International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(11): 1016-1019
www.biochemjournal.com
Received: 25-08-2024
Accepted: 30-09-2024

SB Patil
M.Sc. Student, Department of Agricultural Botany, College of Agriculture, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, India

JH Wagh
Assistant Professor, College of Horticulture Mulde, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, India.

AV Mane
Deputy Director of Research (Seed), Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, India

UB Pethe
Associate Professor (CAS), Department of Agricultural Botany, College of Agriculture, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, India

RV Dhopavkar
Deputy Director of Research (Agri), Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, India

RL Kunkerkar
Head, Department of Agricultural Botany, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, India

VV Jadhav
M.Sc. Student, Department of Agricultural Entomology, College of Agriculture, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, India

KM Lonare
M.Sc. Student, Department of Agricultural Botany, College of Agriculture, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, India

Corresponding Author:
SB Patil
M.Sc. Student, Department of Agricultural Botany, College of Agriculture, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, India

Effect of different levels of potassium fertilizer on yield of cowpea (*Vigna unguiculata* (L.) Walp) variety Konkan Safed under water stress condition

SB Patil, JH Wagh, AV Mane, UB Pethe, RV Dhopavkar, RL Kunkerkar, VV Jadhav and KM Lonare

DOI: https://doi.org/10.33545/26174693.2024.v8.i11m.3017

Abstract
The field experiment was conducted during *rabi* season 2023-24 at Research and Education farm, Department of Agricultural Botany, College of Agriculture, Dapoli to study effect of different levels of potassium on yield of the cowpea *(Vigna unguiculata* (L.) Walp) variety Konkan Safed under water stress condition. The field experiment was laid out in split plot design with sixteen treatment combinations replicated thrice. The experiment consisted of four main plot treatments: T_1- Absolute control (Regular irrigation), T_2- Stress during vegetative phase, T_3- Stress during reproductive phase, T_4- entire stress treatment, along with four sub plot treatments of different levels of potassium: K_1- 0 kg K/ha, K_2- 20 Kg K/ha, K_3- 40 kg K/ha, K_4- 60 Kg K/ha. The result revealed that, the yield attributing characters *viz.*, No. of pods per plant, number of seeds per pod, seed yield per plant, 100 seed weight and harvest index of cowpea is highest in treatment T_1 followed by T_3 water stress treatment and when we consider potassium treatments, the treatment K_4 recorded highest yield attributing characters as compared to the rest of the potassium treatments. Among all the interactions T_1 K_4 recorded better performance in yield contributing characters under regular irrigation and potassium treatment combination. However under water stress conditions, the interaction T_3 K_4 found significantly superior over the rest of the water stress interactions with potassium.

Keywords: Treatment, potassium, cowpea, treatment combination, water stress, yield

Introduction

Cowpea (*Vigna unguiculata* (L.) Walp) is one of the most popular legume and diploid member of the Fabaceae family with a chromosome number 2n=22. Cowpea is regarded as a low energy, high nutrient food. On a dry basis, a cowpea grain typically has 23-32% protein, 50-60% carbohydrates and 1% fat (Jayathilake *et al*., 2018) [10]. Cowpea (*Vigna unguiculata* L.) is a diploid, annual legume known for its high protein content. This resilient crop can withstand heat and drought, making it a valuable component in various agricultural systems worldwide.

Drought is a widespread climatic condition defined by a significant and sustained reduction in precipitation below long-term averages. Under drought conditions, plants may experience reduced growth and development due to factors such as impaired cell division, elongation, and differentiation. This is caused by a loss of turgor pressure, decreased enzyme activity, and diminished energy production from photosynthesis (Ding *et al*., 2013) [6].

Potassium is crucial for various physiological functions, including photosynthesis, the movement of photosynthates to different parts of the plant, maintaining cell turgor, and activating enzymes. There is evidence that plants suffering from environmental stresses like drought have a larger internal requirement for K. The reason for the enhanced need for K by plants suffering from environmental stresses appears to be related to the fact that K is required for maintenance of photosynthetic CO_2 fixation (Cakmak, 2005) [4]. Enhancing plant's K nutritional status appears to be crucial for maintaining high yields in water deficit conditions (Bahrami and Hajiboland, 2017) [3]. It has been shown by Parab (1991) [11], Deokate (1992) [5] and Jadhav (1993) [9] that applying potassium prior to the crop experiencing moisture stress can successfully alleviate the effect of moisture stress in cowpea and lablab beans.

Materials and Methods
The research was carried out at Research and Education farm, Department of Agricultural Botany, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli (MH) during *rabi* season of 2023-24. The research experiment was laid out in split plot design with three replications. Four different stress treatments were assigned to the main plots *viz.,* 1) Absolute Control condition/ Regular irrigation (T_1) maintained by regularly irrigating the crop at 8- 9 days interval. 2) Stress during vegetative phase (T_2) - In this treatment irrigation was withheld after germination upto 40 DAS and thereafter crop was irrigated at 8-9 days interval 3) Stress during reproductive phase (T_3) – In this treatment irrigation was given at 8-9 days interval upto 40 days after sowing thereafter crop was not irrigated. 4) In entire stress treatment (T_4), no water was given to the crop after germination. Four potassium levels *viz.,* K_1- 0, K_2- 20, K_3-40, K_4-60 kg/ha were allocated to the sub plot treatments.

Observations recorded
Following observations were taken during the course of experimentation.

1. Number of pods per plant
Number of pods per plant was counted from pods harvested from five randomly selected plants from each treatment plot at the time of harvest. Later average was worked out to record the observations.

2. Number of seeds per pod
Five mature plant from each treatment were selected randomly. The pods of the plants were threshed separately and average number of seeds per plant was calculated.

3. Seed yield (g/plant)
All the pods of the individual selected plants from each treatment were harvested, threshed and dried. These seeds were separately weighed on weighing balance and then seed yield per plant was recorded in grams.

4. 100 seed weight (g)
The weight of randomly selected hundred seeds from each treatment plot was recorded in grams.

5. Harvest index (%)
It is the ratio of economic yield to the biological yield and is expressed in percentage. It represents the efficiency of photosynthesis translocation to economic parts of the plant. It was estimated by using the formula proposed by Donald (1962) [7].

$$\text{Harvest Index (\%)} = \frac{\text{Grain weight per plant}}{\text{Total dry weight per plant at harvest}} \times 100$$

Results and Discussion
The results pertaining in the present study is presented in table 1.

1. Number of pods per plant
In the study maximum number of pods were recorded from regular irrigation treatment T_1 (9.28), followed by water stress treatment T_3 (9.06) over rest of the all treatments. The number of pods per plant increased by increasing level of potassium and maximum number of pods per plant found in K_4 treatment (8.35) as compared to K_1 (5.93). Under regular irrigation and potassium treatment interactions, maximum number of pods recorded in T_1 K_4 (10.22) which was at par with T_1 K_3 (9.77) and T_3 K_4 (9.76). However interaction T_3 K_4 was found significantly superior over rest of water stress and potassium interactions. Despite the water stress, high potassium levels helped to mitigate some negative effects of limited water availability, leading to a relatively higher number of pods (9.76) compared to other stress treatments. The interaction T_4 K_1 (3.12) produced minimum number of pods per plant. The results are in line with earlier research made by Parab (1991) [11] in cowpea, Shinde (1998) [12] in five legumes crop, Deokete (1992) [5] in the lablab bean and Amanullah *et al.* (2022) [2] in mungbean.

2. Number of seeds per pod
It was found that number of seeds per pod varied significantly among all the treatments. Maximum number of seeds per pod produced by regular irrigation treatment T_1 (9.82), followed by T_3 (9.01) water stress treatment over the rest of water stress treatments. As potassium increased number of seeds per pod, maximum number of seeds per pod recorded in K_4 treatment (9.31) and minimum in K_1 (7.03) where there was no potassium treatment.

Among the interactions, T_1 K_4 (10.24) recorded maximum number of seeds per pod which was at par with T_3 K_4 (10.13) and T_1 K_3 (10.02). As high water stress and no potassium treatment conditions severely hinder seed development, resulting in the minimum productivity of the interaction T_4 K_1 (2.85). The results supported by Parab (1991) [11] in cowpea, Shinde (1998) [12] in five legumes crop, Jadhav (1993) [9] in cowpea and lablab bean and Amanullah *et al.* (2022) [2] in mungbean.

3. 100 seed weight (g)
The maximum 100 seed weight was recorded in regular irrigation treatment T_1 (13.21 g), followed by treatment T_3 (13.14 g) and minimum in T_4 (11.76 g) treatment. Potassium increased 100 seed weight which was found maximum in K_4 treatment (13.14 g) and minimum in control K_1 (11.74 g). The regular irrigation and potassium treatment interaction T_1 K_4 recorded maximum 100 seed weight (13.86 g) which was at par with T_1 K_3 (13.67 g) and T_3 K_4 (13.44 g) while interaction T_3 K_4 was found significantly superior over rest of water stress and potassium interactions. The minimum 100 seed weight observed in interaction T_4 K_1 (10.77 g). Similar findings made by Parab (1991) [11] in cowpea, Shinde (1998) [12] in five legumes crops and Jadhav (1993) [9] in cowpea and lablab bean.

4. Seed yield per plant (g)
Seed yield represents the net economic output derived from the balance between the plant's source capacity (the production of photosynthates) and sink capacity (the plant's ability to allocate resources to seed development). During the study it was observed that, seed yield per plant varied significantly between different irrigation treatments. The significantly higher seed yield per plant was obtained in regular irrigation treatment T_1 (11.64 g), followed by treatment T_3 (11.09 g) and the minimum seed yield per plant observed in T_4 (4.98 g) entire water stress treatment. The seed yield per plant increased by potassium application. The

K_4 potassium treatment recorded maximum seed yield per plant (10.34 g) whereas minimum in K_1 (7.27 g) treatment. Among interactions, T_1 K_4 (13.15 g) recorded maximum seed yield under regular irrigation and potassium treatment which was at par with T_3 K_4 (12.85 g) and T_1 K_3 (12.81 g) while interaction T_3 K_4 was found significantly superior over rest of water stress and potassium interactions. Despite water stress, high potassium levels improve the plant's ability to cope with stress and maintain seed production. Minimum seed yield recorded in the treatment combination T_4 K_1 (3.33 g). Results are in confirmation with the findings made by Parab (1991) [11] in cowpea, Shinde (1998) [12] in five legumes crops, Jadhav (1993) [9] in cowpea and lablab bean, Umar *et al*. (2006) [13] in groundnut, Fooladivanda *et al.* (2014) [8] in mungbean, Abd El–Mageed *et al*. (2016) [1] in soybean, Zoraghi *et al*. (2017) [14] in mungbean and Amanullah *et al*. (2022) [2] in mungbean.

Table 1: Influence of different treatments of water stress and potassium level on yield and yield attributing characters of cowpea var. Konkan Safed:

Treatments of water stress	Treatments of potassium					SE ±	CD at 5%
	K_1	**K_2**	**K_3**	**K_4**	**Mean**		
No. of pods/plant							
T_1	7.93	9.21	9.77	10.22	9.28	T.0.020	0.070
T_2	4.79	6.46	6.52	7.10	6.22	K.0.080	0.232
T_3	7.86	9.15	9.46	9.76	9.06	TXK 0.159	0.465
T_4	3.12	5.26	5.52	6.32	5.06		
Mean	5.93	7.52	7.82	8.35	7.40		
No. of seeds/pod							
T_1	9.64	9.38	10.02	10.24	9.82	T. 0.066	0.230
T_2	7.39	9.27	9.57	9.63	8.97	K. 0.070	0.205
T_3	8.25	8.64	9.02	10.13	9.01	T x K 0.141	0.411
T_4	2.85	6.53	7.78	7.24	6.10		
Mean	7.03	8.46	9.10	9.31	8.47		
100 seed weight (g)							
T_1	12.81	12.51	13.67	13.86	13.21	T. 0.083	0.287
T_2	10.86	11.85	12.71	12.87	12.07	K.0.073	0.212
T_3	12.53	13.21	13.39	13.44	13.14	T x K 0.146	0.425
T_4	10.77	11.79	12.10	12.37	11.76		
Mean	11.74	12.34	12.97	13.14	12.55		
Seed yield (g)							
T_1	9.87	10.71	12.81	13.15	11.64	T.0.071	0.246
T_2	6.89	7.39	7.81	8.81	7.72	K.0.076	0.222
T_3	9.01	10.67	11.82	12.85	11.09	T x K 0.152	0.444
T_4	3.33	4.27	5.78	6.53	4.98		
Mean	7.27	8.26	9.55	10.34	8.85		
Harvest index (%)							
T_1	40.75	43.68	45.07	45.48	43.75	T.0.065	0.225
T_2	29.38	36.68	38.56	40.76	36.34	K. 0.075	0.218
T_3	39.12	41.92	42.68	45.04	42.19	T x K 0.149	0.435
T_4	27.32	31.40	35.33	36.28	32.58		
Mean	34.14	38.42	40.41	41.89	38.72		

T- Treatment K- Potassium T x K- Treatment x Potassium

5. Harvest index (%)

Donald (1962) [7] defined harvest index as, 'the ratio of grain weight to the total dry weight of above ground parts of the crop. Harvest Index is a measure used in agriculture to evaluate the efficiency with which a plant converts its total biomass into the economically valuable crop parts. Under regular irrigation treatment T_1 recorded maximum harvest index (43.75%), followed by T_3 water stress treatment (42.19%) and minimum found in T_4 (32.58%). Potassium treatment K_4 (41.89%) recorded maximum harvest index while minimum recorded in K_1 (34.14%). Under regular irrigation and potassium treatment interactions, T_1 K_4 (45.48%) recorded maximum harvest index which was at par with T_1 K_3 (45.07%) and T_3 K_4 (45.04%) whereas T_3 K_4 (45.04%) was found significantly superior over rest of water stress and potassium interactions. The minimum harvest index recorded in T_4 K_1 (27.32%)) treatment combination. The similar findings recorded in cowpea by Parab (1991) [11], in five legume crops by Shinde (1998) [12], in mungbean by Zoraghi *et al*. (2017) [14].

Conclusion

The potassium application to crop before it subjected to water stress establishes a drought tolerance in the sensitive traits and can help the crop to combat with water stress with a significant extent. Among the stress treatment T_3 K_4 (Stress at reproductive stage and 60 kg/ha potassium treatment) was reported equivalent performance in context with yield *viz.*, number of pods per plant, number of seeds per pod, seed yield per plant, 100 seed weight and harvest index when compared with treatment T_1 K_4 (Regular irrigation with 60 kg/ha potassium treatment). T_1 treatment showed better performance followed by T_3. As stress during the vegetative phase is more detrimental than stress during the reproductive phase, treatment T_3 (stress during the reproductive stage) shows better performance than treatment T_2 (stress during vegetative phase) and T_4 (Entire stress) where plant subjected to stress after germination. The current study revealed that, with low water availability, irrigating the crop up to the reproductive stage with application of potassium (60 kg/ha) to the soil results in a sustainable crop yield.

References

1. Abd El-Mageed TA, El-Sherif AM, Ali MM, Abd El-Wahed MH. Combined effect of deficit irrigation and potassium fertilizer on physiological response, plant water status and yield of soybean in calcareous soil. Arch Agron Soil Sci. 2016;63(6):827-840.
2. Amanullah, Yar M, Khalid S, Elshikh MS, Akram HM, Imran, Ali A. Phenology, growth, productivity, and profitability of mungbean as affected by potassium and organic matter under water stress vs. no water stress conditions. J Plant Nutr. 2022;45(5):629-650.
3. Bahrami-Rad S, Hajiboland R. Effect of potassium application in drought-stressed tobacco (*Nicotiana rustica* L.) plants: Comparison of root with foliar application. Ann Agric Sci. 2017;62:121-130.
4. Cakmak I. The role of potassium in alleviating detrimental effects of abiotic stresses in plants. J Plant Nutr Soil Sci. 2005;168(4):521-530.
5. Deokate BG. Physiological studies on alleviation of drought by potassium in two genotypes of lablab bean (*Lablab purpureus* (L.) Sweet). M.Sc. (Agri.) thesis, Dr. B.S.K.K.V., Dapoli; 1992.
6. Ding Y, Tao Y, Zhu C. Emerging roles of microRNAs in the mediation of drought stress response in plants. J Exp Bot. 2013;64(11):3077-3086.
7. Donald CM. In search of yield. J Aust Inst Agric Sci. 1962;28:171-178.
8. Fooladivanda Z, Hassanzadehdelouei M, Zarifinia N. Effect of water stress and potassium on quantity traits of two varieties of mungbean (*Vigna radiata* L.). Cercet Agron Mold. 2014;47:107-114.
9. Jadhav SB. Alleviation of water stress by potassium in cowpea (*Vigna unguiculata* L. Sweet). M.Sc. (Agri.) thesis, Dr. B.S.K.K.V., Dapoli; 1993.
10. Jayathilake C, Visvanathan R, Deen A, Bangamuwage R, Jayawardana BC, Nammi S, *et al*. Cowpea: an overview on its nutritional facts and health benefits. J Sci Food Agric. 2018;98(13):4793-4806.
11. Parab BY. Effects of different levels of potassium nutrition on growth and yield of cowpea (*Vigna unguiculata* (L.) Walp) variety VCM-8 under the moisture stress at different phases of growth. M.Sc. (Agri.) thesis, Dr. B.S.K.K.V., Dapoli; 1991.
12. Shinde AK. Alleviation of water stress by potassium and growth regulators in five grain legumes. Ph.D. (Agri.) thesis, Dr. B.S.K.K.V., Dapoli; 1998.
13. Umar S. Alleviating adverse effects of water stress on yield of sorghum, mustard and groundnut by potassium application. Pak J Bot. 2006;38(5):1373-1380.
14. Zoraghi Z, Ganjali HR, Mobasser HR. Influence of water stress and potassium fertilizer on mungbean. Indian J Ecol. 2017;5(1):433-439.