Forage Res., **50**(1) : pp. 39-42 (2024) **http://forageresearch.in**

EVALUATION OF VARIOUS AGRO-CHEMICALS TO ENHANCE YIELD OF CLUSTER BEAN (*CYAMOPSIS TETRAGONOLABA*) UNDER RAINFED CONDITIONS

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(Received: 02 April 2024; Accepted: 04 June 2024)

SUMMARY

Present study was conducted at CCSHAU Regional Research Station, Bawal-123501, India, during *Kharif* season of 2016 to 2018. The experiment was laid out in randomized block design with twelve treatments replicated thrice. The treatments consisted of recommended dose of fertilizers {RP (20 kg N, 40 Kg P_2O_5 and 20 kg K_2O)} alone and RDF in combination with seed soaking in thiourea (500 ppm) for 30 minutes alone and with foliar spray of NPK (20:20:20). The liquid fertilizers NPK and KNO_3 at 1% each (separately) were sprayed once and twice at flowering and pod formation stage. The results revealed that two sprays of thiourea, KNO_3 (13:0:45) and NPK at flowering and pod formation stage produced significantly higher seed yield (18, 17 and 22%, respectively) of cluster bean in comparison to control (RP) and were statistically at par with each other. The treatment with seed soaking in thiourea (500 ppm) for 30 minutes + two sprays of NPK at flowering and pod formation stage was found best in terms of productivity (seed yield) as well as profitability (net returns) i.e. 24 and 75% higher than control, respectively.

Key words: clusterbean, agro-chemicals, thiourea, KNO_3, NPK

Biotic and abiotic stresses on agriculture are strongly correlated with one another, as climate change is their primary cause. Crop productivity is significantly impacted by unfavorable environmental conditions (Kumar *et al*., 2023). Climate change frequently poses a threat to the productivity of rainfed pulses because of abnormally high temperatures and droughts, particularly during the pod formation stage. Variations in precipitation patterns, temperature fluctuations and CO_2 concentrations are all linked to climate change. (Jiang *et al*., 2020). The most important environmental factor affecting agricultural productivity in arid and semi-arid regions among the several abiotic stresses is water scarcity or drought stress. Plants suffer from heat stress when there is a simultaneous high temperature and water deficit. By altering molecular processes, temperature stress lowers the plant's ideal biochemical and physiological functioning (Djanaguiraman *et al*., 2018; Muhlemann *et al*., 2018; Takahashi and Shinozaki, 2019). Pulses are smart crops for both people and the cropping system as they improve soil fertility through nitrogen fixation and also supply protein, minerals, vitamins and fiber for human diets. Among various pulses, clusterbean is an important multipurpose leguminous summer season crop. In Haryana, clusterbean was sown on approximately 0.30 million ha during 2022-23 yielding 14.00 million tonnes with an average productivity of 420 kg/ha (India statistics, 2023). It is mostly grown in arid and semiarid regions on light-textured soils with poor soil fertility and low water holding capacity under rainfed circumstances. Consequently, throughout the vegetative or reproductive stages, the crop experiences moisture stress. Certain strategies to check impact of climate change entail planting spring crops earlier, utilizing drought-tolerant plants or applying growth regulators exogenously.

One of the most significant events for sustaining agricultural productivity is the foliar utilization of nutrients. Due to the availability of soluble fertilizers, it has become increasingly important in recent years particularly under rainfed regions to combat challenge of climate change. Studies have shown that foliar nutrition has a positive impact on crop output and quality. The crop may experience nutrient shortages at later stages because nutrients given at the time of planting are not completely utilized by the crop and are lost through leaching, fixation *etc*.

Foliar applications of agro-chemicals like thiourea (37 % N and 42 % S), potassium nitrate (13 % N and 45 % K_2O) and NPK fertilizer (20 % N, P_2O_5 and K_2O each) are helpful in mitigating the abiotic (moisture + nutrient) stresses through physiological and enzymatic activities. Therefore, the present investigation was carried out to evaluate the effectiveness of different agrochemicals in relation to productivity and economic viability of cluster bean under rainfed conditions.

MATERIALS AND METHODS

The experiment was conducted during *Kharif* season of 2016 to 2018 at Research Farm, CCS HAU, Regional Research Station, Bawal, India. It consisted of twelve treatments, laid out in randomized block design, replicated thrice. The clusterbean crop (variety HG 2-20) was raised with recommended practices. The soils of the experimental field were loamy sand in texture, slightly alkaline in reaction, low in organic carbon, nitrogen and phosphorus; and medium in available potash. Total rainfall of 577.3, 451.6 and 381.8 mm was received during consecutive crop seasons. The treatments included (T_1) Control (Recommended package of practices *i.e.* RP), (T_2) RP + Seed soaking in thiourea solution (500 ppm) for 30 minutes (SS), (T_3) RP + Seed soaking in thiourea solution (500 ppm) for 30 minutes + foliar spray of thiourea (500 ppm) at flowering stage, (T_4) RP + Seed soaking in thiourea solution (500 ppm) for 30 minutes + foliar spray of thiourea (500 ppm) at pod formation stage, (T_5) RP + seed soaking in thiourea solution (500 ppm) for 30 minutes + foliar sprays of thiourea (500 ppm) at flowering + pod formation stage, (T_6) RP + Foliar spray of 1% KNO_3 at flowering stage, (T_7) RP + Foliar spray of 1% KNO_3 at pod formation stage, (T_8) RP + Foliar sprays of 1% KNO_3 at flowering + pod formation stage, (T_9) RP + Foliar spray of 1% NPK fertilizer at flowering stage, (T_{10}) RP + Foliar spray of 1% NPK fertilizer at pod formation stage, (T_{11}) RP + Foliar sprays of 1% NPK fertilizer at flowering + pod formation stage, (T_{12}) RP + Seed soaking in thiourea solution (500 ppm) for 30 minutes + foliar sprays of 1% NPK fertilizer at flowering + pod formation stage. The 'OPSTAT' software of CCS Haryana Agricultural University, Hisar, India was used for statistical analysis (Sheoran. *et al*., 1998).

RESULTS AND DISCUSSION

Yield and yield attributes

Data presented in Table 1 revealed that in rainfed cluster bean adoption of recommended practices (RP) + seed soaking in 500 ppm solution of thiourea for 30 minutes + foliar sprays of 1% NPK (20:20:20) fertilizer (T_{12}) at flowering and pod formation resulted into highest seed yield (13.61 q/ha) which was followed by T_{11} *i.e.* RP + two foliar sprays of 1% NPK (20:20:20) fertilizer (13.46 q/ha). RP + SS + two foliar sprays of thiourea (500 ppm) as well as potassium nitrate (1%) at flowering and pod

TABLE 1
Plant height, dry matter/plant, seed yield and its attributes as influenced by foliar spray of different agrochemicals (Mean of 2016-17, 2017-18 and 2018-19)

Treatment	Plant height (cm)		Dry matter/plant (g)		Seed yield (q/ha)	Yield attributes		
	30 DAS	90 DAS	30 DAS	90 DAS		No. of pods/plant	No. of seeds/pod	1,000-seed weight (g)
T_1	26.5	79.5	7.1	38.7	10.99	76.7	4.6	25.2
T_2	30.0	81.9	7.6	41.0	11.21	79.3	4.6	25.8
T_3	29.3	83.5	7.5	42.8	11.79	82.4	4.9	27.1
T_4	29.7	87.4	7.7	44.9	12.35	84.7	5.1	27.7
T_5	30.2	92.9	7.6	47.7	12.99	88.1	5.3	28.8
T_6	27.6	83.5	7.2	44.4	11.78	82.9	5.0	27.3
T_7	26.8	84.0	7.2	46.4	12.40	84.4	5.1	28.2
T_8	26.4	89.8	7.2	47.0	12.88	87.0	5.2	28.7
T_9	27.7	83.3	7.2	46.2	12.29	84.6	5.2	28.2
T_{10}	27.2	86.1	7.2	46.9	12.65	86.9	5.4	28.7
T_{11}	27.9	89.9	7.2	50.8	13.46	90.1	5.4	28.9
T_{12}	27.2	92.3	7.2	53.4	13.61	91.2	5.5	29.7
C. D. (P=0.05)	NS	4.2	NS	4.6	0.91	5.9	0.3	1.6

formation (T_5 and T_8) also gave significantly higher yield i.e. (12.99 and 12.88 q/ha, respectively) over control (10.99 q/ha). Similar trend was observed for plant height, dry matter/plant, yield attributing characters like number of seeds/pod and 1,000 – seed weight. Similar results of improvement in yield with foliar spray of KNO_3 have been recorded by Amarjeet *et al.,* (2018). Applying thiourea has also been shown to dramatically increase the net photosynthetic rate in cluster beans under rainfed conditions (Garg *et al*. 2003). Several reports indicate the involvement of thiourea in the introduction of secondary metabolite synthesis in stressed plants (Hassanein *et al*., 2015; Perveen *et al*., 2016; Waqas *et al*., 2017). Other possible reason for this may be that at the physiological level, thiourea improved source-to-sink relationship leading to increased crop yield. (Pandey *et al.,* 2021). Similarly Kavia *et al.,* 2022b also advised farmers for foliar spray of agrochemicals under water stress condition in barley crop to improve productivity and profitably.

ECONOMICS

The data regarding cost of cultivation, gross returns, net returns and B: C ratio under different treatments is presented in Table 2. Results showed that recommended practices RP + seed soaking in 500 ppm solution of thiourea for 30 minutes + two foliar sprays of 1% NPK (20:20:20) fertilizer at flowering and pod formation fetched highest net returns and B: C (Rs.18391/ha and 1.50) closely followed by RP + foliar sprays of 1% NPK (20:20:20) fertilizer at flowering and pod formation (Rs.17778/ha and 1.49) in comparison to control i.e. Rs. 10530/ha and 1.31 (Table 2). Kavita *et al.,* 2022a also reported significant increase in net returns and B: C with foliar spray of agrochemicals. Garg *et al*., 2006 reported that application of thiourea as a foliar spray or as a pre-sowing seed treatment significantly improved plant height, leaf area, production of dry matter and seed yield as compared to the untreated control plants.

TABLE 2

Economics of cluster bean as influenced by foliar spray of different agrochemicals (Mean of 2016-17, 2017-18 and 2018-19).

Treatments	Economics			
	Cost of cultivation (Rs./ha)	Gross Returns (Rs./ha)	Net Returns (Rs./ha)	B:C
T_1	34001	44531	10530	1.31
T_2	34009	45408	11400	1.34
T_3	34725	47678	12953	1.37
T_4	34725	49895	15169	1.44
T_5	35442	52505	17063	1.48
T_6	35212	47697	12485	1.35
T_7	35212	50107	14895	1.42
T_8	36423	51977	15554	1.43
T_9	35212	49689	14477	1.41
T_{10}	35212	51074	15862	1.45
T_{11}	36423	54211	17788	1.49
T_{12}	36431	54822	18391	1.50

Note: Market price of cluster bean seed was Rs.3200, 3400 and 4200/q in 2016, 2017 and 2018, respectively, and straw @ Rs. 200/q.

CONCLUSION

In rainfed cluster bean, recommended practices (RP) + seed soaking in 500 ppm solution of thiourea for 30 minutes + foliar sprays of 1% NPK (20:20:20) fertilizer at flowering and pod formation; and RP + two foliar sprays of 1% NPK were found more productive and profitable than other treatments over three years of study.

ACKNOWLEDGEMENT

The authors are thankful to CCSHAU, Hisar for providing funds and facilities to conduct this study.

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