



## **Alleviation of Sodicy Stress in Green Gram and Black Gram Using Plant Growth Regulating Substances**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors together collected the data, analysed and prepared the manuscript. All authors read and approved the final manuscript.*

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### **ABSTRACT**

Most of the pulses in India are grown in low fertility, problematic soils and unpredictable environmental conditions. Major issues in pulse production are poor establishment and low harvest index. In pulses harvest index is only 15-20%. Physiological manipulations such as spraying of hormones and nutrients that reduce flower drop and thereby facilitate large sink size. The objective of this research is to study the impact of Growth regulating substances on germination and establishment and economic yield of black gram and green gram under Sodic soil conditions. The study area is Anbil Dharmalingam Agricultural College and Research Institute, Trichy. The nature of soil is sodicity with exchangeable sodium percentage (ESP) of 18.94% with pH of 9.02. The two crop varieties green gram VBN (Gg) 2 & black gram VBN (Bg) 6 were employed under sodic soil condition. Field experiment was conducted during late July to October 2017 under sodic soil condition with ten treatments. The experiment was laid out in a Randomized Block Design with three replications. Foliar spray was given at flower initiation and pod initiation stages. Ten treatment combinations were employed by T<sub>1</sub>: Control, T<sub>2</sub>: Seed Treatment (ST) with Ammonium Molybdate (AM) 0.05% + foliar spray of ZnSO<sub>4</sub> - 0.5%. T<sub>3</sub>: AM 0.05% + Panchagavya -3.0%,

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T<sub>4</sub>: AM 0.05% + foliar spray of KCl -1%, T<sub>5</sub>: ST with GA<sub>3</sub> 50 ppm + foliar spray of ZnSO<sub>4</sub> – 0.5%, T<sub>6</sub>: GA<sub>3</sub> 50 ppm + Panchagavya -3.0%, T<sub>7</sub>: GA<sub>3</sub> 50 ppm + KCl -1%, T<sub>8</sub>: Cowpea Sprout Extract 2% +ZnSO<sub>4</sub> – 0.5%, T<sub>9</sub>: Cowpea Sprout Extract 2% +Panchagavya -3.0%, T<sub>10</sub>: Cowpea Sprout Extract 2% + foliar spray of KCl -1%. In conclusion the yield enhancement in best treatment may be due to the presence of bioactive substances in sprouted cowpea extracts and panchagavya were found effective towards yield maximization.

*Keywords: Cowpea sprout extract; panchagavya; harvest index and sodicity.*

## 1. INTRODUCTION

Pulses being a major source of protein in Indian diet, the increase in pulse production will act as a panacea for problems like national nutritional security. Most of the pulses in India are grown in low fertility, problematic soils and unpredictable environmental conditions. More than 87% of the area under pulses is rainfed. Areas of pulse production in India are subject to drought and heat stress of arid and semi arid regions, which brings down its yield. Further, the arid and semi arid areas of the country face problem of alkaline and acidic soils. More than 20% of cultivated land worldwide (about 45 hectares) is affected by salt stress. Major issues in pulse production are poor establishment and low harvest index. In pulses harvest index is only 15-20% [1]. Physiological manipulations such as spraying of hormones and nutrients that reduce flower drop and thereby facilitate large sink size. Exogenous applications of growth regulators to alleviate salinity stress can be an economic and safe alternative to environment, which delay leaf senescence (cytokinins), prevent the abortion of fruits (auxins and gibberellins) and increase the leaf area (gibberellins). Growth regulators can improve the physiological efficiency including photosynthetic ability and can enhance the effective partitioning of accumulates from source and sink in the field crops. Nasser Akbari et al. [2] also reported that gibberellic acid (100 mg/L as seed pre-soaking and 100 mg/L as foliar application) overcome the effect of salt stress and improve the growth parameters in mung bean. Germinated grains are good sources of ascorbic acid, riboflavin, choline, thiamine, tocopherols and pantothenic acid which increase the nutritional quality. Horse gram and cowpea pulse sprout extract were used for crop fortification. Seed fortification treatment mainly supplies nutrient to the seed to germinate into vigorous seedlings. Jayanthi et al. [3] reported that seed fortification with 2% horse gram extract was found to boost the chlorophyll content of the plant to highest level at both vegetative and maturity stage in rice. Panchagavya acts as

organic manure, biostimulant and gives resistance against pest and diseases. It contains all macronutrients, micronutrients and growth hormones (IAA and GA) required for crop growth. Panchagavya is used as a foliar application to boost yield of crop plants and to restrict the incidence of common disease [4]. The best aim of this study is i. To study the impact of growth regulating substances on germination and establishment under Sodic soil. ii. To study the effect of Growth regulating substances on economic yield of Black gram and Green gram and Benefit Cost ratio.

## 2. MATERIALS AND METHODS

The research work was mainly made to alleviate the adverse effects of sodicity stress with plant growth regulating substances through seed treatment and foliar spray. To achieve these objectives, a laboratory screening and field study were carried out. Green gram variety VBN (Gg) 2 and Black gram variety VBN (Bg) 6 were screened for tolerance to various levels of sodicity stresses, based on germination per cent, seedling growth and vigour index through roll towel method. For imposing sodicity (3 levels) stresses, sodium bicarbonate (NaHCO<sub>3</sub>) solution at 25 (pH: 9.23), 50 (pH: 9.50) and 75 mM (pH: 9.82) were prepared. Seed treatment was imposed. The seeds were allowed to germinate up to 15 days and observations were recorded. The distilled water was used for maintaining the control. A field experiment was carried out to study the effect of seed treatment and foliar spray of various plant growth regulating chemicals on alleviating the adverse effects of sodicity stress in pulses. The two varieties VBN (Gg) 2 & VBN (Bg) 6 were employed in this study conducted under sodic soil condition. Field experiment was conducted during 2014 to 2018 under sodic soil condition. The soil of Anbil Dharmalingam Agricultural College and Research Institute, Trichy is naturally sodic condition. The experiment was laid out in a Randomized Block Design with three replications. Foliar spray was given at flower

initiation and pod initiation stages. Ten treatment combinations were employed by T<sub>1</sub>: Control, T<sub>2</sub>: Seed Treatment (ST) with Ammonium Molybdate (AM) 0.05% + foliar spray of ZnSO<sub>4</sub> – 0.5%. T<sub>3</sub>: AM 0.05% + Panchagavya -3.0%, T<sub>4</sub>: AM 0.05% + foliar spray of KCl -1%, T<sub>5</sub>: ST with GA<sub>3</sub> 50 ppm + foliar spray of ZnSO<sub>4</sub> – 0.5%, T<sub>6</sub>: GA<sub>3</sub> 50 ppm + Panchagavya -3.0%, T<sub>7</sub>: GA<sub>3</sub> 50 ppm + KCl -1%, T<sub>8</sub>: Cowpea Sprout Extract 2% + ZnSO<sub>4</sub> – 0.5%, T<sub>9</sub>: Cowpea Sprout Extract 2% + Panchagavya -3.0%, T<sub>10</sub>: Cowpea Sprout Extract 2% + foliar spray of KCl -1%. First observation was taken on 30th DAS and subsequent observations were taken at 15 days interval up to harvest. The vigour index of the seedlings was calculated using the following formula proposed by Abdul-Baki and Anderson [5] and expressed as per cent. SPAD readings were recorded using Chlorophyll meter (SPAD 502). The data were recorded as described by Peng et al. [6]. Number of pods per plant was counted in the selected plants in each replication and the mean value was expressed as pods plant<sup>-1</sup>. Grain yield and TDMP was calculated based on the plot yield and expressed as kg ha<sup>-1</sup>. Harvest index was calculated by dividing the grain yield by total dry matter produced by the plant and expressed in per cent (Economic yield/Biological yield x 100). Data were statistically analyzed by the 'F' test for significance as suggested by Gomez and Gomez [7].

### 3. RESULTS AND DISCUSSION

Increase the salt stress the vigour index was decreased. Among the treatments Cow pea sprout extract (2%) recorded higher vigour index both in black gram (338.4) and green gram (385.3) varieties under 75 mM concentration. Followed by GA<sub>3</sub> recorded higher vigour index both in green gram (1324.0) and black gram (1311.5) varieties under increased salt concentration.

Both Green gram and Black gram varieties, best performing treatment shows the significant different with control. The results of SPAD value exhibited an increasing trend up to pod formation stage with a drastic reduction at maturity. Both the varieties Treatment T<sub>9</sub> performed better to record higher value. In Green gram T<sub>9</sub> recorded higher SPAD value of (67.6) at pod formation stage compared to black gram variety recorded (35.1) followed T<sub>10</sub>, T<sub>7</sub> and T<sub>6</sub> recorded higher SPAD value. A strong positive correlation was found between SPAD readings and nitrogen content of the leaves of sunflower [8]. A strong positive correlation found between SPAD readings and extracted chlorophyll content was also established by Dwyer et al. [9].

The data on yield components such as number of pods per plant, number of seeds per plant, 100 seed weight, grain yield, biological yield, harvest

**Table 1. Effect of seed treatment on vigour index of green gram and black gram varieties under *In vitro* condition**

Treatments	NaHCO <sub>3</sub>				Mean
	0 mM	25 mM	50 mM	75 mM	
<b>VBN(Gg)2</b>					
Control	2389.3	322.7	164.2	142.0	669.4
CSE (2%)	2842.0	1338.9	938.0	385.3	1324.0
GA <sub>3</sub> (50 ppm)	2730.1	922.1	834.1	264.0	1145.4
AM (0.05%)	2609.7	630.8	530.8	192.0	976.9
Mean	2458.3	798.0	570.4	245.8	
SEd	111.96	39.10	28.18	11.22	
CD (0.05)	258.2	90.2	65.0	25.9	
<b>VBN(Bg)6</b>					
Control	2048.6	570.5	264.4	64.9	822.3
CSE (2%)	2630.6	1316.2	752.4	338.4	1311.5
GA <sub>3</sub> (50 ppm)	2460.6	868.2	761.0	222.2	1102.2
AM (0.05%)	2482.1	602.6	533.1	136.8	970.6
Mean	2589.9	845.1	624.1	190.6	
SEd	110.2	36.64	25.87	8.95	
CD (0.05)	238.4	84.5	59.7	20.7	

**Table 2. Effect of growth regulating substances on SPAD value of green gram under sodicity**

Treatments	30 DAS	45 DAS	60 DAS	Mean
T1	19.2	36.0	24.4	26.53
T2	19.8	38.5	27.8	28.70
T3	20.9	40.5	28.8	30.07
T4	19.9	40.3	28.8	29.67
T5	27.9	45.4	29.7	34.33
T6	31.9	51.2	34.0	39.03
T7	31.1	47.8	33.9	37.60
T8	30.3	47.4	33.0	36.90
T9	33.3	67.6	35.5	45.47
T10	32.1	54.1	35.0	40.40
Mean	26.64	46.88	31.1	
SED	1.11	1.92	1.26	
CD (0.05)	2.33	4.02	2.65	

**Table 3. Effect of growth regulating substances on SPAD value of black gram under sodicity**

Treatments	30 DAS	45 DAS	60 DAS	Mean
T1	17.2	20.1	18.3	18.53
T2	18.3	22.2	19.6	20.03
T3	19.5	23.4	19.9	20.93
T4	19.2	23.8	20.1	21.03
T5	20.1	24.2	20.4	21.57
T6	23.2	31.0	26.3	26.83
T7	22.1	28.4	22.5	24.33
T8	20.3	26.3	24.1	23.57
T9	28.4	35.1	30.1	31.20
T10	26.5	32.8	28.2	29.17
Mean	21.48	26.73	22.95	
SED	0.88	1.09	0.94	
CD (0.05)	1.84	2.30	1.97	

**Table 4. Influence of growth regulating substances on yield and yield contributing characters and Na/K ratio in green gram at maturity**

Treatments	No of pods/Plant	No of seeds/Pod	100 seed weight(g)	Grain yield kg/ha	Biological yield (Kg/ha)	Harvest index (%)	Na/K ratio
T1	12.24	7.14	2.58	601.2	2196.4	27.37	0.825
T2	13.32	7.22	2.60	612.3	2226.4	27.50	0.802
T3	15.12	7.32	2.64	636.1	2284.0	27.85	0.761
T4	14.31	7.20	2.62	629.2	2254.7	27.91	0.777
T5	16.14	7.33	2.65	674.5	2382.5	28.31	0.753
T6	17.42	7.93	2.70	696.2	2434.2	28.60	0.722
T7	17.33	7.51	2.69	683.7	2404.2	28.44	0.728
T8	16.80	7.42	2.68	711.1	2503.2	28.41	0.735
T9	18.30	8.96	2.87	785.3	2624.3	31.45	0.621
T10	17.63	8.51	2.76	754.8	2546.6	29.64	0.698
Mean	15.9	7.7	2.7	682.5	2385.7	28.50	0.7
SED	0.65	0.32	0.11	27.79	97.53	1.17	0.031
CD (0.05)	1.36	0.66	NS	58.4	204.9	2.49	0.065

**Table 5. Influence of growth regulating substances on yield and yield contributing characters and Na/K ratio in black gram**

Treatments	No of pods/Plant	No of seeds/Pod	100 seed weight	Grain yield kg/ha	Biological yield (Kg/ha)	Harvest index (%)	Na/K ratio
T1	6.54	5.21	2.0	519.21	2028.5	19.98	1.285
T2	7.11	5.24	2.1	524.20	2111.4	20.09	1.254
T3	7.24	6.11	2.2	556.10	2201.6	20.72	0.942
T4	8.82	5.85	2.1	553.21	2199.4	20.61	1.223
T5	7.33	6.01	2.2	566.22	2213.2	21.07	0.858
T6	11.25	7.11	2.5	651.30	2298.2	27.47	0.828
T7	10.78	6.45	2.3	635.44	2254.6	22.42	0.795
T8	9.25	6.23	2.3	598.14	2216.3	22.48	0.852
T9	12.24	7.85	2.6	695.10	2482.3	29.23	0.725
T10	11.82	7.52	2.5	685.30	2345.3	27.94	0.768
Mean	9.24	6.36	2.28	523.32	2235.1	23.25	1.0
SED	0.38	0.26	0.10	21.56	91.2	0.96	0.040
CD (0.05)	0.80	0.55	NS	45.30	191.6	2.01	0.082

Index and lower Na/K ratio were recorded at the time of harvest. The data are presented in Table 4 for green gram. In green gram variety treatment T<sub>9</sub> recorded higher No of pods/plant (18.30), No of seeds/pod (8.96), 100 seed weight (2.87), biological yield (2624.3), grain yield (785.3) and Harvest Index (29.64) followed by treatment T<sub>10</sub>, T<sub>6</sub> and T<sub>7</sub> recoded the higher yield under sodicity with control. All the treatments differed significantly in Na/K ratio at Maturity stages (Table 4). The best performing treatment maintain lowest Na/K ratio. Among the treatments, T<sub>9</sub> registered the lowest Na/K ratio of 0.621 at maturity stage and shows higher tolerance.

In Black gram variety Treatment T<sub>9</sub> recorded higher No of pods/plant (12.24), No of seeds/pod (7.85), 100 seed weight (2.6), Biological yield (2482.3), grain yield (695.10) and Harvest Index (29.23) followed by treatment T<sub>10</sub>, T<sub>6</sub> and T<sub>7</sub> recoded the higher yield under sodicity with control. All the treatments differed significantly in Na/K ratio at Maturity stages (Table 5). The best performing treatment maintain lowest Na/K ratio. Among the treatments, T<sub>9</sub> registered the lowest Na/K ratio of 0.725 at maturity stage and shows higher tolerance.

#### 4. CONCLUSION

The result revealed that seed treatment with Cowpea sprout extract (2%) + foliar spray of Panchagavya -3.0% was more effective to increase seed and seedling establishment and yield under sodic soil. Use of organic substances

maintain and improve fertility, soil structure and biodiversity and reduce erosion. Maintaining and improving soil fertility for sustainable agriculture is becoming more crucial due to increasing complexity of the nutritional problems. Since organic substances are constantly undergoing changes in the tropical soils, it must be replenished.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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