

EFFECT OF THIOUREA FOLIAR APPLICATION ON YIELD AND ECONOMICS OF FODDER SORGHUM VARIETIES UNDER SALINE SOIL CONDITIONS

RITU YADAV^{1*}, POOJA GUPTA SONI², SATPAL², NEERAJ KHAROR² AND KANNOJ²

¹Department of Agronomy, ²Forage section, Department of Genetic & Plant Breeding
CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

*(e-mail: yritu360@gmail.com)

(Received: 14 December 2025; Accepted: 29 December 2025)

SUMMARY

The cultivable area under fodder production in India is consistent over the years and is facing deficiency in fodder requirement. Soil salinity is also major challenge to get sufficient production. So, with some management practices saline soils can be taken under cultivation and gap between the fodder requirement and availability can be reduced. With this objective the experiment was conducted at Forage Research Farm, CCSHAU, Hisar during the *kharif* season of 2024. It consists of 14 treatments formed by combination of two fodder sorghum varieties (HJ 260 and HJ 541) and seven thiourea doses involving: control, foliar spray of TU @ 400, 500 and 600 ppm at 30-40 DAS and @ 400, 500 and 600 ppm at 30-40 DAS and 50-60 DAS. The experiment resulted that among varieties, HJ 541 recorded the significantly highest green and dry fodder yield (30.25 and 7.37 t/ha) as compared to HC 260 (26.25 and 5.85 t/ha, respectively). Across the thiourea treatments, significantly highest green and dry fodder yield were recorded under foliar spray of TU @ 600 ppm at 30 and 50 DAS over the other treatments. Significant interaction was observed between cultivar and thiourea dosage for different characters including green fodder yield. Both cultivars *viz.* HC 260 and HJ 541, recorded significantly higher green fodder yield (28.75 and 32.26 t/ha, respectively) for foliar application of TU @ 600 ppm at 30 DAS and 50 DAS. Additionally, cultivar HJ 541 exhibited a statistically at par yield performance with foliar spray of TU @ 500 ppm at 30 and 50 DAS. So, it can be concluded that sorghum cultivars HJ 541 with foliar application of TU @ 500 ppm at 30 and 50 DAS can be recommended for higher green and dry fodder yield to meet the fodder requirement during *kharif* season under saline soil condition.

Key words: Sorghum, salinity, thiourea, foliar spray, green fodder and BC ratio

According to 20th livestock census (2019), livestock population in India is 535.8 million (Anonymous, 2019). But India is facing a net deficiency of 11.24% green fodder and 23.4% dry fodder in the country (Roy *et al.*, 2019). Due to growing competition between other land uses for cultivable land further increase in the acreage of fodder crops is quite hard. Sorghum (*Sorghum bicolor* L. Moench) is cultivated in *Kharif* as well as in summer season to meet the fodder requirements. Sorghum which is known as camel crop is among one of the five major cultivated species in the world. India had 4.08 million hectares (mha) under sorghum cultivation in 2023-24 and produced 4.74 mt, attaining an average grain yield of 1162 kg/ha. The total sorghum area in Haryana is 0.147 mha out of which only 0.01 mha area is under grain sorghum, with an average productivity of 527 kg/ha (CARP, 2024). Sorghum crop performs well under diverse edapho-climatic conditions across the

country including saline conditions (Satpal *et al.*, 2025).

Soil salinity is one of the main problems for agriculture, especially in countries where irrigation is an essential aid to agriculture (Ahloowalia *et al.*, 2004). When the EC_e of soil is more than 4 dS/m then the soil is categorized as saline soil. Total salt affected area of India is 6.7 mha and saline soils have occupied 2.9 mha (44 %) and in Haryana, the total area under salt affected soils is 232.5 thousand hectares out of which 49.2 thousand hectares area is under saline soil (Mandal *et al.*, 2010). Salt stress disrupts several physiological and biochemical processes at metabolic levels in plants. Salinity stress stimulates the formation of ROS (Reactive oxygen species), damages lipids and proteins, and alters chlorophyll content, nitrogen metabolism, and antioxidant mechanisms (Hussein and Alshammari, 2022). Compared to a healthy plant, the plants grown in salt stress condition has reduced growth. Moreover,

in highly saline soils the germination of plant is hampered and, in some cases, there is no germination at all leading to crop failure. With application of proper management practices in saline soils, it could be possible to increase the productivity of the soil and the crop productivity of the crop.

Uses of thiourea (TU), recognized as plant growth regulator which contains 42.1 % sulphur and 36.8 % nitrogen, plays a vital role in physiology of plant both as sulphhydryl compound and as an amino compound like urea and with its foliar application it effectively improved the mineral nutrition and its metabolism in plants irrespective of the growth stage at which TU is applied (Wahid *et al.*, 2017). TU positively influences the source-to-sink dynamics in plants, thereby boosting crop yield. At the molecular level, TU enhances cellular energy processes, synchronizes calcium and abscisic acid (ABA) signaling pathways, maintains optimal water balance, strengthens antioxidant systems, and improves sulfur metabolism. These diverse physiological and biochemical responses underscore the critical role of redox homeostasis in orchestrating various stress mitigation mechanisms. The activation of such defense pathways involves extensive transcriptional shifts (Srivastava *et al.*, 2017). Therefore, TU has been used as a strategy to alleviate abiotic stress in crop plants. Keeping the above facts in view, present study was carried out during *kharif* season of 2024 to evaluate the effects of foliar spray of thiourea on the growth, yield and economics of sorghum cultivars under saline condition.

MATERIALS AND METHODS

The field experiment was conducted at Forage Research Farm, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar (29°10' N, 75°46' E, with average elevation of 215.2 m above the mean sea level). The soil of experimental field containing 56 % sand, 33 % silt and 11 % clay, respectively was sandy loam in texture. The experimental field was low in available nitrogen (181.8 kg/ha), medium in available phosphorus (13.8 kg/ha), medium in available potassium (271.8 kg/ha) with 0.44 % organic carbon. It was saline in reaction with pH 8.4 and electrical conductivity of 3.2-4.23 dS/m. The region is characterized by a semi-arid, sub-tropical climate with hot, dry summers and cold winters. The average rainfall is 450 mm, approximately. The weekly meteorological data recorded during the crop growth period are presented in Fig. 1. The experiment was conducted in split plot design in three replicates. In

the main plots there were two varieties – HC 260 (V₁) and HJ 541 (V₂) and in sub-plots seven doses of thiourea *viz.* T₁: Control, T₂: Foliar spray TU @ 400 ppm at 30-40 DAS, T₃: Foliar spray TU @ 500 ppm at 30-40 DAS, T₄: Foliar spray TU @ 600 ppm at 30-40 DAS, T₅: Foliar spray TU @ 400 ppm at 30-40 DAS and 50-60 DAS, T₆: Foliar spray TU @ 500 ppm at 30-40 DAS and 50-60 DAS and T₇: Foliar spray TU @ 600 ppm at 30-40 DAS and 50-60 DAS at different stages of applications were applied. Sorghum was sown in June and harvested in September. Row to row spacing was 30 cm and recommended dose of fertilizer was applied *i.e.*, 75: 30: 30 kg/ha (N: P₂O₅: K₂O). One irrigation was applied on as per the requirement of the crop and thereafter rainfall of 447.1 mm was received during the crop period and no irrigation was applied to crop. The yield attributing parameters were recorded at different stages of crop growth. Five plants per plot were randomly selected to record data on plant height, number of leaves and stem girth. Additionally, to record data on dry matter accumulation and leaf : stem, one and two plants per plot were selected at random, respectively. The leaf area index (LAI) was calculated directly by taking sample of foliage from a plant canopy, measuring the green leaf area and dividing it by the ground area covered by each plant.

The weight of harvested green fodder from each plot was taken (kg/plot) and then converted into t/ha. A random green fodder sample of 500 g was collected from each plot at the time of harvest, sun-dried and then oven-dried at 60°C till it achieved constant weight. The weight of each sample was weighed separately and then converted it into dry fodder yield.

$$\text{Dry matter (\%)} = \frac{\text{wt. of oven dry sample}}{\text{wt. of sample before drying}} \times 100$$

$$\text{Dry fodder yield} = \frac{\text{Fresh fodder yield} \times \text{Dry matter content (\%)}}{100}$$

The data on various parameter *viz.*, growth, yield, quality and economics were analyzed statistically by the method of analysis of variance (ANOVA). F test significance was calculated as per method described by Pance and Sukhatme (1985) using online statistical package OPSTAT developed by Sheoran *et*

TABLE 1
Effect of cultivars and thiourea doses on plant population of fodder sorghum under saline condition

Treatments	Plant population per meter row					
	20 DAS			At harvest		
	HC 260	HJ 541	Mean	HC 260	HJ 541	Mean
T ₁ : Control	11.7	14.6	13.1	7.3	9.3	8.3
T ₂ : Foliar spray of TU @ 400 ppm at 30 DAS	11.9	15.1	13.5	8.9	10.9	9.9
T ₃ : Foliar spray of TU @ 500 ppm at 30 DAS	11.9	14.6	13.2	8.8	11.6	10.2
T ₄ : Foliar spray of TU @ 600 ppm at 30 DAS	12.5	14.8	13.6	9.5	11.7	10.6
T ₅ : Foliar spray of TU @ 400 ppm at 30 and 50 DAS	12.2	14.3	13.3	9.5	11.6	10.5
T ₆ : Foliar spray of TU @ 500 ppm at 30 and 50 DAS	12.5	14.8	13.6	9.5	12.7	11.1
T ₇ : Foliar spray of TU @ 600 ppm at 30 and 50 DAS	12.5	14.6	13.6	10.6	12.9	11.8
Mean	12.2	14.7		9.2	11.5	

Factors	20 DAS				At harvest			
	Varieties (Factor A)	Thiourea doses (Factor B)	Factor (B) at same level of A	Factor (A) at same level of B	Varieties (Factor A)	Thiourea doses (Factor B)	Factor (B) at same level of A	Factor (A) at same level of B
SEm ±	0.06	0.06	0.06	0.16	0.10	0.12	0.27	0.19
CD ($p = 0.05$)	0.39	NS	NS	NS	0.68	0.36	0.70	0.77

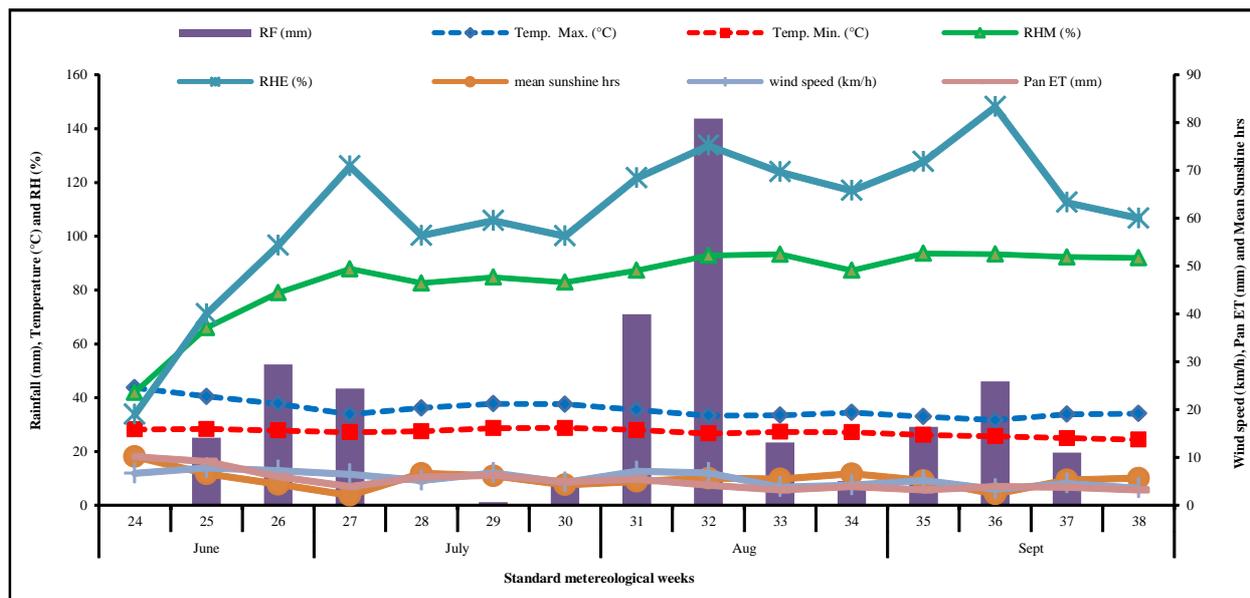


Fig. 1. Mean weekly meteorological data during kharif 2024

al. (1998). The results are presented at five per cent level of significance ($p = 0.05$).

RESULTS AND DISCUSSION

Growth parameters

As in Table 1, at 20 DAS and at harvest, cultivar HJ 541 exhibited a significantly higher plant

population (14.7 and 11.5, respectively) compared to HC 260. The difference in plant population may be due difference in salinity tolerance of both the cultivars. Ramadan *et al.* (2001) in has also reported in his study that increasing the salinity levels decreased the germination percentage in all three crops of the experiment i.e., maize, soybean and sorghum. Application of TU @ 600 ppm at 30 and 50 DAS resulted in significantly higher plant population across

TABLE 2
Effect of cultivars and thiourea doses on plant height of sorghum under saline condition

Treatments	Plant height (cm)											
	20 DAS			40 DAS			60 DAS			At harvest		
	HC 260	HJ 541	Mean	HC 260	HJ 541	Mean	HC 260	HJ 541	Mean	HC 260	HJ 541	Mean
T ₁ : Control	23.9	28.3	26.1	50.8	60.8	55.8	107.9	122.8	115.4	150.4	172.9	161.6
T ₂ : Foliar spray of TU @ 400 ppm at 30 DAS	25.2	27.9	26.6	58.3	71.1	64.7	118.7	131.6	125.2	161.2	181.6	171.4
T ₃ : Foliar spray of TU @ 500 ppm at 30 DAS	23.3	30.4	26.9	62.9	81.1	72.0	119.1	134.8	127.0	161.6	184.9	173.3
T ₄ : Foliar spray of TU @ 600 ppm at 30 DAS	24.3	31.3	27.8	71.9	82.4	77.2	120.3	135.7	128.0	162.8	185.7	174.3
T ₅ : Foliar spray of TU @ 400 ppm at 30 and 50 DAS	25.6	30.5	28.1	58.4	71.4	64.9	121.5	145.9	133.7	164.0	195.9	180.0
T ₆ : Foliar spray of TU @ 500 ppm at 30 and 50 DAS	25.7	30.4	28.1	62.3	82.4	72.4	125.3	158.1	141.7	167.8	208.1	188.0
T ₇ : Foliar spray of TU @ 600 ppm at 30 and 50 DAS	25.3	31.5	28.4	73.6	83.1	78.4	136.4	159.4	147.9	178.9	209.5	194.2
Mean	24.8	30.1	28.4	62.6	76.0	70.0	121.3	141.2	131.2	163.8	191.2	171.2

Factors	20 DAS						40 DAS						60 DAS						At harvest					
	Thiourea doses (Factor B)		Factor (B) at same level of A		Factor (A)		Thiourea doses (Factor B)		Factor (B) at same level of A		Factor (A)		Thiourea doses (Factor B)		Factor (B) at same level of A		Factor (A)		Thiourea doses (Factor B)		Factor (B) at same level of A		Factor (A)	
	(Factor B)	level of A	(Factor B)	level of A	(Factor A)	level of B	(Factor B)	level of A	(Factor B)	level of A	(Factor A)	level of B	(Factor B)	level of A	(Factor B)	level of A	(Factor A)	level of B	(Factor B)	level of A	(Factor B)	level of A	(Factor A)	level of B
SEM ±	0.44	0.74	1.17	NS	1.07	1.07	0.37	1.08	0.98	1.47	1.47	0.97	0.70	0.70	1.30	0.22	0.97	0.97	2.84	2.84	4.17	4.17	1.29	3.92
CD (p = 0.05)	2.90	NS	NS	NS	NS	NS	2.43	3.18	4.85	4.64	4.64	2.85	4.24	4.24	4.01	1.46	2.84	2.84	4.17	4.17	4.17	4.17	3.92	3.92

TABLE 3
Effect of cultivars and thiourea doses on number of leaves of fodder sorghum under saline condition

Treatments	Number of leaves/plant											
	20 DAS			40 DAS			60 DAS			At harvest		
	HC 260	HJ 541	Mean	HC 260	HJ 541	Mean	HC 260	HJ 541	Mean	HC 260	HJ 541	Mean
T ₁ : Control	3.33	4.08	3.71	5.28	6.11	5.69	7.50	8.58	8.04	9.15	11.0	10.1
T ₂ : Foliar spray of TU @ 400 ppm at 30 DAS	3.42	4.42	3.92	6.06	7.11	6.58	8.30	9.42	8.86	9.95	11.8	10.9
T ₃ : Foliar spray of TU @ 500 ppm at 30 DAS	3.47	4.42	3.94	6.36	7.97	7.16	8.50	9.49	9.00	10.1	11.9	11.0
T ₄ : Foliar spray of TU @ 600 ppm at 30 DAS	3.83	4.58	4.21	7.13	8.05	7.59	7.90	9.55	8.73	9.55	11.9	10.7
T ₅ : Foliar spray of TU @ 400 ppm at 30 and 50 DAS	3.80	4.67	4.23	6.04	7.14	6.59	8.00	9.58	8.79	9.65	12.0	10.8
T ₆ : Foliar spray of TU @ 500 ppm at 30 and 50 DAS	4.08	4.67	4.38	6.31	7.90	7.11	8.08	10.2	9.16	9.73	12.6	11.2
T ₇ : Foliar spray of TU @ 600 ppm at 30 and 50 DAS	4.05	4.75	4.40	7.16	8.07	7.61	9.73	10.3	10.0	11.4	12.7	12.0
Mean	3.71	4.51	4.11	6.33	7.48	6.82	8.29	9.59	8.73	9.9	12.0	11.2

Factors	20 DAS						40 DAS						60 DAS						At harvest					
	Thiourea doses (Factor B)		Factor (B) at same level of A		Factor (A)		Thiourea doses (Factor B)		Factor (B) at same level of A		Factor (A)		Thiourea doses (Factor B)		Factor (B) at same level of A		Factor (A)		Thiourea doses (Factor B)		Factor (B) at same level of A		Factor (A)	
	(Factor B)	level of A	(Factor B)	level of A	(Factor A)	level of B	(Factor B)	level of A	(Factor B)	level of A	(Factor A)	level of B	(Factor B)	level of A	(Factor B)	level of A	(Factor A)	level of B	(Factor B)	level of A	(Factor B)	level of A	(Factor A)	level of B
SEM ±	0.09	0.20	0.23	NS	0.27	0.27	0.03	0.07	0.09	0.10	0.10	0.12	0.22	0.22	0.17	0.08	0.12	0.12	0.34	0.34	0.62	0.62	0.17	0.66
CD (p = 0.05)	0.56	NS	NS	NS	NS	NS	0.22	0.21	0.34	0.33	0.33	0.34	0.62	0.62	0.66	0.55	0.34	0.34	0.62	0.62	0.62	0.62	0.66	0.66

TABLE 4
Effect of cultivars and thiourea doses on dry matter accumulation of fodder sorghum under saline condition

Treatments	Dry matter accumulation (g/plant)											
	20 DAS			40 DAS			60 DAS			At harvest		
	HC 260	HJ 541	Mean	HC 260	HJ 541	Mean	HC 260	HJ 541	Mean	HC 260	HJ 541	Mean
T ₁ : Control	1.45	2.60	2.02	8.907	15.37	12.14	21.75	39.37	30.56	42.22	65.39	53.80
T ₂ : Foliar spray of TU @ 400 ppm at 30 DAS	1.81	2.68	2.24	10.62	17.94	14.28	28.51	48.98	38.75	50.45	73.91	62.18
T ₃ : Foliar spray of TU @ 500 ppm at 30 DAS	1.92	2.84	2.38	10.90	20.12	15.51	30.34	49.45	39.89	53.40	75.47	64.43
T ₄ : Foliar spray of TU @ 600 ppm at 30 DAS	1.97	3.26	2.62	11.58	20.23	15.91	32.43	53.56	42.99	55.49	78.14	66.82
T ₅ : Foliar spray of TU @ 400 ppm at 30 and 50 DAS	2.39	3.45	2.92	10.64	17.97	14.31	33.73	54.63	44.18	56.79	80.65	68.72
T ₆ : Foliar spray of TU @ 500 ppm at 30 and 50 DAS	2.46	3.51	2.98	10.91	20.19	15.55	34.52	64.65	49.58	57.58	90.67	74.12
T ₇ : Foliar spray of TU @ 600 ppm at 30 and 50 DAS	2.47	3.80	3.14	11.60	20.30	15.95	41.02	65.88	53.45	65.18	91.90	78.54
Mean	2.07	3.16	2.61	10.74	18.88	15.95	31.76	53.79	43.45	54.44	79.45	65.45

Factors	20 DAS						40 DAS						60 DAS						At harvest					
	Varieties (Factor A)		Thiourea doses (Factor B)		Factor (A) at same level of B		Varieties (Factor A)		Thiourea doses (Factor B)		Factor (A) at same level of B		Varieties (Factor A)		Thiourea doses (Factor B)		Factor (A) at same level of B		Varieties (Factor A)		Thiourea doses (Factor B)		Factor (A) at same level of B	
	Factor A	Factor B	Factor A	Factor B	Factor A	Factor B	Factor A	Factor B	Factor A	Factor B	Factor A	Factor B	Factor A	Factor B	Factor A	Factor B	Factor A	Factor B	Factor A	Factor B	Factor A	Factor B	Factor A	Factor B
SEM ±	0.02	0.31	0.31	NS	0.41	NS	0.15	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
CD(p=0.05)	0.15	NS	NS	NS	NS	NS	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29

treatments (11.8). The significant difference between the plant population of control and the treatments indicate that foliar spray of thiourea had mitigated effect of soil salinity and aid in survival of the crop till maturity.

The plant height (Table 2) was significantly higher in cultivar HJ 541 (30.1, 76.0, 141.2 and 191.2 cm at 20, 40, 60 DAS and harvest, respectively) compared to HC 260 at all growth stages indicating variation might be due to difference in their genetic makeup. Similar results of cultivar effected height difference has been reported by Satpal *et al.* (2020). Across treatments, on mean basis, the foliar spray of TU @ 600 ppm at 30 and 50 DAS produced significantly maximum plant height (194.2 cm at harvest) compared to other treatments. The spray of TU in increasing plant height has been proved beneficial. Yadav *et al.* (2020) in their experiments has reported that TU has overcome the effect of salinity and increase in height has been reported.

The number of leaves per plant (Table 3) was significantly higher in cultivar HJ 541 (4.51, 7.48, 9.59 and 12.0 at 20, 40, 60 DAS and harvest, respectively) at all growth stages compared to HC 260. On mean basis, application of TU @ 600 ppm at 30 and 50 DAS resulted in significantly higher number of leaves per plant (12.0 at harvest) as compared to other treatments. The exogenous application of TU effectively ameliorated the deleterious impact of salinity stress. TU when enter into plant system acts at molecular level and aid plant overcome abiotic stress and is believed to improve photosynthetic efficiency, coordinating regulation of source to sink relationship and hence the number of leaves and other yield attributing factors. This result was similar to the findings of Kumar *et al.* (2018).

The dry matter accumulation (Table 4) was found significantly highest in cultivar HJ 541 (3.16, 18.88, 53.79 and 79.45 g/plant, at 20, 40, 60 DAS and harvest, respectively) over HC 260 and on basis of mean, foliar spray of TU @ 600 ppm at 30 and 50 DAS showed significantly highest biomass production as compared to other treatments. The foliar spray of bioregulators (TU, TGA and SA) significantly increased the plant height of barley at maturity stage and dry matter accumulation at successive growth stages and at maturity (Dhikwal *et al.*, 2012).

Leaf: Stem (Table 5) was significantly higher in cultivar HJ 541 (0.29) as compared to HC 260 (0.25) at harvest and with application of TU @ 600 ppm at

TABLE 5

Effect of cultivars and thiourea doses on leaf: stem, stem girth and leaf area index at harvest of sorghum under saline condition

Treatments	Leaf: Stem			Stem girth (mm)			LAI		
	HC 260	HJ 541	Mean	HC 260	HJ 541	Mean	HC 260	HJ 541	Mean
T ₁ : Control	0.16	0.21	0.18	13.57	11.67	12.62	3.10	4.20	3.65
T ₂ : Foliar spray of TU @ 400 ppm at 30 DAS	0.24	0.27	0.26	14.82	13.86	14.34	3.87	5.07	4.47
T ₃ : Foliar spray of TU @ 500 ppm at 30 DAS	0.26	0.28	0.27	15.03	13.97	14.50	3.93	5.12	4.53
T ₄ : Foliar spray of TU @ 600 ppm at 30 DAS	0.27	0.29	0.28	15.17	14.12	14.65	4.45	5.66	5.06
T ₅ : Foliar spray of TU @ 400 ppm at 30 and 50 DAS	0.27	0.30	0.29	15.20	14.14	14.67	4.60	5.74	5.17
T ₆ : Foliar spray of TU @ 500 ppm at 30 and 50 DAS	0.28	0.32	0.30	15.23	15.17	15.20	4.68	6.22	5.45
T ₇ : Foliar spray of TU @ 600 ppm at 30 and 50 DAS	0.30	0.33	0.31	16.35	15.20	15.78	5.14	6.25	5.70
Mean	0.25	0.29		15.05	14.02		4.25	5.47	

Factors	40 DAS				60 DAS				At harvest			
	Varieties (Factor A)	Thiourea doses (Factor B)	Factor (B) at same level of A	Factor (A) at same level of B	Varieties (Factor A)	Thiourea doses (Factor B)	Factor (B) at same level of A	Factor (A) at same level of B	Varieties (Factor A)	Thiourea doses (Factor B)	Factor (B) at same level of A	Factor (A) at same level of B
SEm±	0.001	0.003	0.003	0.004	0.10	0.12	0.27	0.18	0.03	0.03	0.08	0.05
CD(p = 0.05)	0.01	0.01	0.02	0.01	0.67	0.34	0.67	0.74	0.20	0.09	0.18	0.21

TABLE 6

Effect of cultivars and thiourea doses on green and dry fodder yield of sorghum under saline condition

Treatments	Green fodder yield (t/ha)			Dry fodder yield (t/ha)		
	HC 260	HJ 541	Mean	HC 260	HJ 541	Mean
T ₁ : Control	22.72	27.93	25.32	4.34	6.90	5.62
T ₂ : Foliar spray of TU @ 400 ppm at 30 DAS	24.69	28.99	26.84	5.86	8.05	6.95
T ₃ : Foliar spray of TU @ 500 ppm at 30 DAS	25.93	29.50	27.72	6.71	8.46	7.58
T ₄ : Foliar spray of TU @ 600 ppm at 30 DAS	26.63	29.79	28.21	6.97	9.01	7.99
T ₅ : Foliar spray of TU @ 400 ppm at 30 and 50 DAS	27.38	31.38	29.38	7.18	10.01	8.59
T ₆ : Foliar spray of TU @ 500 ppm at 30 and 50 DAS	27.62	31.91	29.76	7.45	11.14	9.30
T ₇ : Foliar spray of TU @ 600 ppm at 30 and 50 DAS	28.75	32.26	30.51	9.66	11.50	10.58
Mean	26.25	30.25		6.88	9.30	

Factors	Green fodder yield (t/ha)				Dry fodder yield (t/ha)			
	Varieties (Factor A)	Thiourea doses (Factor B)	Factor (B) at same level of A	Factor (A) at same level of B	Varieties (Factor A)	Thiourea doses (Factor B)	Factor (B) at same level of A	Factor (A) at same level of B
SEm±	0.03	0.09	0.08	0.12	0.04	0.13	0.11	0.17
CD (p = 0.05)	0.20	0.25	0.39	0.37	0.28	0.37	0.57	0.54

30 and 50 DAS (0.31), significantly highest Leaf: Stem was measured as compared to other treatments (Fig. 2). The beneficial role of TU, a sulphhydryl compound, improves the translocation of photosynthates and improving yield attributing factors in plants (Srivastava, 2008).

As in Table 5, stem girth was significantly higher in cultivar HC 260 (15.05 mm) as compared to HJ 541 (14.02 mm) and on mean basis foliar spray of TU @ 600 ppm at 30 and 50 DAS improved stem girth in both cultivars *i.e.* HC 260 and HJ 541 (16.35

and 15.20 mm, respectively). However, HJ 541 was statistically at par with TU @ 500 ppm at 30 and 50 DAS (15.17 mm).

The LAI measured significantly higher in cultivar HJ 541 (5.47) than in HC 260 (Table 5) and, on an average, foliar spray of TU @ 600 ppm at 30 and 50 DAS measured significantly highest LAI (5.70) over other treatments. This might be due to improvement in crop allometric traits such as LAI and morphological traits with thiourea application might be due to better translocation of photosynthates and

TABLE 7
Effect of cultivars and thiourea doses on economics of fodder sorghum under saline condition

Treatments	Cost of cultivation (Rs./ha)			Gross returns (Rs./ha)			Net returns (Rs./ha)			BC ratio		
	HC	HJ	Mean	HC	HJ	Mean	HC	HJ	Mean	HJ	Mean	
	260	541		260	541		260	541		260	541	
T ₁ : Control	36045	36045	36045	45433	55860	50647	9388	19815	14602	1.26	1.55	1.41
T ₂ : Foliar spray of TU @ 400 ppm at 30 DAS	37265	37265	37265	49387	57978	53682	12122	20713	16417	1.32	1.56	1.44
T ₃ : Foliar spray of TU @ 500 ppm at 30 DAS	37445	37445	37445	51869	59000	55435	14424	21555	17990	1.39	1.58	1.48
T ₄ : Foliar spray of TU @ 600 ppm at 30 DAS	37625	37625	37625	53253	59579	56416	15628	21954	18791	1.42	1.59	1.50
T ₅ : Foliar spray of TU @ 400 ppm at 30 and 50 DAS	38185	38185	38185	54767	62756	58761	16582	24571	20576	1.43	1.64	1.54
T ₆ : Foliar spray of TU @ 500 ppm at 30 and 50 DAS	38845	38845	38845	55236	63814	59525	16391	24969	20680	1.42	1.64	1.53
T ₇ : Foliar spray of TU @ 600 ppm at 30 and 50 DAS	39205	39205	39205	57500	64527	61013	18295	25322	21808	1.47	1.65	1.56
Mean	37802	37802	37802	52492	60502	57000	14690	22700	21808	1.39	1.60	1.56

an increase in the ability of plants to withstand abiotic stress (Sher *et al.*, 2021).

Yield

Green and dry fodder yields were found lowest in control (25.32 and 5.63 t/ha) as effected by soil salinity (Table 6). Li *et al.* (2024) reported that the salinity stress reduces plant stomatal conductance, leading to decreased leaf transpiration rates and intercellular CO₂ concentration, ultimately resulting the reduction in photosynthetic capacity and a reduction in yield at harvest. While green and dry fodder yields were significantly higher in cultivar HJ 541 (30.35 and 7.37 t/ha, respectively) over HC 260 (26.25 and 5.85 t/ha, respectively). The application of TU @ 600 ppm at 30 and 50 DAS produced significantly higher green and dry fodder yields *i.e.* 20.5 and 34.1% higher yield, respectively as compared to control. Interaction among cultivars and TU treatment further indicated that the foliar spray of TU @ 500 ppm at 30 and 50 DAS and TU @ 600 ppm at 30 and 50 DAS yielded statistically at par results for HJ 541 but for HC 260, application of TU @ 600 ppm at 30 and 50 DAS performed significantly better over the other treatments. This might be due to the fact that foliar application of TU improves the CO₂ uptake by stomata and its utilization by Rubisco, which carries great implications for final yield. Exogeneous application of TU enhance the germination, growth and photosynthetic attributes of various plants species under stressful condition (Garg *et al.*, 2006).

ECONOMICS

The cost of cultivation (Table 7) was incurred similar (Rs. 37802) for both cultivars *i.e.* HC 260 and HJ 541. On mean basis maximum cost of cultivation was found under foliar spray of TU @ 600 ppm at 30 and 50 DAS (Rs. 39205) compared to other treatments. Meena *et al.* (2023) in their experiment has reported that application of thiourea increases the cost of cultivation. The gross and net returns were highest for cultivar HJ 541 (Rs. 60502 and Rs. 22700, respectively) over HC 260 (Rs. 52492 and Rs. 14690, respectively) and on the basis of average, significantly highest net returns were measured under foliar spray of TU @ 600 ppm at 30 and 50 DAS (Rs. 21808) as compared to other treatments. The similar findings were also reported by Feitosa *et al.* (2016). Among cultivars, highest B:C was fetched with HJ 541 (1.60). On an average, it was found that foliar spray of TU @

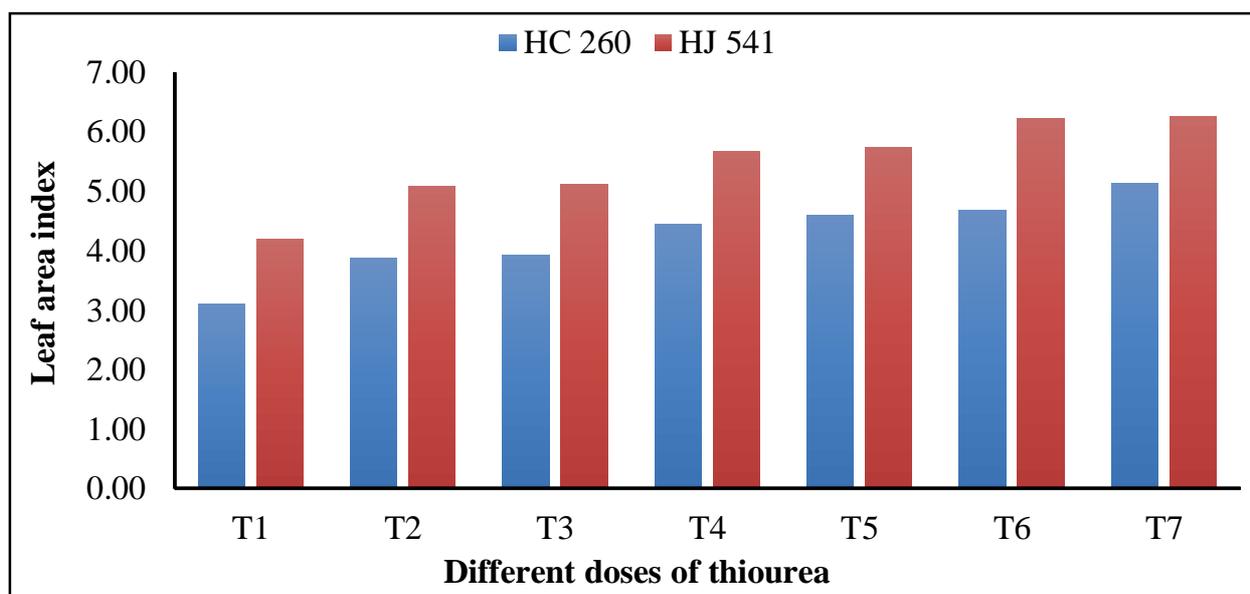


Fig. 2. Effect of cultivars and thiourea doses on LAI of fodder sorghum under saline condition

(T₁: Control, T₂: Foliar spray of TU @ 400 ppm at 30 DAS, T₃: Foliar spray of TU @ 500 ppm at 30 DAS, T₄: Foliar spray of TU @ 600 ppm at 30 DAS, T₅: Foliar spray of TU @ 400 ppm at 30 and 50 DAS, T₆: Foliar spray of TU @ 500 ppm at 30 and 50 DAS, T₇: Foliar spray of TU @ 600 ppm at 30 and 50 DAS)

600 ppm at 30 and 50 DAS had significantly highest B:C (1.56) compared to other treatments. Anitha *et al.* (2004) had also reported increased net returns and high B:C with the application of thiourea.

CONCLUSION

Based on the results, it can be concluded that under saline soil conditions, sorghum cultivar HJ 541 outperformed HC 260 in terms of growth and fodder yield. Across the thiourea treatments, foliar application of thiourea @ 600 ppm at 30 and 50 DAS significantly improved the plant height, LAI, dry matter accumulation and fodder yield. HJ 541 responded better with the foliar application of TU @ 500 as well as 600 ppm but HC 260 responded only at 600 ppm when sprayed at 30 DAS and 50 DAS. Maximum B:C was fetched with sorghum cultivar HJ 541 and application of TU @ 600 ppm at 30 and 50 DAS under saline field conditions.

REFERENCES

- Ahloowalia, B. S., M. Meluzynski and K. Nichterlein, 2004 : Global impact of mutation-derived varieties.
- Anitha, S., E. Sreenivasan and S. M. Purushothaman, 2004 : Effect of thiourea application on cowpea [*Vigna unguiculata* (L.) Walp.] productivity under rainfed conditions. *Journal of Tropical Agriculture*, **42**: 53-54.
- Anonymous (2019). Department of Animal Husbandry &

Dairying, Ministry of Fisheries, Animal Husbandry & Dairying, New Delhi.

CARP, 2024 : Crop Outlook Reports of A.P – Sorghum (2023-24). Centre for Agriculture & Rural development policy research (CARP), ANGARU, Guntur – 522034.

Dhikwal, S. R., S. M. Kumawat, S. Das and B. L. Jat, 2013 : Effect of bio-regulators application on productivity of barley (*Hordeum vulgare* L.) in arid conditions of western Rajasthan. *Forage Research*, **38**(2): 106-111.

Feitosa de Oliveira, H., C. F. de Lacerda, A. B. Marinho, C. M. de Carvalho and H. R. Gheyi, 2016 : Productivity and economic analysis of sunflower/maize crop rotation under different levels of salinity and nitrogen. *African Journal of Agricultural Research*, **11**(23): 1999-2006.

Garg, B. K., U. Burman and S. Kathju, 2006 : Influence of thiourea on photosynthesis, nitrogen metabolism and yield of clusterbean (*Cyamopsis tetragonoloba* (L.) Taub.) under rainfed conditions of Indian arid zone. *Plant Growth Regulation*, **48**(3): 237-245.

Hussein, H. A. A. and S. O. Alshammari, 2022 : Cysteine mitigates the effect of NaCl salt toxicity in flax (*Linum usitatissimum* L.) plants by modulating antioxidant systems. *Scientific Reports*, **12**(12): 1–10.

Kumar, A., S. N. Singh and M. A. Khan, 2018 : To know the effect of foliar application of thiourea and potassium nitrate on physiological growth at different stages of sesame (*Sesame indicum*

- L.). *Journal of Pharmacognosy and Phytochemistry*, **7**(2): 2156-2158.
- Li, J., L. Xu, P. Xuan, Z. Tian and R. Liu, 2024 : Thiourea and arginine synergistically preserve redox homeostasis and ionic balance for alleviating salinity stress in wheat. *Scientific Reports*, **14**(1): 21375.
- Mandal, A.K., R. C. Singh, Gurbachan and J. C. Dagar, 2010 : Computerized Database on Salt Affected Soil in India. *CSSRI Publ. No. 2/2010*, Karnal, pp- 15.
- Meena, D. K., A. Kumar, A. Bhatnagar, R. K. Sharma, A. K. Yogi, K. S. Reddy, P. Naithani and T. Singh, 2023 : Enhancing Soybean Performance with Foliar Application of Thiourea: A Study on Yield, Quality and Economics. *Biological Forum – An International Journal*, **15**(2): 843-851.
- Pance, V. G. and P. V. Sukhatme, 1985 : Statistical methods for agricultural workers, ICAR, Publication, New Delhi.
- Ramadan, H.A., S. A. Al-Niemi and Y. K. Al-Hadathi, 2001 : Salinity and seed germination of corn, sorghum and soybean. *Journal of Agricultural Science*, **12**(2): 97-102.
- Roy, A. K., R. K. Agrawal, N. R. Bhardwaj, A. K. Mishra and S. K. Mahanta, 2019 : Revisiting national forage demand and availability scenario. *Indian fodder scenario: Redefining state wise status. ICAR-AICRP on Forage Crops and Utilization, Jhansi, India*, 1-21.
- Satpal, B. Gangaiah, N. Kumar, S. Devi, N. Kharor, K. K. Bhardwaj, P. Kumari, D. S. Phogat and Neelam, 2020 : Performance of single cut forage sorghum cultivars at different fertilizer levels. *Forage Research*, **46**(2): pp. 202 – 207.
- Satpal, B. Gangaiah, S. Devi, N. Kharor, P. Kumari and B. L. Sharma, 2025 : Performance of brown mid rib (BMR) and Non-BMR single cut forage sorghum [*Sorghum bicolor* (L.) Moench] genotypes under varying levels of NPK fertilizer. *Forage Res.*, **50**(4): 474-482
- Sheoran, O.P., D. S. Tonk, L. S. Kaushik, R. C. Hasija and R. S. Pannu, 1998 : Statistical software package for agricultural research workers. *Recent advances in information theory, statistics & computer applications by DS Hooda & RC Hasija*, Department of Mathematics Statistics, CCSHAU, Hisar, 139- 143.
- Sher, A., X. Wang, A. Sattar, M. Ijaz, S. Ul-Allah, M. Nasrullah, Y. Bibi, A. Manaf, S. Fiaz and A. Qayyum, 2021 : Exogenous application of thiourea for improving the productivity and nutritional quality of bread wheat (*Triticum aestivum* L.). *Agronomy*, **11**(7): 1432.
- Srivastava, A. K., G. Sablok, M. Hackenberg, U. Deshpande and P. Suprasanna, 2017 : Thiourea priming enhances salt tolerance through coordinated regulation of microRNAs and hormones in *Brassica juncea*. *Scientific reports*, **7**(1): 45490.
- Srivastava, A. K., N. S. Nathawat, N. K. Ramaswamy, M. P. Sahu, G. Singh, J. S. Nair and S. F. D'Souza, 2008 : Evidence for thiol-induced enhanced in situ translocation of 14C-sucrose from source to sink in *Brassica juncea*. *Environmental and experimental botany*, **64**(3): 250-255.
- Wahid, A., S. M. A. Basra and M. Farooq, 2017 : Thiourea: A Molecule with Immense Biological Significance for Plants. *International Journal of Agriculture & Biology*. **19**(4): 911-20.
- Yadav, T., A. Kumar, R. K. Yadav, G. Yadav, R. Kumar and M. Kushwaha, 2020 : Salicylic acid and thiourea mitigate the salinity and drought stress on physiological traits governing yield in pearl millet- wheat. *Saudi Journal of Biological Sciences*, **27**(8): 2010-2017.