*Forage Res.,* **38** (2) : pp. 106-111 (2012) **http://forageresearch.in**

# EFFECT OF BIO-REGULATORS APPLICATION ON PRODUCTIVITY OF BARLEY (*HORDEUM VULGARE* L.) IN ARID CONDITIONS OF WESTERN RAJASTHAN

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(Received: 29 December, 2012, Accepted: 26 July, 2013)

**SUMMARY**

A field experiment entitled "Effect of Bio-regulators application on productivity of barley (*Hordeum vulgare* L.) in arid conditions of Western Rajasthan" was conducted on loamy sand soil of the Agronomy farm, College of Agriculture, Bikaner during **rabi** season of 2009-2010. The experiment was comprised of three bio-regulators (500 ppm thiourea, 100 ppm thioglycolic 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 (2743 kg/ha), straw yield (3101kg/ha), biological yield (5844 kg/ha), harvest index (47.10 %), protein and total protein content were obtained with 500 ppm thiourea at 40 and 60 DAS.

**Key words :** Bio-regulators thiourea, thioglycolic acid, salicylic acid, productivity, *Hordeum vulgare*

Barley (*Hordeum vulgare* L.) is an important cereal crop of India, which play a major role in the barley producing countries. 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, Himachal Pradesh, Bihar, Jharkhand and Jammu and Kashmir. It is also grown in small pockets in the other states like Chhattisgarh, West Bengal, Nagaland, Maharashtra, Sikkim and Delhi. 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 (Dogra, 2008). Rajasthan ranks second after Uttar Pradesh both in area and production. During the year 2008-09, it was grown in nearly 2.87 lakh hectares with production and productivity levels of 8.78 lakh tonnes and 3061 kg/ha, respectively (Anonymous, 2009).

In the state of Rajasthan, important barley growing regions are Jaipur, Bharatpur, Sriganganagar, Bhilwara and Jodhpur. Presently, with the advent of irrigation facilities through canals and tube-wells, area under barley cultivation is increasing in arid western region comprising districts of Bikaner, Jaisalmer, Barmer, Jodhpur and Churu. But productivity level is too low fluctuating between 10-18 q/ha because of course textured sandy soils with poor fertility status, low water retention capacity and stressful environmental conditions. Though, 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 cannot be grown successfully.

Foliar application of thiourea (TU), a novel bio-regulator significantly improved growth and yield of several crops (Sahu and Singh 1995, Garg *et al.,* 2006 and French *et al.*, 2008). Further, long-term experimentation and demonstration trials on use of thiol including thiourea (TU) and thioglycolic acid (TGA) conducted at research station and in the fields of farmers at different locations in Rajasthan have shown positive effect in improving growth and yield of pearl millet, wheat and mustard (Sahu *et al.,* 2007 and Kumawat *et al.,* 2009). They further reported that thiourea bio-regulators

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has potential for increasing crop productivity under environmental stresses, which are now on the increase in the wake of changing climate and global warming. Moreover, laboratory study conducted at BARC, Mumbai with the use of these thiol bioregulators (seed soaking and foliar spray) has further indicated positive influence on the translocation of 14-C sucrose from source to sink and also multi-stress tolerance in mustard (Srivastava *et al.*, 2009). Threfore, keeping the above discussion in view present investigation was carried out to observe the effect of different bio-regulators on barley for increasing crop productivity under environmental stresses.

## MATERIALS AND METHODS

The experiment was conducted at Agronomy Farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner. Geographically, Bikaner is situated at $28.01^0$N latitude and $73.22^0$ E longitude at an altitude of 234.70 meters above mean sea level under agro climatic zone 1c (Hyper arid partially irrigated north western plain) of Rajasthan. The experiment was laid out in Randomized Block Design (RBD) with three replications. The treatments were randomized with the help of random number table (Fisher, 1950). Sowing was done at R x R spacing of 25 cm apart towards width 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 thioglycolic 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), Harvest index (%). Statistical analysis of data was carried out for each character as described by Panse and Sukhatme (1967).

## RESULTS AND DISCUSSION

Foliar sprays of bio-regulators viz. 500 ppm thiourea (TU), 100 ppm thioglycolic 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 bioregulators (TU, TGA and SA) significantly increased plant height of barley at maturity stage. The highest plant height (81.93 cm) was recorded with 500 ppm thiourea spray at 40 and 60 DAS, closely followed by 100 ppm TGA spray (80.8 cm) and both these treatment registered statistically superiority over 100 ppm SA spray and water spray control treatments. The corresponding in increases in plant height was of the order of 4.30 and 2.86 per cent over 100 ppm SA spray and by 7.60 and 6.12 per cent over water spray control, respectively. Foliar sprays of 100 ppm SA at 40 and 60 DAS also registered statistically superiority to the tune of 3.17 per cent as compared to water spray control. Foliar application of thiourea (TU), a novel bio-regulator

TABLE 1
Effect of bio-regulators on plant stand and plant height of barley

| Treatment Bio-regulators spray | Plant stand/m row length at 20 DAS | Plant height at harvest |
|---|---|---|
| Water spray at 40 and 60 DAS | 24.58 | 76.1 |
| Thiourea (500 ppm) spray at 40 and 60 DAS | 25.68 | 81.9 |
| Thioglycollic acid (100 ppm) spray at 40 and 60 DAS | 25.35 | 80.8 |
| Salicylic acid (100 ppm) spray at 40 and 60 DAS | 25.14 | 78.5 |
| S. Em± | 0.328 | 0.55 |
| C. D. at 5% | NS | 1.6 |

NS – Non-significant.

significantly improved growth of several crops (Sahu and Singh 1995, Garg *et al.*, 2006 and French *et al.*, 2008). Similar results were also reported by Kumawat (2004) in mustard, Yadav (2005) in wheat.

**Dry matter accumulation**

Data presented in Table 2 revealed that foliar sprays 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 13.84 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 grain statistically significance over water spray (control). Data further indicated that foliar spray of bio-regulators (TU, TGA and SA) significantly increased dry matter accumulation per plant at later growth stages (90 and 120 DAS) in comparison to water spray (control). The maximum dry matter accumulation per plant was recorded with 500 ppm thiourea spray (10.04 and 15.36 g/plant) being at par with 100 ppm TGA spray (9.86 and 15.17 g/plant) and both these treatments increased dry matter accumulation per plant by 3.99, 2.71 and 9.79, 8.43 per cent over 100 ppm SA spray and water spray control, respectively at maturity stage. Foliar application of thiourea (TU), a novel bio-regulator significantly improved yield of several crops (Sahu and Singh 1995, Garg *et al.*, 2006 and French *et al.*, 2008). 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. However, dry matter accumulation at early growth stage (30 DAS) did not influenced as the treatments were applied at 40 and 60 DAS. Thiourea has also been reported to stimulate to dark fixation of CO2 in embryonic axes (Hemandez-Nistal *et al*., 1983) which has resulted into improved photosynthetic efficiency and other physiological processes. Almost similar findings were also reported by Ramaswamy *et al.(*2007) in pearl millet and Nathawat *et al*. (2007) in wheat. Thus, these favourable influences of thiourea brought significant improvement in the plant height, dry matter accumulation per plant and effective tillers. Similar results were also reported by Kumawat (2004) in mustard, Yadav (2005) in wheat.

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 | 0.17 | 1.59 | 9.40 | 13.99 |
| Thiourea (500 ppm) spray at 40 and 60 DAS | 0.18 | 1.81 | 10.04 | 15.36 |
| Thioglycollic acid (100 ppm) spray at 40 and 60 DAS | 0.17 | 1.63 | 9.86 | 15.17 |
| Salicylic acid (100 ppm) spray at 40 and 60 DAS | 0.17 | 1.1.63 | 9.70 | 14.77 |
| S.Em± | 0.006 | 0.032 | 0.089 | 0.093 |
| CD at 5% | NS | 0.09 | 0.26 | 0.27 |

NS – Non-significant.

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 | 63.92 | 17.13 | 31.00 | 39.32 |
| Thiourea (500 ppm) spray at 40 and 60 DAS | 69.58 | 18.22 | 33.25 | 41.39 |
| Thioglycollic acid (100 ppm) spray at 40 and 60 DAS | 68.33 | 18.05 | 32.88 | 40.93 |
| Salicylic acid (100 ppm) spray at 40 and 60 DAS | 66.58 | 17.65 | 32.13 | 40.40 |
| S.Em± | 0.42 | 0.09 | 0.32 | 0.28 |
| CD at 5% | 1.22 | 0.25 | 0.93 | 0.81 |

**Effect of Bio-Regulators on Yield Attributes**

**Effective tillers**

A critical examination of data Table 3.showed that foliar spray of bioregulators (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 1.83, 4.51 and 8.85 per cent over thioglycolic acid (100 ppm), salicylic acid (100 ppm) and water spray control, respectively. Also foliar spray with 100 ppm TGA at 40 and 60 DAS registered significantly higher effectively tillers per metre row length in comparison to 100 ppm SA spray and water spray control.

**Spike length**

The data furnished in Table 3 revealed that bio-regulators sprays (TU, TGA and SA) onto barley significantly increased spike length as compared to water spray control. The maximum spike length (18.22 cm) was noted with 500 ppm thiourea spray which was found at par with 100 ppm TGA spray at 40 and 60 DAS and increased the spike length by 3.23 and 2.27 per cent over 100 ppm salicylic acid spray and by 6.36 and 5.37 per cent over water spray control, respectively.

**Grains per spike**

Data revealed that bioregulators 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 (33.25) was recorded with 500 ppm thiourea spray closely followed by 100 ppm TGA spray (32.87) which were significantly higher by 3.49 and 7.26 per cent over 100 ppm salicylic acid and water spray control respectively. Further foliar spray of 100 ppm TGA and 100 ppm SA at 40 and 60 DAS proved statistically identical in this regard.

**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 (41.39 g) was recorded under 500 ppm thiourea sprayed plots being at par with thioglycolic acid (100 ppm) sprayed plot and was higher by 2.45 and 5.26 per cent over 100 ppm SA spray and water spray control, respectively. The beneficial effect of TU and TGA on the yield attributes in crops has also been reported by several research workers Lakhana *et al.*(2005)

**Effect of Bio-Regulators on Yield**

**Grain yield**

Data in table 4 further indicated that bio-regulators spray (TU, TGA and SA) significantly increased grain yield of barley over water spray control. The maximum grain yield (2892 kg/ha) was observed with 500 ppm thiourea spray which was significantly higher by 5.43, 10.80 and 19.75 per cent over 100 ppm TGA and 100 ppm SA sprays and water sprays control treatments, respectively. Also, 100 ppm thioglycolic acid spray also showed significant edge in grain yield to the tune of 5.10 and 13.58 per cent over 100 ppm salicylic acid and water spray control, respectively. Similarly 100 ppm SA spray increased grain yield of barley by 8.07 per cent over control. Kumawat *et al.*, (2009) also reported that thiourea bio-regulators has potential for increasing crop productivity under environmental stresses, which are now on the increase in the wake of

TABLE 4
Effect of bio-regulators on grain, straw and biological yield and harvest index of barley

| Treatments Bio-regulators spray | Grain yield (kg/ha) | Straw yield (kg/ha) | Biological yield (kg/ha) | Harvest index (%) |
|---|---|---|---|---|
| Water spray at 40 and 60 DAS | 2415 | 2823 | 5238 | 46.11 |
| Thiourea (500 ppm) spray at 40 and 60 DAS | 2892 | 3244 | 6137 | 47.10 |
| Thioglycollic acid (100 ppm) spray at 40 and 60 DAS | 2743 | 3101 | 5844 | 46.92 |
| Salicylic acid (100 ppm) spray at 40 and 60 DAS | 2610 | 3011 | 5621 | 46.41 |
| S.Em± | 44.6 | 43.8 | 85.7 | 0.20 |
| CD at 5% | 129 | 126 | 247 | 0.59 |

changing climate and global warming.

The beneficial effect of TU and TGA on the grain yield in crops has also been reported by several research workers Lakhana *et al.*(2005) and Sahu *et al.* (2005 and 2007). Significant improvement in the grain yield due to foliar spray of 500 ppm TU was also reported Yadav (2000) in oat, Choudhary (2005) in mustard, and Yadav (2005) in wheat.

**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 3244 kg/ha was observed with 500 ppm thiourea spray (at 40 and 60 DAS) which was significantly higher by 4.61, 7.74 and 14.91 per cent over 100 ppm TGA, 100 ppm SA and water spray control, respectively. Foliar sprays with 100 ppm TGA and 100 ppm SA (at 40 and 60 DAS) onto barley being at par with each other, improved straw yield by 9.85 and 6.66 per cent over water spray control, respectively. Above findings were supported by Sahu *et al.,* 2007 and Kumawat *et al.,* (2009).

**Biological yield**

It is apparent from Table 4 showing the significantly increased in biological yield of barley due to spray of bio-regulators (TU, TGA and SA) at 40 and 60 DAS as compared to water spray (control). The foliar spray of 500 ppm TU, 100 ppm TGA and 100 ppm SA at 40 and 60 DAS have resulted in increased biological yield to the tune of 17.16, 11.57 and 7.31 per cent, respectively over water spray (control). The maximum biological yield (5844 kg/ha) was recorded with 500 ppm thiourea sprays which was significantly higher by 5.01, 9.18 and 17.16 per cent over 100 ppm TGA and 100 ppm SA spray and water spray control, respectively. Foliar application of thiourea (TU) have been advocated in several crops for yield improvement (Sahu and Singh 1995, Garg *et al.,* 2006 and French *et al.,* 2008).

**Harvest index**

It is apparent 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. Further, foliar spray of 100 ppm TGA proved statistically at par with 100 ppm SA spray and registered statistically superiority 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 (Donold and Habablin, 1976). The partitioning of dry matter in plants depends on its distribution between leaves and stem. The beneficial role of thiol, (DTT, TU and TGA) a sulphydryl 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 labeled sucrose ($^{14}$-c) from stem to pod of mustrad was increased by 88, 44.1, 35.1 per cent over foliar spray treatments as compared to unsprayed control, respectively (Srivastava 2008). 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 (Lakhana, 2001 and Solanki, 2002 and Sahu *et al.* 2007).

## CONCLUSION

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. The cumulative effect of improved growth parameters, DMA and 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 on loamy sandy soils of zone IC (Hyper Arid Partially Irrigated Western Plains). However, these results are only indicative and require further experimentation for confirmation before making final recommendation.

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