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Effect of Stress Mitigating Chemicals on Nodulation, Total Nutrient Uptake and Protein Content of Clusterbean [*Cyamopsis tetragonoloba* (L.) Taub] Varieties

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A B S T R A C T

A field experiment was conducted on experimental field of S. K. N. College of Agriculture, Jobner, during *kharif* 2017 to work out the effect of different stress mitigating chemicals on productivity of clusterbean [*Cyamopsis tetragonoloba* (L.) Taub] varieties. The treatments consisted of combinations of four varietites (RGC-1003, RGC-1033, RGC-1038 and RGC-1055) and five stress mitigating chemicals (Control, Thiourea, Thioglycolic acid, Salicylic acid and Muriate of Potash) were tested in Randomised Block Design with three replications. Results revealed that variety RGC-1033 proved significantly superior to variety RGC- 1003, RGC- 1038 and RGC- 1055 in respect of number of total and effective root nodules and dry weight of total and effective root nodules. Similarly the seed yield (1469 kg/ha), stover yield (3266 kg/ha) and biological yield (4735 kg/ha) were also significantly higher with variety RGC-1033. A significant increase in N, P and K concentration in seed and straw and their total uptake, protein content (27.43 %) were recorded in variety 'RGC- 1033' and proved best and economically profitable as compared to other varieties. Results also showed that application on 500 ppm thiourea at branching and flowering stage significantly increased the number of total and effective root nodules and their dry weight, protein content (27.4 %) stover and biological yield (1369, 3106 and 4475 kg/ha) and proved economically beneficial as compared to control. However, spray of thioglycolic acid @ 100 ppm at branching and flowering recorded at par net returns with foliar application of thiourea @ 500 ppm.

Introduction

Clusterbean [*Cyamopsis tetragonoloba* (L.) Taub] popularly known by its vernacular name "*Guar*" is an important legume crop of *kharif* season in arid and semi-arid regions of tropical India. Clusterbean is a robust, bushy crop and has well-developed tap root system. It is considered as one of the most drought tolerant grain legumes grown on sandy soils of arid and semi-arid regions. In India, this crop is mostly grown in the dry habitats of Rajasthan, Haryana, Gujarat and Punjab and to a limited extent in U.P. and M.P. In Rajasthan, clusterbean is mainly grown in Barmer, Churu, Sriganganagar, Nagaur, Jalore, Sikar, Jaisalmer, Bikaner, Jaipur and Alwar districts. In India, clusterbean is grown on 5.6 million

hectares with the annual production of 2.7 million tonnes and productivity of 485 kg/ha (Anonymous, 2013-14). The maximum contribution in respect of area is shared by Rajasthan (4.9 m ha) with the annual production of 2.2 million tonnes and productivity of 447 kg/ha (Anonymous, 2016-17). The crop survives best even at moderate levels of soil salinity and alkalinity.

Use of stress mitigating chemicals has been stated to modify various metabolic processes to regulate plant growth. Several researchers working on different crops have reported that use of growth substances/ regulators is one of the effective means for delaying senescence of leaves as well as retarding abscission of reproductive organs. Application of growth regulators increases flower, fruit setting, grain filling and test weight of different crops.

Among stress mitigating chemicals, thiourea play vital role in physiological processes of plants and modifying growth, yield and quality of clusterbean crop. Thiourea is a sulphahydral compound containing one –SH group (Jocelyn 1972). It is easily available and cost wise cheaper than others. The –SH group has been implicated in photosynthate translocation in crop plant (Giaquinta 1976).

Materials and Methods

The experiment was conducted at agronomy farm, S.K.N. College of Agriculture, Jobner during *kharif* season of 2017. Geographically, Jobner is situated 45 km west of Jaipur at 26^0 05' North latitude, 75^0 28' East longitude and at an altitude of 427 metres above mean sea level. The area falls in agro-climatic zone-IIIA (Semi-arid eastern plain zone) of Rajasthan. Soil was loamy sand in texture, alkaline in nature (P^H – 8.2), poor in organic carbon content (0.17 %) with low available nitrogen (128.5 kg /ha) and medium phosphorus and potassium content (18.30 and154.28 kg /ha), respectively. Rainfall received during the period of June to October was 382 mm. The twenty treatment combinations consisting of four varieties (RGC-1003, RGC-1033, RGC-1038 and RGC-1055) and five stress mitigating chemicals (Control, Thiourea, Thioglycolic acid, Salicylic acid and Muriate of Potash) were tested in Randomised Block Design with three replications. Seeds were sown manually on 5^{th} July, 2017 maintaining a spacing of 30 cm X 10 cm, with 20 kg/ ha seed rate. Each plot consisted of a gross size of 3.0 m X 4.0 m and net size of 1.8m X 2.0 m. Phosphorus as per treatments was applied as basal dose. In order to all three operations *VIZ.,* thinning, howeing and weeding were done 20 DAS to maintain the recommended spacing, proper aeration and weed free field. Net returns and benefit: Cost ratio were evaluated by using the prevailing market prices for clusterbean varieties. Growth parameters like Leaf Area Index, Leaf Area Duration, Crop Growth Rate and Relative Growth Rate and quality parameters like number of total and effective root nodules, uptake of nitrogen, phosphorus and potassium and protein content were worked out by using standard methods of analysis and formulas:

Nitrogen concentration and its uptake

The seed and straw samples were analyzed separately for nitrogen concentration (%) by standard (Nessler's reagent) colorimetric method (Snell and Snell, 1949). The uptake of nitrogen by crop was calculated using following formula:

N uptake (kg/ha) = N conc. In seed % X Seed yield (kg/ha) + N conc. in straw (%) X Straw yeld (kg/ha) / 100

Phosphorus concentration and its uptake

The seed and straw samples were analyzed for phosphorus concentration by Vanadomolybdo

phosphoric yellow colour method in sulphuric acid system (Method No. 60, USDA Hand Book No. 60, Richards, 1954).The uptake of phosphorus by crop was calculated using following formula:

$$\text{P uptake (kg/ha)} = \frac{\text{P conc. in seed (\%)} \times \text{Seed yield (kg/ha)} + \text{P conc. in straw (\%)} \times \text{Straw yield (kg/ha)}}{100}$$

Potassium concentration and its uptake

Potassium concentration in seed and straw was estimated by flame photometer method (Jackson, 1973). The uptake of potassium by crop was calculated using following formula:

$$\text{K uptake (kg/ha)} = \frac{\text{K conc. in seed (\%)} \times \text{Seed yield (kg/ha)} + \text{K conc. in straw (\%)} \times \text{Straw yield (kg/ha)}}{100}$$

Protein content in grain

Protein content in grain was calculated by multiplying nitrogen concentration in grain (%) with a factor 6.25 (A.O.A.C., 1960).

Results and Discussion

Effect of varieties

It is evident from the data (Table 1) that different varieties of clusterbean differ significantly in producing number of total and effective root nodules per plant. The maximum number of total and effective root nodules were obtained with variety RGC-1033 which was significantly superior with variety RGC-1003 and RGC-1038 and remained at par with variety RGC-1055. Variety RGC-1033 being at par with RGC-1055 and RGC-1038 recorded significantly higher dry weight of total and effective root nodules per plant (61.7 and 38.3 mg /plant) over RGC-1003. As a result variety RGC-1033 produced maximum seed (1469 kg/ha), stover (3266 kg/ha) and biological yield (4735 kg/ha) over RGC-1003, RGC-1038 and RGC-1055, which are in accordance with the work of Rwawat *et al.,* (2015) and Solanki *et al.,* (2015). The per cent increase in the dry weight of total and effective root nodules of RC-1033 was 10.97 and 20.82 percent over RGC-1003 (Table 1). The total nitrogen uptake was found significantly higher in variety RGC-1033 (98.49 kg N/ha) over the variety RGC- 1003 (67.78 kg/ha), RGC- 1038 (82.98 kg/ha) and RGC- 1055 (76.46 kg/ha). Varieties RGC-1033, RGC-1038 and RGC-1055 indicated an increase of 49.8, 21.5 and 21.2 per cent, respectively, over variety RGC-1003 in total P uptake. Clusterbean varieties differed significantly in total potassium uptake wherein, RGC-1033 recorded significantly higher total K uptake and indicated an increase of 44.1, 16.6 and 24.0 per cent over variety RGC-1003, RGC-1038 and RGC-1055, respectively. Results also showed that variety RGC-1033 recorded significantly higher protein content (27.4 per cent) as compared to RGC-1003, RGC-1038 RGC-1055. Similar results were obtained by Ayub *et al.,* (2010), Klyani and Lakshmi (2012), Pathak *et al.,* (2010), Rawat *et al.,* (2015) and Yadav *et al.,* (2017). The differential behaviour among the varieties could be explained by variation in their genetic makeup and their differential behaviour under different climatic conditions.

Effect of foliar application of stress mitigating chemicals

Application of thiourea @ 500 ppm at branching and flowering significantly increased the number of total and effective root nodules over control, thioglcolic acid, salicylic acid and MOP and registered an increase of 29.4, 11.6, 16.6 and 8.78 per cent in number of total nodules and 31.7, 18.2, 16.5 and 13.3 per cent in effective nodules over control, thioglcolic acid, salicylic acid and MOP respectively.

Table.1 Effect of stress mitigating chemicals on number and weight of nodules, seed yield and stover yield of clusterbean varieities

Treatments	Nodules/ plant (mg)		Dry weight of nodules/ plant (mg)		Seed yield (kg/ha)	Stover yield (kg/ha)
	Total	Effective	Total	Effective		
Varieties						
RGC-1003	21.7	11.7	55.6	31.7	1082	2506
RGC-1033	24.1	15.6	61.7	38.3	1469	3266
RGC-1038	23.5	14.4	59.0	35.7	1298	2973
RGC-1055	23.1	14.1	58.9	33.0	1206	2786
SEm+	0.44	0.35	1.16	0.78	30.14	65.01
CD (P=0.05)	1.27	1.00	3.33	2.24	86.28	186.09
Stress mitigating chemicals						
Control	20.1	12.3	52.3	29.8	1130	2605
Thiourea (500 ppm)	26.0	16.2	64.8	40.4	1369	3106
Thioglycolic Acid (TGA) (100 ppm)	23.3	13.7	59.3	34.3	1354	3079
Salicylic Acid (100 ppm)	22.3	13.3	56.2	33.3	1301	2965
Muriate of Potash (2%)	23.9	14.3	61.5	35.6	1164	2658
SEm+	0.50	0.39	1.30	0.87	33.70	72.69
CD (P=0.05)	1.42	1.11	3.72	2.50	96.47	208.05
CV (%)	7.43	9.67	7.66	8.74	9.24	8.73

Table.2 Effect of stress mitigating chemicals on total nutrient uptake and protein content of clusterbean varieties

Treatments	Total N uptake (kg/ha)	Total P uptake (kg/ha)	Total K uptake (kg/ha)	Protein content (%)
Varieties				
RGC-1003	67.78	7.27	32.04	25.38
RGC-1033	98.49	10.89	46.15	27.43
RGC-1038	82.99	8.83	39.60	25.73
RGC-1055	76.48	8.81	37.22	25.63
SEm+	2.14	0.21	1.02	0.45
CD (P=0.05)	6.11	0.60	2.93	1.28
Stress mitigating chemicals				
Control	61.19	7.05	33.45	21.69
Thiourea (500 ppm)	100.79	10.89	42.49	30.33
Thioglycolic Acid (TGA) (100 ppm)	92.88	9.95	40.64	27.75
Salicylic Acid (100 ppm)	82.33	9.18	39.05	26.28
Muriate of Potash (2%)	69.98	7.69	38.15	24.15
SEm+	2.39	0.24	1.14	0.50
CD (P=0.05)	6.83	0.67	3.27	1.43
CV (%)	10.15	9.11	10.23	6.64

Data (Table 2) shows that application of thiourea significantly increased the dry weight of total and effective nodules over rest of the treatments. Increase in the dry weight of total nodules was to the extent of 23.9, 9.27, 15.3 and 5.36 per cent over control, TGA, Salicylic acid and MOP respectively and dry weight of effective root nodules increased by 35.6, 17.8, 21.3 and 13.5 per cent over control, TGA, Salicylic acid and MOP, respectively.

Results of the experiment (Table 2) also indicate that the spray of stress mitigating chemicals brought about significant improvement in total nitrogen, phosphorus and potassium uptake by clusterbean over control. The maximum total nitrogen uptake was recorded with thiourea (100.60 kg/ha) which proved significantly superior to control, TGA, salicylic acid and MOP and represented an increase of 64.3, 8.47, 22.0 and 43.1 per cent, respectively. The per cent increase in N uptake due to application of TGA over control was 51.5. Application of stress mitigating chemicals significantly increased the uptake of phosphorus over control. Spray of 500 ppm thiourea, 100 ppm TGA, 100 ppm salicylic acid and 2 per cent MOP at branching and flowering registered an increase of 54.5, 41.1, 30.2 and 9.07 per cent in total P uptake respectively, over control. Foliar application of thiourea @ 500 ppm increased protein content in seed of clusterbean over control, TGA, salicylic acid and MOP by 39.8, 9.29, 15.4 and 25.6 percent respectively. A further reference to data (Table 2) showed that foliar application of stress mitigating chemicals brought about perceptible improvement in seed yield of clusterbean. Maximum seed yield (1369 kg/ha) recorded with thiourea was at par with TGA (1354 kg/ha) but both the chemicals enhanced the seed yield over control by 21.15 and 18.82 per cent, respectively. The maximum stover yield of clusterbean was recorded with thiourea (3106 kg/ha) which was at par with TGA (3079 kg/ha) and salicylic acid (2965 kg/ha) proved significantly superior over control and MOP and indicated an increase of 19.3 and 16.9 per cent. The results are in close confirmity with the findings of Burman *et al.,* (2000), Dikhwal *et al.,* (2013), Garg *et al.,* (2006), Kumar and Kaushik (2014) and Meena *et al.,* (2014).

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