Effect of Hormones on Yield and Economics of Mustard (*Brassica juncea* L.) under Southern Telangana Agro-Climatic Conditions

Ganta Harshitha¹*, Ch. Bharat Bhushan Rao¹, T. Ram Prakash² and S. A. Hussain¹

¹Professor Jayashankar Telangana State Agriculture University, Hyderabad, Telangana, India.
²Department of SSAC, AICRP on Weed Management, Hyderabad, Telangana, India.

Authors’ contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJECC/2021/v11i730445

Editor(s):
(1) Dr. Anthony R. Lupo, University of Missouri, USA.
Reviewers:
(1) A. W. Paulus, Indonesia.
(2) R. Raju, India.
(3) Pradeep Kumar Rajput, The Maharaja Sayajirao University of Baroda, India.
Complete Peer review History: https://www.sdiarticle4.com/review-history/72732

Received 12 June 2021
Accepted 19 August 2021
Published 08 September 2021

Original Research Article

ABSTRACT

An experiment was carried out at student farm, College of Agriculture, Rajendranagar, Hyderabad, Telangana, in sandy loam soils during *rabi* 2020 to study the effect of hormones on growth and yield of mustard under Southern Telangana Agro-climatic conditions. The experiment was laid out in randomized block design with ten treatments. The treatments comprised were: T₁-Control (RDF 60:40:40 N, P₀O₅, K₀O kg ha⁻¹), T₂ (RDF + foliar spray of GA₃ @ 45 ppm at flowering), T₃ (RDF + foliar spray of GA₃ @ 45 ppm at pod development), T₄ (RDF + foliar spray of GA₃ @ 45 ppm at flowering and pod development), T₅ (RDF + foliar spray of humic acid @ 1.5% at flowering), T₆ (RDF + foliar spray of humic acid @ 1.5% at pod development), T₇ (RDF + foliar spray of humic acid @ 1.5% at flowering and pod development), T₈ (RDF + foliar spray of GA₃ @ 45 ppm fb humic acid @ 1.5% with 2 days interval at flowering), T₉ (RDF + foliar spray of GA₃ @ 45 ppm fb humic acid @ 1.5% with 2 days interval at pod development) and T₁₀ (RDF + foliar spray of GA₃ @ 45 ppm fb humic acid @ 1.5% with 2 days interval at flowering and pod development). Results indicated that, application of RDF + foliar spray of GA₃ @ 45 ppm fb humic acid @ 1.5% with 2
days interval at flowering and pod development (T10) and application only at flowering (T8) gave the similar and higher yields and economic returns. As the cost of cultivation of T10 was higher than T8, BC ratio was higher for T8.

Keywords: Flowering; foliar application; GA3; humic acid; mustard; pod development.

1. INTRODUCTION

Rapeseed-mustard (*Brassica* spp.) is one of the most important oilseed crops of the world where India ranks third in area and production in the world [1]. Among the seven edible oilseeds cultivated in India, rapeseed-mustard contributes 28.6% in the total oilseeds production and ranks second after groundnut sharing 27.8% in the India’s oilseed economy [2]. Its seed contains 37 to 49% edible oil [3]. Demand of edible oil has increased with increasing population and improvement in the living standard of the people, resulting thereby in short supply of edible oils which is being met with imports of edible oil worth 44,000 crores per annum. Thus, there is need to boost the oilseed production through area expansion and productivity enhancement. In India, rapeseed-mustard occupy 6.23 million ha area with production and productivity of 9.34 million tonnes and 1499 kg ha⁻¹ respectively (India stat 2019-20 [4]). It is a major rabi crop. Cultivation of mustard is taken up between October-November and February-March.

Gibberellic acid is a phytohormone that is needed in small quantities at low concentration so as to accelerate the plant growth and development. Because, favourable conditions may be induced by applying growth regulator exogenously in proper concentration at a proper time in a specific crop. It is a diterpenoid carboxylic acid that belongs to the family gibberellins and acts as a natural plant growth hormone, which can manipulate a variety of growth and development phenomena in various crops. GA₃ enhances growth activities of plant, stimulates stem elongation [5]. It is applied to crops, orchards, and ornamental plants, where it plays a role in seed germination, response to abiotic stress, stem elongation, flowering and other physiological effects that occur in its interaction with other phytohormones [6].

Humic acid is an organically charged bio-stimulant that significantly affects plant growth and development and increases crop yield. It has been extensively investigated that humic acid improves physical, chemical and biological properties of soils [7]. Humic acid-based fertilizers increase crop yield, stimulate plant hormones and improve soil fertility ecologically and environmentally. Many studies highlighted the positive benefits of humic acid application on higher plants. Humic acids also reduce toxic effects of salts on monocots [8] and dicots [9], including rapeseed. Enhanced nutrient uptake by plants as a result of humic acid application is also well established. Likewise, the increased yield is also observed in many crops due to its application, including potato, brassica [10], tomato, onions and other leafy vegetables.

2. MATERIALS AND METHODS

The present experiment was conducted at student farm, College of Agriculture, Rajendranagar, Hyderabad, Telangana, India during *rabi* 2020. The soil of experimental plot was sandy loamy and slightly alkaline (pH 7.6), with available nitrogen (128 kg ha⁻¹), phosphorus (61.6 kg ha⁻¹) and potassium (414 kg ha⁻¹) content. Geographically it is situated between 17°19’118.39’’ N latitude and 78°25’138.67’’ E longitude and its mean height above sea level is 534 m. The total rainfall received during the crop growth period was 363.4 mm in 11 rainy days. To study the effect of hormones on growth and yield of mustard (*Brassica juncea* L.) under Southern Telangana Agro-climatic conditions, randomized block design was used with ten treatments replicated thrice. The experimental field was laid out in 30 unit plots, each plot measuring 21.6 m² (5.4m x 4.0m). There were thirteen rows of mustard crop in each plot and forty plants in each row. One row of crop from both sides of length and also both sides of breadth were left as guard rows. The net plot consisted of eleven rows with thirty-eight plants per row (4.6m x 3.8m). Seeds of mustard variety Pusa-Agrani were sown @ 5 kg ha⁻¹ (250000 plants ha⁻¹), on 9th October 2020 with the spacing of 40 cm between the rows and 10 cm between the plants. A fertilizer dose of 60 kg N, 40 kg P₂O₅ and 40 kg K₂O per ha through urea, single super phosphate and muriate of potash was applied at the time of sowing (basal application) to all the plots.

Foliar application of gibberellic acid and humic acid was done as per the treatments. For the
foliar application of gibberellic acid a solution of 45 ppm was prepared by using 45 mg of gibberellic acid along with premix (solvent) dissolved in distilled water and made the volume to 1000ml using volumetric flask. It was utilized for foliar application in the plots which are selected for gibberellic acid spray. For the foliar application of humic acid 15 ml of the solvent was mixed in water and made up to 1000 ml to get 1.5% solution of humic acid. This was sprayed in the plots selected for HA application. Timely recommended plant protection measures for mustard crop were followed to save the crop from pests and diseases. The mustard crop was harvested manually. Different growth and yield components were recorded periodically. Data obtained from various parameters under study were analyzed by the method of analysis of variance (ANOVA) as described by Gomez and Gomez [11]. The level of significance used in the “F” test was given at 5 per cent.

The prices of the inputs prevailed in local market during experimentation were considered for working out the cost of cultivation of Mustard. The gross returns were calculated using the yield of mustard and the market price of the produce at the time of marketing. The net returns per hectare were calculated by deducting the cost of cultivation per hectare from the gross returns per hectare.

Net monetary return = Gross monetary return - Total cost of cultivation Benefit cost ratio was worked out for each treatment by using the formula given by Subba Reddy and Raghuram [12].

Benefit cost ratio = Gross returns (Rs ha⁻¹)/ Cost of cultivation (Rs ha⁻¹)

3. RESULTS AND DISCUSSION

3.1 Seed Yield

Seed yield (kg ha⁻¹) was significantly influenced by the spray of hormones (Table 1). Highest seed yield (1632) was observed with the application of RDF + foliar spray of GA₃ @ 45 ppm fb humic acid @ 1.5% with 2 days interval at flowering and pod development (T10), which was on par with the application of RDF + foliar spray of GA₃ @ 45 ppm at pod development (T₃) (1163). There was increase of 46.7% in the grain yield observed with RDF + foliar spray of GA₃ @ 45 ppm fb humic acid @ 1.5% with 2 days interval at flowering and pod development (T10) as compared to control (T1).

The highest seed yield was observed with the application of GA₃ and humic acid at flowering and pod development. The PGRs divert the photosynthate towards the harvested product thus enhancing the actual productivity (Abdelgadira et al., 2010). The stimulating effect of humic acid on yield and yield components has been related in part to enhanced uptake of mineral nutrients. Also, this could be explained as humic acid is rich in and mineral substances which are essential to plant growth and consequently increase yield quality and quantity. Humic acid influence plant growth both in direct and indirect ways. it increases chlorophyll content, accelerates plant respiration and hormonal growth responses, increases penetration in plant membranes [13]. Humic acid has been shown to stimulate plant growth and consequently yield by acting on mechanisms involved in cell respiration, photosynthesis, protein synthesis and enzyme activities [14]. The application of GA₃ was more effective to reduce yield loss due to siliquea shattering [15]. An increase in vascular capacity brought about by GA₃ under an enhanced sink potential, facilitating increased translocation of photo-assimilates to the developing reproductive organs. The capacity of GA₃ to regulate the induction of fruit set [16] could also have supplemented the other causes to result in an overall enhancement of yield. It is increased due to cumulative effect of yield attributing characters, enhanced photosynthetic efficiency and improvement in the capacity of the reproductive sinks to utilize the incoming assimilates due to the foliar application of GA₃.

3.2 Stover Yield

Stover yield (kg ha⁻¹) was significantly influenced by the spray of hormones (Table 1). Highest stover yield (5468) was observed with the application of RDF + foliar spray of GA₃ @ 45 ppm fb humic acid @ 1.5% with 2 days interval at flowering and pod development (T₁₀), which was on par with the application of RDF + foliar spray of GA₃ @ 45 ppm @ 1.5% with 2 days interval at flowering (T₈) (5305). Lowest stover yield (3720) was observed with the application of RDF (60:40:40 N, P₂O₅, K₂O kg ha⁻¹) (T₁), which was on par with the application of RDF + foliar spray
of GA$_3$ @ 45 ppm at pod development (T$_3$) and RDF + foliar spray of humic acid @ 1.5% at pod development (T$_6$) (3964 and 3915). There was increase of 47.0% in the stover yield observed with RDF + foliar spray of GA$_3$ @ 45 ppm fb humic acid @ 1.5% with 2 days interval at flowering and pod development (T$_{10}$) as compared to control (T$_1$).

The highest stover yield was recorded with the application of GA$_3$ and humic acid at flowering and pod development. Humic acid with its auxin activity, induced hormonal effect on respiratory catalytic activity, cell permeability and increased nutrient uptake might have contributed to greater plant height and dry matter accumulation, thus increasing the stover yield. Exogenous application of GA$_3$, N and P played an important role in the development of taller plants with more number of branches and better orientation of leaves facilitating the leaf expansion. This inturn leads to increase of stover yield.

3.3 Economics

Economics of mustard production was significantly influenced by the GA$_3$ and humic acid application (Table 2). The highest gross returns (78600 Rs. ha$^{-1}$) was obtained with the application of RDF + foliar spray of GA$_3$ @ 45 ppm fb humic acid @ 1.5% with 2 days interval at flowering and pod development (T$_{10}$) which was on par with the application of RDF + foliar spray of GA$_3$ @ 45 ppm fb humic acid @ 1.5% with 2 days interval at flowering (T$_8$) (75535 Rs. ha$^{-1}$). Application of RDF (60:40:40 N, P$_2$O$_5$, K$_2$O kg ha$^{-1}$) (T$_1$) recorded the lowest gross returns (53569 Rs. ha$^{-1}$), which was on par with the application of RDF + foliar spray of GA$_3$ @ 45 ppm at pod development (T$_3$) (56066 Rs ha$^{-1}$).

The highest net returns (50550 Rs. ha$^{-1}$) was obtained with the application of RDF + foliar spray of GA$_3$ @ 45 ppm fb humic acid @ 1.5% with 2 days interval at flowering (T$_8$) which was on par with the application of RDF + foliar spray of GA$_3$ @ 45 ppm fb humic acid @ 1.5% with 2 days interval at flowering and pod development (T$_{10}$) (50547 Rs ha$^{-1}$). Application of RDF (60:40:40 N, P$_2$O$_5$, K$_2$O kg ha$^{-1}$) (T$_1$) recorded the lowest net returns (31645 Rs. ha$^{-1}$) which was on par with the application of RDF + foliar spray of GA$_3$ @ 45 ppm at pod development (T$_3$) (33165 Rs ha$^{-1}$).

Highest BC ratio (3.02) was obtained with the application of RDF + foliar spray of GA$_3$ @ 45 ppm fb humic acid @ 1.5% with 2 days interval at flowering (T$_8$). The lowest BC ratio (2.44) was with the application of RDF (60:40:40 N, P$_2$O$_5$, K$_2$O kg ha$^{-1}$) (T$_1$) which was on par with the application of RDF + foliar spray of GA$_3$ @ 45 ppm at pod development (T$_3$) and RDF + foliar spray of humic acid @ 1.5% at pod development (T$_6$) (2.45 and 2.55).

The difference in gross, net returns and BC ratio among treatments might be due to the higher nutrient efficiency due to foliar application of hormones, which led to higher yields and thus produced maximum economics. This is due to achieved higher productivity as well as the lower cost of cultivation owing to increased economic returns.

| Treatments                                                                 | Seed yield (kg/ha) | Stover yield (kg/ha) |
|---------------------------------------------------------------------------|--------------------|----------------------|
| $T_1$- RDF (60:40:40 N, P$_2$O$_5$, K$_2$O kg ha$^{-1}$)                    | 1112               | 3720                 |
| $T_2$- RDF + foliar spray of GA$_3$ @ 45 ppm at flowering                  | 1231               | 4132                 |
| $T_3$- RDF + foliar spray of GA$_3$ @ 45 ppm at pod development           | 1163               | 3964                 |
| $T_4$- RDF + foliar spray of GA$_3$ @ 45 ppm at flowering and pod development | 1395               | 4994                 |
| $T_5$- RDF + foliar spray of humic acid @ 1.5% at flowering               | 1346               | 4071                 |
| $T_6$- RDF + foliar spray of humic acid @ 1.5% at pod development         | 1273               | 3915                 |
| $T_7$- RDF + foliar spray of humic acid @ 1.5% at flowering and pod development | 1447               | 4177                 |
| $T_8$- RDF + foliar spray of GA$_3$ @ 45 ppm fb humic acid @ 1.5% with 2 days interval at flowering | 1567               | 5305                 |
| $T_9$- RDF + foliar spray of GA$_3$ @ 45 ppm fb humic acid @               | 1495               | 5152                 |
Harshitha et al.; IJECC, 11(7): 89-94, 2021; Article no.IJECC.72732

Treatments | Seed yield (kg/ha) | Stover yield (kg/ha) |
--- | --- | --- |
1.5% with 2 days interval at pod development | | |
T10-RDF + foliar spray of GA3 @ 45 ppm fb humic acid @ 1.5% with 2 days interval at flowering and pod development | 1632 | 5468 |
SE(m) ± | 35.5 | 88.8 |
CD(p=0.05) | 103 | 264 |

### Table 2. Economics of mustard as influenced by GA3 and humic acid spray

| Treatments | Cost of cultivation (Rs/ha) | Gross returns (Rs/ha) | Net returns (Rs/ha) | B-C Ratio |
|---|---|---|---|---|
| T1 | 21924 | 53569 | 31645 | 2.44 |
| T2 | 22902 | 59315 | 36414 | 2.59 |
| T3 | 22902 | 56066 | 33165 | 2.45 |
| T4 | 23884 | 67375 | 43491 | 2.82 |
| T5 | 24007 | 64637 | 40630 | 2.69 |
| T6 | 24007 | 61155 | 37146 | 2.55 |
| T7 | 26094 | 69382 | 43288 | 2.66 |
| T8 | 24985 | 75535 | 50550 | 3.02 |
| T9 | 24985 | 72092 | 50547 | 2.89 |
| T10 | 28054 | 78600 | 43288 | 2.66 |
SE(m) ± | - | 1099 | 581 | 0.04 |
CD(p=0.05) | - | 3264 | 1727 | 0.12 |

*Market rates of mustard seed @ Rs. 4600/- per quintal; mustard stover @ 50/- per quintal*

### 4. CONCLUSION

The seed, stover yields and economics of the mustard crop are significantly influenced by the foliar application of GA3 and humic acid. Application of RDF + foliar spray of GA3 @ 45 ppm fb humic acid @ 1.5% with 2 days interval at flowering and pod development (T10) and application RDF + foliar spray of GA3 @ 45 ppm fb humic acid @ 1.5% with 2 days interval at flowering (T8) gave the higher and similar yields and economic returns. But as the cost of cultivation of T10 was higher than T8, the BC ratio was higher for T8 (RDF + foliar spray of GA3 @ 45 ppm fb humic acid @ 1.5% with 2 days interval at flowering).

### COMPETING INTERESTS

Authors have declared that no competing interests exist.

### REFERENCES

1. DRMR. Vision 2050. Directorate of Rapeseed- Mustard Research, Bharatpur, Rajasthan. India Statistics; 2019-20.
2. Shekhawat K, Rathore SS, Premi OP, Kandpal, Chauhan JS. Advances in agronomic management of Indian mustard (Brassica juncea (L.) Czernj, Cosson): An over view. International Journal of Agriculture. 2012;1-14.
3. Singh M, Rathore SS, Raja P. Physiological and stress studies of different rapeseed mustard genotypes under terminal heat stress. International Journal of Genetic Engineering and Biotechnology. 2009;5(2):133-142.
4. Deotale RD, Mask VG, Sorte NV, Chimurkar BS, Yerre AZ. Effect of GA3 and IAA on morpho-physiological parameters of soybean. Journal of Soils & Crops. 1998;8(1):91-94.
5. Hedden Peter and Valerie Sponse. A Century of Gibberellin Research. Journal of Plant Growth Regulators. 2015;34: 740-760.
6. Nardi S, Pizzeghello D, Pandalai SG. Rhizosphere: A communication between plant and soil. Recent Research and Development in Crop Sciences. 2004;1(2): 349-360.
7. Masciandaro G, Ceccanti B, Ronchi V, Benedicto S, Howard L. Humic substances to reduce salt effect on plant germination and growth. Communications in Soil Science and Plant Analysis. 2002;33(3-4):365-378.
9. Ferrara G, Loffredo E, Senesi N. Antimutagenic and antitoxic actions of humic substances on seedlings of monocotyledon and dicotyledon plants. Special publication-royal society of chemistry. 2001;273:361-372.

10. Vetayasuporn S. Effects of biological and chemical fertilizers on growth and yield of glutinous corn production. Journal of Agronomy. 2006;5(1):1-4.

11. Gomez AK, Gomez AA. Statistical Procedures for Agriculture Research. Awiley-Inter Sci. Publication. Johan Wiley and Sons, New York; 1984.

12. Subba Reddy S, Raghu Ram. Agricultural Economics. Oxford and IBH Publishing Cooperative Private Limited., New Delhi; 1996.

13. El-Hak, Gad SH, Ahmed AM, Moustafa YMM. Effect of Foliar Application with Two Antioxidants and Humic Acid on Growth, Yield and Yield Components of Peas (Pisum sativum L.). Journal of Horticultural Science & Ornamental Plants. 2012;4(3): 318-328.

14. Chen Y, Nobili M, Avid T. Stimulatory effect of humic acid substances on plant growth. Magdoff FR, Weil RR, (Eds.) Soil Organic Matter in Sustainable Agriculture, CRC Press, New York. 2004; 103-129.

15. Akter A, Ali E, Islam MMZ, Karim R, Razzaque AHM. Effect of GA3 on growth and yield of mustard. International Journal of Sustainable Crop Production. 2007;2(2): 16-20.

16. Arteca RN. Plant Growth Substances: Principles and Applications. CBS Publishers, New Delhi; 1996.