### *Original Research Article*

### **Optimizing Paclobutrazol-Based Growth Regulation: Effects of Butrabloom Super 40% on Major Crops**

### Abstract

Climate stress disrupts crop development by unbalancing vegetative and reproductive phases, reducing yield potential. This study evaluated paclobutrazol-based Butrabloom Super (Paclobutrazol 40% SC), a triazole derivative that inhibits gibberellin biosynthesis, on wheat, mustard and tomato grown in Kachchh during Rabi 2024. Using a Randomized Block Design with three replications, three BBS doses (30, 40, and 50 ml/150L) were applied once (50–55 DAS) and twice (30–35 and 65–70 DAS), compared to a recommended fertilization dose (RFD) as control. Results demonstrated BBS effectiveness across all crops. Wheat yield increased by 13.12% with 40 ml/acre applied twice, improving tiller formation and ear length. Mustard showed optimal seed yield at the same dosage and frequency. Tomato yielded best (18.1% increase) with 50 ml/acre applied twice due to increased fruit numbers. Lower doses (30-40 ml) proved more effective for cereals and oilseeds, while tomato responded better to higher concentrations (50 ml). These findings established BBS as an effective growth regulator for enhancing productivity in diverse crops, with benefits maximized through strategic timing and crop-specific dosage optimization.

Key words: Butrabloom Super,paclobutrazol, wheat, fertilization, mustard, seed, tomato

### Introduction

Agricultural intensification and climate change pose significant threats to food security and environmental sustainability. Climate change disrupts plant growth and development, with aberrant weather events affecting the balance between vegetative and reproductive phases. This imbalance compromises sink formation and the efficient movement of photosynthates, ultimately reducing crop productivity. (Farhana & Rahman, 2023; Semeraro *et al*., 2023).

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Plant growth regulators (PGRs) can be defined as naturally occurring or synthetic compounds that affect develop-mental or metabolic processes in higher plants, mostly at low dosages. They do not possess a nutritive value and, typically, are not phytotoxic (Rademacher, 2015). Plant hormones play a crucial role in regulating these processes, particularly under stress conditions. (Vineeth *et. al*. 2016) Among them, triazole derivatives such as Butrabloom Super (BBS), a paclobutrazol-based product, function as both fungicides and plant growth regulators (PGRs). When applied as a foliar spray or soil drench, BBS controls excessive shoot elongation, strengthens root systems and enhances resistance to abiotic stresses, ultimately improving yield. (Zhu *et al*., 2021). They play a role in affecting growth, yield and quality of crops (Yan *et. al*. 2011)

BBS exerts its protective effects by modulating key hormones like elevating cytokinins, temporarily increasing abscisic acid (ABA) and reducing ethylene levels. (Li *et al*., 2016). It inhibits gibberellin (GA) biosynthesis, promoting compact growth while preventing ABA degradation. This regulation helps maintain water balance, reduce electrolyte leakage and enhance photosynthetic efficiency by increasing osmolytes, antioxidants and endogenous hormones. By suppressing vegetative overgrowth and counteracting GA-induced elongation, BBS fosters sturdier, more resilient plants. (Sarkar *et al*., 2020). The application of paclobutrazol can inhibit crop height, increase stress tolerance, promote tillering, and increase spike number and yield (Hajihashemi *et al*., 2007; Gómez *et al*., 2011; Peng *et al*., 2014; Dwivedi *et. al*, 2017). Considering these attributes, the present study was undertaken to evaluate the impact of Butrabloom Super on diverse crops viz; wheat, mustard and tomato.

### Materials and Method

Field experiments were conducted in a Randomized Block Design (RBD) with three replications at AGROCEL Industries Pvt. Ltd. R&D Farm, Koday, Mandvi, Kachchh during the *Rabi* season of 2024 to assess the effect of Butrabloom Super 40% on the growth and yield of wheat (*Triticum aestivum* L.), mustard (*Brassica juncea* L.) and tomato (*Lycopersicon esculentum*). The experiments comprised comparison of three 3 doses (30, 40 & 50 ml/150 L) of Butrabloom Super 40% applied once (50-55 DAS) and twice (30-35//65-70 DAS) in addition to the RFD of the respective crop and RFD as check.

The experiments site represented sandy loam soil with a light brown colour, well-drained and fairly retentive of moisture. The soil was low in available nitrogen, optimum in available phosphorus and medium in available potassium. Fertilizer application was carried out according to the respective treatments for each crop. GW 496, GDM 4 and F1 Hybrid (No. 525) were used as a cultivar for wheat, mustard and tomato, respectively. All necessary agronomic practices were followed as per the recommended practices for the respective crops. The biometric observations were recorded from five randomly selected plants within each net plot. The parameters observed included plant height, effective tillers/plant, ear length, seeds/ear, test weight, grain yield, primary branch/plant, secondary branch/plant, siliqua/plant, seeds/siliqua, seed yield, No. of fruits/plot, fruit diameter, fruit weight, fruit yield. The data recorded for various parameters during the course of investigation were statistically analysed by a producer appropriate to the design of experiment as described by Panse and Sukhatme (1985). The significance of difference was tested by “F” test at 5 per cent level.

### Results and discussion

Effect of Butrabloom Super 40% on Wheat

The conduct of the experiment was precise as indicated by lower values of CV across different characters (5.03%-7.83%). The treatments differences were significant for effective tillers/plant and ear length (Table 1). All the treatments gave numerical higher grain yield than RFD (1359 kg/acre) that ranged from 0.18% in BBS 50 ml/acre/150L water to 13.12% in BBS 40 ml/acre/150L water both applied twice at 30-35//65-70 DAS. Improvement in effective tillers/plant that ranged from 8.57% to 20.00% was quite conspicuous in all the treatments where BBS was applied. Further, application twice (30-35//65-70 DAS) was better than once (50-55 DAS) and that BBS was more effective at lower doses (30 ml and 40 ml/150L) than at higher dose of 50ml/150L of water.

Reza *et al* (2023) reported that peclobutrazol (PBZ) was effective in increasing grain yield by 14% compared to control treatment. They further reported that a combination of PBZ and PGPR treatments as a highly recommended approach for mitigating the adverse effects of water deficits, especially in the context of escalating climate change challenges. Pirahmadi (2017) showed that seed priming had significant effects on number of spikelets per spike /square meter, grain numbers/spike, spike length, 1000-seed weight and grain yield. Further, priming the seeds with 25 mg/L PBZ increased the length of the spike and the number of spikelets/spike with prolonged period of spikelet growth.

Effect of Butrabloom Super 40% on Mustard

In mustard too, lower doses of 30 ml and 40 ml/acre/150L water applied twice (30-35//65-70 DAS) exhibited 7.15% and 15.96% higher yields over RFD (878 kg/acre), respectively, compared to 5.25% and 6.06% higher yields when applied once (50-55 DAS), respectively. However, at a higher dose of 50 ml, only one application was better giving an 11.01% higher seed yield compared to two applications, which resulted in a 5.79% increase.

Among the yield attributes, Butrabloom Super 40% reduced plant height ranging from 1.69% to 6.42% over RFD, the reduction in plant height was more effective as the dose was increased (Table 2). There was increase in primary branches by 6.10% to 14.63%, secondary branches by 13.65% to 20.48%, siliqua per plant by 0.74% to 4.72% and test weight by 0.77% to 9.54% over RFD. The number of seeds per siliqua exhibited no pattern with the application of Butrabloom Super 40%. Overall, application of 40 ml Butrabloom Super 40% twice (30-35//65-70 DAS) appeared to be the best dose in mustard. Soumya *et al*; (2017) have also reported reduction in plant height with PBZ application in mustard with concomitant increase in resistance to lodging, branching and yield. They also reported that PBZ provided plant protection against numerous abiotic stresses by maintaining relative water content, membrane stability index, photosynthetic activity, photosynthetic pigments and protects the photosynthetic machinery by enhancing the level of osmolytes, antioxidant activities and level of endogenous hormones and thereby enhances the yield.

Effect of Butrabloom Super 40% on Tomato

In tomato, all treatments of BBS showed an increase in fruit yield over RFD (17.05 tons/acre), ranging from 3.4% in BBS 30 ml/acre/150L water applied twice at 25-30//45-50 DAS to 18.1% in BBS 50 ml/acre/150L water applied twice at 25-30//45-50 DAS (Table 3). The increase in fruit yield was mainly attributed to an increase in the number of fruits, which varied from 2.1% in BBS 30 ml/acre to 19.8% in BBS 50 ml/acre. Other yield attributes, such as fruit diameter and fruit weight, also increased in some treatments but showed no consistent trends. Overall, higher dose of BBS 50 ml/acre/150L water applied twice at 25-30//45-50 DAS appeared as the best dose for realizing higher fruit yield with more numbers of fruits. In consonance to the present findings, Berova and Zlatko (2000) have also reported that PBZ application in tomato led to reduced plant height, increased stem thickness, accelerated root formation and improved overall fruit yield. Soumya *et al*; (2017) reported that tomato plants treated with PBZ demonstrated significant enhancements in fruit yield and water use efficiency, indicating PBZ's potential to improve productivity in tomato cultivation. Souza-Machado *et al* (1999) reported that significant earliness in harvest maturity was recorded in PBZ-treated tomato plants but no significant total yield differences were recorded between the PBZ and control plants. These studies collectively underscore the potential of paclobutrazol to enhance yield and yield attributes in wheat, mustard, and tomato by modulating plant growth characteristics and improving stress resilience.

Conclusion

The study demonstrated the efficacy of Butrabloom Super (BBS) in enhancing crop performance across different crops viz; wheat, mustard and tomato. In wheat, BBS significantly improved effective tillers per plant and ear length, leading to higher grain yields across all treatments compared to RFD, with the best response observed at 40 ml/acre applied twice. Mustard showed a similar trend, where two applications of 40 ml BBS resulted in the highest seed yield and improved key yield attributes, including primary and secondary branches, siliqua per plant and test weight. In tomato, BBS application consistently increased fruit yield, primarily due to a higher number of fruits, with the best results observed at 50 ml/acre applied twice. Overall, lower doses of BBS (30–40 ml) applied twice proved more effective in wheat and mustard, while a higher dose (50 ml) was optimal for tomato. These findings highlight the potential of BBS as an effective plant growth regulator for improving yield and stress resilience across diverse crops.

**COMPETING INTERESTS DISCLAIMER:**

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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Table 1. Impact of different doses and frequencies of Butrabloom Super 40% on grain yield and its components in Wheat

| **Treatment Designation** | **Plant Height (cm)** | **Effective Tillers/Pl.** | **Ear Length (cm)** | **Seeds**  **/Ear** | **Test Wt (g)** | **Grain Yield (kg/acre)** |
| --- | --- | --- | --- | --- | --- | --- |
| **T1** BBS 30 ml 1X | 76.07 | 5.07 | 7.33 | 32.67 | 45.90 | 1383 |
| **T2** BBS 30 ml 2X | 80.73 | 5.33 | 7.87 | 34.60 | 46.45 | 1533 |
| **T3** BBS 40 ml 1X | 80.47 | 5.13 | 8.33 | 33.33 | 40.20 | 1415 |
| **T4** BBS 40 ml 2X | 82.80 | 5.60 | 8.27 | 33.13 | 43.74 | 1537 |
| **T5** BBS 50 ml 1X | 79.47 | 5.13 | 7.00 | 36.40 | 45.37 | 1385 |
| **T6** BBS 50 ml 2X | 78.20 | 5.07 | 7.73 | 31.87 | 45.18 | 1396 |
| **T7** RFD (48:24:16:00 kg NPKS) | 75.00 | 4.67 | 7.67 | 34.40 | 43.24 | 1359 |
| **S.Em.±** | 2.67 | 0.16 | 0.24 | 0.98 | 2.00 | 46.19 |
| **CD 5%** | NS | 0.50 | 0.74 | NS | NS | NS |
| **CV %** | 5.87 | 5.47 | 5.41 | 5.03 | 7.83 | 5.61 |

Table 2. Impact of different doses and frequencies of Butrabloom Super 40% on seed yield and its components in mustard

| **Treatment** | **Plant Height (cm)** | **Primary Br./Pl.** | **Secondary Br./Pl.** | **Siliqua**  **/Plant** | **Seeds**  **/Siliqua** | **Test Wt (g)** | **Seed Yield (kg/acre)** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **T1** BBS 30 ml 1X | 165.07 | 5.80 | 18.87 | 315.67 | 11.53 | 4.560 | 924 |
| **T2** BBS 30 ml 2X | 164.33 | 6.07 | 19.33 | 317.47 | 12.27 | 4.846 | 941 |
| **T3** BBS 40 ml 1X | 162.60 | 6.13 | 19.73 | 317.27 | 11.73 | 4.475 | 932 |
| **T4** BBS 40 ml 2X | 159.00 | 6.27 | 20.00 | 328.13 | 11.07 | 4.864 | 1018 |
| **T5** BBS 50 ml 1X | 166.27 | 6.13 | 19.87 | 317.73 | 10.93 | 4.800 | 975 |
| **T6** BBS 50 ml 2X | 158.27 | 6.00 | 19.07 | 316.93 | 11.40 | 4.743 | 929 |
| **T7**RFD (20:20:00:16) | 169.13 | 5.47 | 16.60 | 313.33 | 11.73 | 4.441 | 878 |
| **S.Em.±** | 6.19 | 0.27 | 0.79 | 13.36 | 0.36 | 0.13 | 51.86 |
| **CD 5%** | NS | NS | NS | NS | NS | NS | NS |
| **CV %** | 3.66 | 7.71 | 7.18 | 7.28 | 5.43 | 4.75 | 9.53 |

Table 3. Impact of different doses and frequencies of Butrabloom Super 40% on fruit yield and its components in tomato

| **Treatment Designation** | **No. of Fruits/Plot** | **Fruit Diameter (mm)** | **Fruit Weight (g)** | **Fruit Yield (kg/plot)** | **Fruit Yield (t/acre)** |
| --- | --- | --- | --- | --- | --- |
| **T1** BBS 30 ml 1X | 659 | 48.51 | 42.30 | 27.06 | 18.02 |
| **T2** BBS 30 ml 2X | 642 | 49.16 | 43.33 | 26.47 | 17.63 |
| **T3** BBS 40 ml 1X | 673 | 46.70 | 41.36 | 27.62 | 18.40 |
| **T4** BBS 40 ml 2X | 685 | 47.30 | 41.52 | 27.63 | 18.40 |
| **T5** BBS 50 ml 1X | 651 | 48.22 | 42.36 | 27.31 | 18.19 |
| **T6** BBS 50 ml 2X | 753 | 48.02 | 41.67 | 30.23 | 20.13 |
| **T7** RFD (30:15:15:00 kg NPKS/Acre) | 629 | 47.71 | 41.67 | 25.61 | 17.05 |
| **S.Em. ±** | 50.94 | 1.64 | 0.79 | 2.34 | 1.56 |
| **CD 5%** | NS | NS | NS | NS | NS |
| **CV %** | 13.16 | 5.91 | 3.27 | 14.80 | 14.80 |