

# Application of Bio-Regulators and its Effect on Productivity of Barley (*Hordeum Vulgare* L.) in Arable Land of Bundelkhand region (U.P.) India

NEEL RATAN<sup>1</sup>, R.K. GUPTA<sup>1</sup>, NEETU SINGH<sup>2</sup> AND U.N. SINGH<sup>3\*</sup>

<sup>1</sup>Department of Botany, D.V. (P.G.) College, Orai-285001 (U.P.) India

<sup>2</sup>Department of Botany, L.C.H. Mahavidyalaya, Karsan, Orai-285001 (U.P.) India

<sup>3</sup>Retd. Reader, Deptt. of Botany, D.V. (P.G.) College, Orai-285001 (U.P.) India.

\*Corresponding Author Email - drunsingh1945@gmail.com

**Abstract:** A field experiment was conducted on sandy loam soil of Govt. Agriculture Farm of Bohadpura, Orai (Jalaun) during rabi season of 2021-2022. The experiment was comprised of three bio-regulators (500 ppm thiourea, 100 ppm thioglycollic acid and 100 ppm salicylic acid) spray at 40 and 60 DAS with water spray. Foliar spray of bio-regulators (TU, TGA and SA) significantly improved plant height, dry matter accumulation, effective tillers per meter row length, spike length, grains per spike and test weight of barley over water spray control. The maximum grain yield (2844 kg/ha), straw yield (3202 kg/ha), biological yield (5945 kg/ha) and harvest index (47.98%) were obtained with 500 ppm thiourea at 40 and 60 DAS.

**Keywords:** Bio-regulators, *Hordeum vulgare*, Productivity, Salicylic acid (SA), Thioglycollic acid (TGA), Thiourea (TU)

## INTRODUCTION

Barley (*Hordeum vulgare*) is an important cereal crop of India. Ranking of barley is next to the maize, wheat and rice both in acreage and in production of grain. In India, the major states growing barley are Uttar Pradesh, Rajasthan, Punjab, Haryana, Madhya Pradesh, Bihar, Jharkhand and Jammu and Kashmir. It is also grown in small pockets in the other states. However, barley cultivation is concentrated mostly in Uttar Pradesh, Rajasthan and Madhya Pradesh which, put together, account for 80.34 per cent of total barley acreage<sup>[2]</sup>.

Barley is well suited to the condition of water scarcity, poor fertility, salinity and sodicity of soils. Thus, it is grown well where other crops can not be grown successfully.

Foliar application of thiourea (TU), a novel bio-regulator significantly improved growth and yield of several crops<sup>[13,5,4]</sup>. Further, long-term

experiment and demonstration trials on use of thiol including thiourea (TU) and thioglycollic acid (TGA) conducted at research station and in the fields of farmers at different locations have shown positive effect in improving growth and yield of pearl millet, wheat and mustard<sup>[15,8]</sup>. Laboratory study conducted at BARC, Mumbai with the use of thiol bio-regulators (seed soaking and foliar spray) has indicated sensitive influence on the translocation of <sup>14</sup>C sucrose from source to sink and also multi-stress tolerance in mustard<sup>[17]</sup>. Therefore, keeping the above facts in view present investigation was carried out to observe the effect of different bio-regulators on barley for increasing crop productivity under ecologically degraded arable land in Bundelkhand region (U.P.).

## MATERIALS AND METHODS

The experiment was conducted during 2021-22 at Govt. Agriculture Farm, Bohadpura, Orai

(Jalaun) which lies between 25°59' N latitude and 79°37' E longitude at an elevation of 141.6 m above mean sea level under agroclimatic zone (partially irrigated). The climate of the experimental site is dry sub-humid.

The soil of the region is alluvial sandy loam and usually light olive brown in colour, having a slightly alkaline pH range (pH 7.3-7.6).

The experiment was laid out in Randomize block design (RBD) with three replications. The treatments were randomized with the help of random number table (Fischer, 1950). Sowing was done at RxR spacing of 25cm apart towards with dimension of 3.0 m, thus 12 rows in each plot. Each plot consisted gross dimension of 4.0 m x 3.0 m and net area 3.0 m x 2.0 m. Foliar sprays of bio-regulators viz., 500 ppm thiourea (TU), 100 ppm thioglycollic acid (TGA) and 100 ppm salicylic acid (SA) were done at 40 and 60 DAS. Observations were recorded on plant height, dry matter accumulation, effective tillers/meter row length, spike length (cm), number of grains per spike, test weight (g), grain yield (kg/ha), straw yield (kg/ha), biological yield (kg/ha) and harvest index (%). Statistical analysis of data was carried out to each character as described by Agricultural workers<sup>[12]</sup>.

## RESULTS AND DISCUSSION

Foliar spray of bio-regulators viz., 500 ppm thiourea (TU), 100 ppm thioglycollic acid (TGA) and 100 ppm salicylic acid (SA) were done at 40 and 60 DAS. Therefore, effect on growth parameters observed during early growth stages (at 20 and 30 DAS) were due to selective treatments only and at later growth stages 60 and 90 DAS and at maturity (120 DAS) the effect seems due to all treatments under study.

### Effect of bio-regulators on growth parameters Plant height

A critical examination of data (Table 1) indicated that when compared with water spray control, foliar sprays of bio-regulators (TU, TGA and SA) significantly increased plant height of barley at maturity stage. The highest plant height (82.8 cm) was recorded with 500 ppm thiourea spray at 40 and 60 DAS. Foliar sprays of 100 ppm SA at 40 and 60 DAS also registered statistically superiority to

the tune of 3.11 per cent as compared to water spray control. Foliar application of thiourea (TU), a novel bio-regulator significantly improved growth of several crops<sup>[13,5,4]</sup>. Similar reports were also reported by other workers<sup>[7,18]</sup>.

**Table 1 : Effect of bio-regulators on plant stand and plant height of barley**

Treatments Bio-regulators spray	Plant stand/m row length at 20 DAS	Plant height at harvest (cm)
Water spray at 40 and 60 DAS	25.69	77.2
Thiourea (500 ppm) spray at 40 and 60 DAS	26.79	82.8
Thioglycollic acid (100 ppm) spray at 40 and 60 DAS	26.46	81.9
Salicylic acid (100 ppm) spray at 40 and 60 DAS	26.25	79.6
S.Em ±	0.317	0.49
C.D. at 5%	NS	1.5
NS-Non-significant.		

### Dry matter accumulation

Data presented in Table 2 revealed that foliar spray of 500 ppm thiourea at 40 and 60 DAS significantly increased dry matter accumulation per plant noted at 60 DAS over water spray control. The increase was to the tune of 10.48 per cent over water spray (control). Similarly, foliar sprays of TGA and SA also improved dry matter accumulation per plant at 60 DAS, but failed to gain statistically significance over water spray (control). The maximum dry matter accumulation per plant was recorded with 500 ppm thiourea spray (11.14 and 16.46 g/plant). Foliar application of thiourea (TU), a novel bio-regulator significantly improved yield of several crops<sup>[13,5,4]</sup>. Foliar spray of bio-regulators (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. Thiourea has also been reported to stimulate to dark fixation of CO<sub>2</sub> in embryonic axes<sup>[6]</sup> which has resulted into improved photosynthetic efficiency and other physiological processes. Almost similar finding was also reported by someone<sup>[11]</sup>. Thus, these favourable influences of thiourea brought significant improvement in the plant height,

**Table 2: Effect of bio-regulators on dry matter accumulation of barley**

Treatments Bio-regulators spray	Dry matter accumulation (g/plant)			
	30 DAS	60 DAS	90 DAS	120 DAS
Water spray at 40 and 60 DAS	0.18	2.10	10.50	14.09
Thiourea (500 ppm) spray at 40 and 60 DAS	0.19	2.32	11.14	16.46
Thioglycollic acid (100 ppm) spray at 40 and 60 DAS	0.18	2.14	10.96	16.27
Salicylic acid (100 ppm) spray at 40 and 60 DAS	0.18	2.14	10.80	15.87
S.Em $\pm$	0.006	0.31	0.088	0.082
C.D. at 5%	NS	0.08	0.25	0.26
NS-Non-significant.				

dry matter accumulation per plant and effective tillers. Similar results were also reported by some researchers<sup>[7,18]</sup>.

### Effect of bio-regulators on yield attributes Effective tillers

A critical examination of data (Table 3) showed that foliar spray of bio-regulators (TU, TGA and SA) significantly increased the effective tillers per meter row length over water spray control. The maximum effective tillers per meter row length was recorded with 500 ppm thiourea sprayed plots which was higher by 1.77, 4.37 and 8.57 per cent over thioglycollic acid (100 ppm), salicylic acid (100 ppm) and water spray control respectively.

### Spike length

The data furnished in Table 3 revealed that bio-regulators spray (TU, TGA and SA) on the barley significantly increased spike length as compared to water spray control. The maximum spike length (18.77cm) was noted with 500 ppm thiourea spray.

### Grains per spike

Data revealed that bio-regulators spray (TU, TGA and SA) applied at 40 and 60 DAS to barley significantly increased grains per spike over water spray control (Table 3). The maximum grains per spike (36.35) was recorded with 500 ppm thiourea spray.

**Table 3: Effect of bio-regulators on yield attributes of barley at harvest**

Treatments Bio-regulators spray	Effective tillers/ meter row length	Spike length (cm)	Grains/spike (Nos.)	Test weight (g)
Water spray at 40 and 60 DAS	66.02	17.68	34.10	40.43
Thiourea (500 ppm) spray at 40 and 60 DAS	71.68	18.77	36.35	42.50
Thioglycollic acid (100 ppm) spray at 40 and 60 DAS	70.43	18.60	35.98	42.04
Salicylic acid (100 ppm) spray at 40 and 60 DAS	68.68	18.20	35.23	41.51
S.Em $\pm$	0.53	0.10	0.43	0.30
C.D. at 5%	1.33	0.36	0.94	0.88

### Test weight

Data presented in Table 3 revealed that foliar spray of bio-regulators (TU, TGA and SA) significantly increased the test weight of barley grain over water spray control. The maximum test weight (42.50 g) was recorded under 500 ppm thiourea sprayed plot. The beneficial effect of TU and TGA on the yield attributes in crops has also been reported by several research workers<sup>[10]</sup>.

### Effect of bio-regulators on yield Grain yield

Data furnished in Table 4 indicated that bio-regulators spray (TU, TGA and SA) significantly increased grain yield of barley over water spray control. The maximum grain yield (2993kg/ha) was observed with 500 ppm thiourea spray which was significantly higher by 5.24, 10.40 and 11.01 per cent over 100 ppm TGA and 100 ppm SA sprays and water spray control treatments

respectively. Foliar spray with 100 ppm SA also increased grain yield of barley by 7.75 per cent over control. It was also reported that thiourea bio-regulator has potential for increasing crop productivity under environmental changes, which are now on the increase in the wake of changing climate and global warming<sup>[8]</sup>.

The beneficial effect of TU and TGA on the grain yield in crops has also been reported by several research workers<sup>[10,14,15]</sup>. Significant improvement in the grain yield due to foliar spray of 500 ppm TU was also reported by many workers<sup>[19,1,18]</sup>.

### Straw yield

Data presented in Table 4 reveals that bio-regulators spray (TU, TGA and SA) significantly increased straw yield over water spray control. The maximum straw yield of 3345 kg/ha was observed with 500 ppm thiourea spray (at 40 and 60 DAS) which was significantly higher by 4.46, 7.45 and 14.39 per cent over 100 ppm TGA, 100 ppm SA and water spray control respectively. The above findings are in support of other workers<sup>[15,8]</sup>.

**Table 4: Effect of bio-regulators on yield attributes of barley at harvest**

Treatments Bio-regulators spray	Grain yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Harvet index (%)
Water spray at 40 and 60 DAS	2516	2924	5339	47.12
Thiourea (500 ppm) spray at 40 and 60 DAS	2993	3345	6238	47.98
Thioglycollic acid (100 ppm) spray at 40 and 60 DAS	2844	3202	5945	47.84
Salicylic acid (100 ppm) spray at 40 and 60 DAS	2711	3112	5722	47.39
S.Em $\pm$	45.7	44.9	86.8	0.21
C.D. at 5%	130	127	248	0.60

### Biological yield

It is apparent from Table 4 showing the significant increase in biological yield of barley due to the spray of bio-regulators (TU, TGA and SA) at 40 and 60 DAS as compared to water spray (control). The maximum biological yield (6238 kg/ha) was recorded with 500 ppm thiourea spray which was significantly higher by 4.93, 9.02 and 16.8 per cent over 100 ppm TGA, and 100 ppm SA spray and water spray control respectively. Foliar application of thiourea (TU) has been advocated in several crops for yield improvement<sup>[13,5,4]</sup>.

### Harvest index

It is visible from Table 4 that foliar sprays of 500 ppm thiourea and 100 ppm TGA at 40 and 60 DAS significantly increased the harvest index over water spray control. In cereals, grain yield is the ultimate aim and therefore, the partitioning of dry matter between grain and vegetative parts is of great importance<sup>[3]</sup>. The partitioning of dry matter in plant depends on its distribution between leaves and stem. The beneficial role

of thiol, (DTT, TU and TGA) a sulphhydryl compound, in improving the translocation of photosynthates for yield formation has been proved recently in pot study in laboratory conditions at BARC, Mumbai and reported that the efficiency of transport of labelled sucrose (<sup>14</sup>C) from stem to pod of mustard was increased by 88, 44.1, 35.1 per cent over foliar spray treatments as compared to unsprayed control respectively<sup>[17]</sup>. Also enhanced crop growth in terms of plant height and dry matter accumulation per plant increased the straw yield and further increases in biological yield as well as in grain yield i.e., the cumulative effect of improved growth parameters, DMA and grain yield due to foliar spray treatments. Similar results were also reported by several workers<sup>[9,16,15]</sup>.

### CONCLUSIONS

Enhanced crop growth in terms of plant height and dry matter accumulation per plant increased the straw yield and further increases in biological yield as well grain yield was observed due to foliar spray treatments. On the basis of present

investigation, it may be concluded that yield of barley can be maximized with application of thiourea (500 ppm) spray at 40 and 60 DAS gave significantly higher grain and straw yields over water spray control in sandy loam soil of Bundelkhand region (partially irrigated). However, these results are only indicative and require further experimentation for confirmation before making final recommendation.

### ACKNOWLEDGEMENTS

The authors are highly grateful to the head of division, Govt. Agriculture Farm, Bohadpura at Orai (Jalaun) for permitting to conduct the field experiment and providing some facilities and encouragement. Authors are further thankful to the Principal, D.V. Postgraduate College, Orai (U.P.) for rendering the necessary laboratory facilities for carrying out the study. Last but not the least the authors wish to extend the sincere thanks to the Head of Division of Seed Technology, IGFRI, Jhansi for fruitful discussion.

### REFERENCES

1. Choudhary BR, Keshwa GL, Parihar CM. *Ann. Agric. Res.* 2005; **26** : 424-427.
2. Dogra S. *Barley farming the next big thing*. Business Standard Books. 2008.
3. Donnal CM, Hamblin J. The biological yield and harvest index of cereals as agronomic and plant breeding criteria. *Adv. Agron.* 1976; **28** : 361-405
4. French A, Wahid A, Arshad M. *International J. Agric. Biol.* 2008; **10** : 619-626.
5. Garg BK, Burman U, Kathju S. *Plant Growth Regulation.* 2006; **48** : 237-245.
6. Hernandez- Nistal, Aidasora JD, Matilla A, Nicolas G. *Physiologia Plantarum.* 1983; **57**: 273-278.
7. Kumawat PD. *Ph. D. Thesis.* RAU, Bikaner. 2004.
8. Kumawat SM, Garg DK, Bunia SR. *Krishi Anusandhan Ki Uplobdhiyan*, 2001-2008; pub, DOR (Ag)/2009/02 pp 1-12.
9. Lakhana RC. *M.Sc. (Ag.) Thesis.* RAU, Bikaner. 2001.
10. Lakhana RC, Gupta AK, Shivran AC, Shivran RK. *Ann. Agric. Res.* 2005; **26** : 218-223.
11. Nathawat NS, Nair JS, Kumawat SM, Yadav NS, Singh G, Ramaswamy NK, Sahu MP, D'souza SF. *Biologia Plantarum.* 2007; **51**(1) : 93-97.
12. Panse VG, Sukhatme PV. *Statistical Methods for Agricultural Workers.* ICAR, New Delhi, 1967.
13. Sahu MP, Singh D. *J. Pl. Growth Regulation.* 1995; **14** : 169-173.
14. Sahu MP, Kumawat SM, D'souza SF, Ramaswamy NK, Singh G. Sulphydryl bio-regulator technology for increasing mustard production. *Research Bulletin RAU-BARC No. 1.* 2005; pp. 52.
15. Sahu MP, Kumawat SM, Singh G, Ramaswamy NK, D'souza SF. Consolidated progress report of the research project entitled "Establishment of Radiotracer Laboratory and Multilocation testing of crop varieties developed at BARC 2000-2007" sponsored by BRNS, Deptt. of Atomic Energy, Govt. of India. Published by RAU, Bikaner-334006 (Raj.). 2007; pp 1 to 128.
16. Solanki NS. *Ph.D. Thesis.* MPUAT, Udaipur. 2002.
17. Srivastava AK, Nathawat NS, Ramaswamy NK, Sahu MP, Singh G, Nair JS, Paladi RK, D'souza SF. *Environ. and Exper. Botany.* 2008; **64** : 250-255.
18. Yadav LR. *Ph.D. Thesis* RAU, Bikaner. 2005.
19. Yadav NS. *Ph.D. Thesis.* RAU, Bikaner. 2002.