2O ha^{-1}	34.8	13.0	2.58
T_6 - 50 kg of K_2O ha^{-1}	38.1	15.9	2.78
T_7 - 62.5 kg of K_2O ha^{-1}	36.9	14.5	2.75
T_8 - 75 kg of K_2O ha^{-1}	35.0	13.9	2.69
SE	0.48	0.63	0.01
CD (0.05)	1.16	1.38	0.02

Results and Discussion

K plays an important role in the maintenance of electrical potential gradients across cell membranes and the generation of turgor. It is also essential for photosynthesis, protein synthesis and regulation of stomatal movement and it is the major cation in maintenance of cation-anion balances (Marschner, 1995). The results obtained from the present investigation as well as relevant discussion have been summarized.

Growth parameters table 1

Plant height (cm)

The treatments T_1 recorded the lowest plant height of 22.1 cm and the treatment T_6 recorded the highest plant height of 38.1 cm. However, the treatment T_5 which recorded 34.8 cm was on par with treatment T_8 (35.0 cm). The other treatments T_3, T_4, T_7 recorded plant height of 28.8, 32.5 and 35.0 cm which were found to be statistically significant. The treatment T_2 recorded a plant height of 24.5 cm at harvest. Potassium plays a crucial role in meristematic growth through its effect on the synthesis of phyto hormones. Among various plant hormones, cytokinin plays an important role in growth of plant Thakur *et al.*, (2017).

Number of branches $plant^{-1}$

The treatments T_1 recorded the lowest number of branches $plant^{-1}$ of 6.76 and the treatment T_6 recorded the highest number of branches of $plant^{-1}$ 15.9. However, the treatment T_5 which recorded 13.0 was on par with treatment T_8 (13.9). The other treatments T_3, T_4 and T_7 recorded number of branches $plant^{-1}$ of 9.93, 10.8 and 14.5 which were found to be statistically significant. The treatment T_2 recorded a number of branches $plant^{-1}$ of 7.97 at harvest. The results of this experiment were in accordance with these Teggelli *et al.*, (2016), who noticed with the application of K, the plants grew vigorously to produce more branches $plant^{-1}$.

Leaf area index

The treatments T_1 recorded the lowest leaf area index of 1.96 and the treatment T_6 recorded the highest leaf area index of 2.78. However, the treatment T_5 which recorded 2.58 was on par with treatment T_8 (2.69). The other treatments T_3, T_4 and T_7 recorded leaf area index of 2.37, 2.46 and 2.75 which were found to be statiscally significant. The treatment T_2 recorded a leaf area index of 2.23. This might be due to optimum supply of nutrients

which increased the plant growth, leaf number, leaf length and breadth. Similar results were also observed by Geetha and Velayutham (2009) and Nazir Hussain *et al.,* (2011).

YIELD table 2

Grain and haulm yield (kg ha^{-1})

The treatments T_1 recorded the lowest grain yield and haulm yield of 655 and 805 kg ha^{-1}. Treatment T_6 recorded the highest grain yield and haulm yield of 1083 and 1489 kg ha^{-1}. However, the treatment T_5 which recorded (1034 and 1397 kg ha^{-1}) was on par with treatment T_8 (1048 and 1400 kg ha^{-1}). The other treatments T_3, T_4 and T_7 recorded grain and haulm yields of 948, 987, 1064 kg ha^{-1} and 1180, 1276, 1418 kg ha^{-1} which were found to be statistically significant. The treatment T_2 recorded a grain yield and haulm yield of 913 and 1100 kg ha^{-1}. It was clearly observed that yield increased with the optimum dose of potassium (50 kg ha^{-1}). Similar results were reported by Chaudhry and Mahmood (1999). Leaf area index and higher photosynthetic rate as a perfect and prolonged nutrient management which might have contributed to higher haulm yield as reported by Singh *et al.,* (2007) and Suriyalashmi (2013).

Table 2: Effect of graded levels of potassium on grain and haulm yield of black gram.

Treatments	Yield	
	Grain yield (kg ha^{-1})	Haulm yield (kg ha^{-1})
T_1 - Absolute Control	655	805
T_2 - control (- K)	913	1100
T_3 - 12.5 kg of K_2O ha^{-1}	948	1180
T_4 - 25 kg of K_2O ha^{-1}	987	1276
T_5 - 37.5 kg of K_2O ha^{-1}	1034	1397
T_6 - 50 kg of K_2O ha^{-1}	1083	1489
T_7 - 62.5 kg of K_2O ha^{-1}	1064	1418
T_8 - 75 kg of K_2O ha^{-1}	1048	1400
SE	9.4	33.5
CD (0.05)	18.6	69.0

Table 3: Effect of graded levels of potassium on grain and haulm yield of black gram.

Treatments	Nutrient uptake					
	Grain (kg ha^{-1})			Haulm (kg ha^{-1})		
	N	P	K	N	P	K
T_1 - Absolute Control	17.0	1.83	6.91	10.8	1.23	11.6
T_2 - control (- K)	28.7	2.99	12.3	18.1	2.56	18.6
T_3 - 12.5 kg of K_2O ha^{-1}	33.8	3.14	15.9	22.5	3.05	22.1
T_4 - 25 kg of K_2O ha^{-1}	36.4	5.38	18.8	25.0	4.76	25.1
T_5 - 37.5 kg of K_2O ha^{-1}	39.9	6.49	19.9	28.0	6.08	27.0
T_6 - 50 kg of K_2O ha^{-1}	43.4	9.06	22.1	31.1	8.21	31.0
T_7 - 62.5 kg of K_2O ha^{-1}	41.9	8.01	20.0	29.6	7.20	29.9
T_8 - 75 kg of K_2O ha^{-1}	40.5	7.61	19.9	28.8	6.80	27.6
SE	0.69	0.49	1.02	0.64	0.48	0.50
CD (0.05)	1.41	1.03	2.04	1.50	1.00	1.03

Nurient uptake table 3

N, P, K uptake by grain (kg ha^{-1})

The treatment T_1 recorded the lowest nitrogen, phosphorus and potassium uptake by grain of 17.0, 1.8 and 6.9 kg ha^{-1} respectively and the treatment T_6 recorded the highest and nitrogen, phosphorus and potassium uptake by grain (43.4, 9.0 and 22.1 kg ha^{-1}). However, the treatment T_5 recorded 33.9, 6.4 and 19.9 kg ha^{-1} respectively which were on par with treatment T_8 (40.0, 7.6, 19.9 kg ha^{-1}). The other treatments, T_3, T_4 and T_7 recorded nitrogen, phosphorus and potassium uptake by grain 33.8, 3.1, 15.9 kg ha^{-1}, 36.4, 5.3, 18.8 kg ha^{-1} and 41.9, 8.0, 20.0 kg ha^{-1} respectively which were found to be statistically significant. The treatment T_2 recorded nitrogen, phosphorus and potassium uptake of 28.7, 2.9, 12.3 kg ha^{-1} by grain at harvest. In addition, mineralization of immobilized nutrients by legumes increased their availability to residual crops and increased nutrients uptake by crop. Similar results were documented by Patil *et al.,* (2010) and Suriyalashmi, (2013).

N, P, K uptake by haulm (kg ha^{-1})

The treatment T_1 recorded the lowest nitrogen, phosphorus and potassium uptake of 10.8, 1.2 and 11.6 kg ha^{-1} by haulm and the treatment T_6 recorded the highest nitrogen, phosphorus and potassium uptake of 31.9, 8.2 and 31.0 kg ha^{-1} by haulm. However, the treatment T_5 which recorded nitrogen, phosphorus and potassium uptake of 28.0, 6.0 and 27.0 kg ha^{-1} by haulm which was on par with treatment T_8 (28.8,6.8,27.6 kg ha^{-1}) respectively. The other treatments, T_3, T_4 and T_7 recorded nitrogen, phosphorus and potassium uptake of 22.5, 3.0, 22.1 kg ha^{-1}, 25.0, 4.7, 25.1 kg ha^{-1} and 29.6, 7.2, 29.9 kg ha^{-1} by haulm respectively which were found to be statistically significant. The treatment T_2 recorded nitrogen, phosphorus and potassium uptake of 18.1, 2.5 and 18.6 kg ha^{-1} respectively by haulm at harvest. This increase in uptake by black gram haulm may be ascribed to higher grain and haulm production due to K addition (Brar *et al.* 2004; Dinesh Pratap Singh, 2017; Singh *et al.,* 2016).

Conclusion

It can be concluded that significantly highest yield and uptake of NPK was deliberated with treatment of fertilizer consisting recommended dose of fertilizer with 50 kg ha^{-1} of potassium application. Application of potassium in the form of muriate of potash significantly

increased the growth components *viz.*, plant height, number of branches plant^{-1}, leaf area index of crop growth.

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