Effect of Potassium and Gibberellic Acid on the growth and yield of Cowpea (*Vigna unguiculata* L.)

Abstract

The field experiment was conducted at experimental field of the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India. The soil of experimental field is Sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36%) available N (171.48 kg/ha), available P (27.0 kg/ha) and K (291.2 kg/ha). The Experiment was laid out in Randomized Block Design with nine treatments and one control plot replicated thrice on the basis of one year experimentation. To determine the Effect of Potassium and Gibberellic Acid on the growth and yield of Cowpea (*Vigna unguiculata* L.). The treatments consisted of three levels of Potassium – 20 kg/ha, 25 kg/ha and 30 kg/ha and three levels of Gibberellic acid spray – 100 ppm, 120 ppm and 150 ppm. The results showed that treatment with the application of Potassium – 30 kg/ha + GA_3 - 100 ppm was recorded significantly higher Plant height (68.8 cm), no. of nodules/plant (40.9), dry weight (39.32 g). Whereas, maximum Number of pods per plant (16.94), seeds per pod (13.46), seed index (18.36 g), higher seed yield (1459.70 kg/ha) and Haulm yield (2952.30 kg/ha).

Key words: *Potassium, Gibberellic acid, Cowpea, Growth and Yield.*

1. INTRODUCTION

"Cowpea [*Vigna unguiculata* (L.) Walp] is of immense importance, as it is a multipurpose grain legume extensively cultivated in arid and semi-arid tropics. The cowpea is used as grain, green pods and fodder. Cowpea is grown as a catch crop, weed smothering crop, intercrop, mixed crop and green manure crop. It has ability to fix atmospheric nitrogen in soil at the rate of 56 kg per hectare in association with symbiotic bacteria under favourable conditions" **(Yadav, 2007) and Umadevi, G.D. (2019)**. "Cowpea is the most versatile *kharif* legume because of its drought tolerant character, soil restoring properties and multipurpose use" **Patel Hirenkumar *et al.* (2011).**

"Potassium has a direct and indirect impact on the plant growth. Using potassium directly causes the reduced transpiration, increasing water absorption or creating internal conditions in order to endure the dryness. The indirect effects take place when using potassium has no value in the plant water relations but based on feeding grounds, it causes the growth increasing. Therefore, the amount that is needed for producing each dry material is being reduced. Studies show that potassium ion gathering in plants before the stresses likes water shortage, coldness, and salinity is insurance for plant survival" **Mansouri and Shokoohfar (2015).**

"Plant growth regulators may be defined as any organic compounds, which are active at low concentrations in promoting, inhibiting or modifying growth and development. The naturally occurring (endogenous) growth substances are commonly known as plant hormones, while the synthetic ones are called growth regulator Range", **V. K. and Giri (2020).** "Gibberellins are numerous groups of plant hormones that in addition to auxins are one of the main groups of plant regulators" **(Bethke, 1998)**. "They all differ in physiological activity and structure, and the first identified gibberellins was Gibberellic acid (GA_3). Gibberellins are extensively involved in all phases of plant growth and development, from seed germination to senescence. They promote seed germination, stimulate stem elongation, leaf expansion, flowering, pollen, and seed development, delay ripening, and inhibit senescence" **Mshelmbula *et al.* (2021)**.

2. MATERIALS AND METHODS

The present examination was carried out during *Zaid* 2022 at latitude 250 30'42 'N and longitude 810 60'56' E at Crop Research Farm, Department of Agricultural Sciences, Naini Agricultural Institute, SHUATS, Prayagraj (UP). On average, the elevation is 98 meters above sea level. On 04 April 2022, the crop was sown with the Gomti (V.U-89) variety. The treatments used was Potassium and Gibberellic acid in which Potassium is applied as basal dose and gibberellic acid is applied as foliar spray at pre-flowering and pod filling stages.T_1 : Potassium – 20 kg/ha + GA_3 - 100 ppm, T_2 : Potassium – 20 kg/ha + GA_3 - 120 ppm, T_3 : Potassium – 20 kg/ha + GA_3 - 150 ppm, T_4 : Potassium – 25 kg/ha + GA_3 - 100 ppm, T_5 : Potassium – 25 kg/ha + GA_3 - 120 ppm, T_6 : Potassium – 25 kg/ha + GA_3 - 150 ppm, T_7 : Potassium – 30 kg/ha + GA_3 - 100 ppm, T_8 : Potassium – 30 kg/ha + GA_3 - 120 ppm, T_9 : Potassium – 30 kg/ha + GA_3 -

150 ppm and T_{10} : Control (RDF – N:P:K- 25:50:25 kg/ha). All fertilizers were applied to the soil using urea, single superphosphate (SSP), and potash muriate (MOP). During the 15, 30, 45, and 60 DAS intervals, five randomly selected plant growth symptoms were assessed in each treatment. The mean was compared with a 5% chance of significant results and statistical analysis was performed.

3. RESULTS AND DISCUSSIONS

3.1 GROWTH PARAMETERS

The effect of Potassium and Gibberellic Acid on growth of Cowpea growth attributes was shown in Table 1.

3.1.1. Plant height (cm)

Significantly higher plant height (68.8 cm) was recorded with application of Potassium - 30 kg/ha + GA_3 - 100 ppm whereas, the treatment Potassium - 25 kg/ha + GA_3 - 100 ppm (67.8 cm) was found to be statistically at par to the treatment with the application of Potassium - 30 kg/ha + GA_3 - 100 ppm.

"The GA_3 induced at all the growth stages influenced in plant height was attributed to the role of gibberellins in increasing cell elongation and division and internodal elongation" **(Taiz and Zeiger 2002), (Sauter and kende 1992)** reported that "gibberellins increased both cell elongation and division, as evidenced by increase in cell length". "Gibberellins might have increased cowpea plant height by increasing cell wall extensibility, **Behringer *et al.* (1990)** reported that in peas, gibberellins decreased the minimum force that will cause cell wall extension. Increased plant height with GA_3 spray may be due to rapid cell elongation in apical region of the plant". **Hirenkumar and Emongor (2011)** reported same findings who indicated that "exogenous application of GA_3 increased plant height and number of trifoliate leaves".

3.1.2. Number of Nodules/plant

Significantly higher nodules/plant (40.9) was recorded with application of Potassium - 30 kg/ha + GA_3 - 100 ppm whereas, the treatment Potassium - 25 kg/ha + GA_3 - 100 ppm (39.5) was found to be statistically at par to the treatment with the application of Potassium - 30 kg/ha + GA_3 - 100 ppm.

"Legume plants develop a symbiotic interaction with rhizobia by forming root nodules in which the bacteria fix atmospheric nitrogen. Nodule formation integrates several developmental processes, such as induction of cortical and pericycle cell division and rhizobia invasion, which are coordinated in time and space" **(Lievens *et al.*, 2005)**. "Exogenous application of GA_3 has been reported to induce the formation of nodule-like structures on the roots of Lotus japonicus" **(Kawaguchi *et al*., 1996).**

3.1.3 Dry weight (g/plant)

At 60 DAS, significantly maximum dry weight (39.32 g/plant) was recorded with application of Potassium - 30 kg/ha + GA_3 - 100 ppm whereas, the treatment Potassium – 25 kg/ha + GA_3 - 100 ppm (38.86 g/plant) was found to be statistically at par to the treatment with the application of Potassium - 30 kg/ha + GA_3 - 100 ppm.

Total dry matter was found to be increase gradually from 15 DAS to 60 DAS. The increase of plant dry weight in GA_3 treated plants was attributed to the increase in leaf area and number of leaves per plant, dry matter accumulation and ultimately induced yield components. These findings are in accordance with those of **Deotale *et al.* (1998)** in soyabean, in various physiological processes governed under plant levels which ultimately reflected in increased leaf area index, chlorophyll content and net assimilation rate, thus increased of dry weight. These results are in conformity with the results obtained by **Fattah (1997)** in broad bean; **Mohandoss and Rajesh (2003) and Emongor (2007)** in cowpea.

3.2 YIELD AND YIELD ATTRIBUTES

The effect of Potassium and Gibberellic Acid on growth of Cowpea yield attributes was shown in Table 2.

Significantly Maximum Number of Pods/plant (16.94), Number of seeds/pod (13.6), seed index (18.36 g), Seed yield (1459.70 kg/ha) and Haulm yield (2952.3 kg/ha) were recorded in the treatment application of Potassium - 30 kg/ha + GA_3 - 100 ppm over all the treatments. However, the treatment with (16.57) Potassium - 25 kg/ha + GA_3 - 100 ppm which was found to be statistically at par with Potassium - 30 kg/ha + GA_3 - 100 ppm.

Significantly highest harvest index (34.15 %) was recorded with the treatment application of Potassium - 30 kg/ha + 150 ppm GA_3 over all the treatments. However, the treatments with application of Potassium - 25 kg/ha + GA_3 - 100 ppm (34.04 %) and Potassium - 30 kg/ha + GA_3 – 120 ppm (33.58%) in were found to be statistically at par with RDF- N:P:K 25:50:25 kg/ha. Harvest index is directly correlated with seed: straw ratio and is the result of increased in seed and straw yield. Application of urea at pre-flowering and pod initiation stages recorded significantly higher harvest index than the other remaining treatments.

Gibberellic acid can stimulate rapid stem and root growth, induce mitotic division in the leaves of some plants, and increase seed germination and ultimately crop production. Crop yield depends on the accumulation of photo-assimilates during the growing period and the way they are partitioned between desired storage organs of plant. Similar results are reported by **Ferdowsi Noor *et al.*, (2017)** revealed that significantly higher number of pods/plant, seeds/pod, test weight, seed yield and stover yield were recorded under application of gibberellic acid respectively.

4. CONCLUSION

On the basis of the results in this study, it is concluded that the application of potassium 30 kg/ha in combination with 100 ppm GA_3 (T_7) was found to be more desirable to be adopted as it recorded higher performance in growth parameter, yield and yield attributes during *zaid* season under Uttar Pradesh conditions.

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Table 1. Effect of Potassium and Gibberellic Acid on growth of Cowpea.

S.No.	Treatment Combinations	Plant Height(cm)	No. of nodules	Dry weight (g/plant)
1	Potassium 20 kg/ha + 100 ppm GA_3	60.9	36.4	35.11
2	Potassium 20 kg/ha + 120 ppm GA_3	59.8	35.2	34.43
3	Potassium 20 kg/ha + 150 ppm GA_3	59.2	35.1	33.85
4	Potassium 25 kg/ha + 100 ppm GA_3	67.8	39.5	38.86
5	Potassium 25 kg/ha + 120 ppm GA_3	64.8	38.0	36.99
6	Potassium 25kg/ha + 150 ppm GA_3	62.2	36.9	35.98
7	Potassium 30 kg/ha + 100 ppm GA_3	68.8	40.9	39.32
8	Potassium 30 kg/ha + 120 ppm GA_3	65.9	38.5	37.69
9	Potassium 30 kg/ha + 150 ppm GA_3	63.6	37.2	36.57
10	Control-N:P:K-25:50:25 kg/ha	58.7	34.9	33.03
	F test	S	S	S
	S.E.m (±)	0.34	0.44	0.17
	CD (5%)	1.04	1.31	0.52

Table 2. Effect of Potassium and Gibberellic Acid on yield of Cowpea.

S. No	Treatments	At Harvest					
		No. of Pods/plant (No)	No. of seeds /pod	Seed index (g)	Seed yield (kg/ha)	Haulm yield (kg/ha)	Harvest index (%)
1	Potassium 20 kg/ha + 100 ppm GA_3	14.04	11.03	16.80	1208.2	2464.4	32.90
2	Potassium 20 kg/ha + 120 ppm GA_3	13.49	10.87	16.68	1150.3	2387.9	32.51
3	Potassium 20 kg/ha + 150 ppm GA_3	12.58	10.39	16.31	1097.0	2285.9	32.43
4	Potassium 25 kg/ha + 100 ppm GA_3	16.57	13.17	18.17	1433.0	2899.0	33.15
5	Potassium 25kg/ha + 120 ppm GA_3	15.73	12.72	17.21	1377.4	2669.0	34.04
6	Potassium 25kg/ha + 150 ppm GA_3	14.53	11.46	17.08	1248.3	2486.9	33.42
7	Potassium 30 kg/ha + 100 ppm GA_3	16.94	13.46	18.36	1459.7	2952.3	33.09
8	Potassium 30 kg/ha + 120 ppm GA_3	16.16	12.94	17.43	1403.1	2775.5	33.58
9	Potassium 30 kg/ha + 150 ppm GA_3	15.17	11.98	17.06	1336.2	2577.0	34.15
10	Control-N:P:K-25:50:25 kg/ha	12.04	10.15	16.12	1029.0	2464.4	31.45
	F test	S	S	S	S	S	S
	S.E.m (±)	0.14	0.09	0.08	9.10	22.10	0.25
	CD (5%)	0.43	0.29	0.27	27.07	65.67	0.75