Chemical Science Review and Letters ISSN 2278-6783

www.chesci.com Research Article

Effectiveness of GA3 and Humic Acid Foliar Sprays on Crop Yield and Growth Parameters in Rabi Season of Mustard (*Brassica* spp.)

Monika Kumari, Babu Lal Choudhary, Abhinav, Mahaveer Prasad Ola* and Ekta

Department of Agriculture, Vivekananda Global University, Jaipur- 303012

Abstract

The research conducted to investigate effect of foliar spray of hormones during rabi, 2023-24 at Research farm, Vivekananda Global University, Jaipur and designed in a randomized block design with ten treatments and each one replicated thrice. The treatments comprised were : T1- RDF, T2- RDF + foliar spray of GA3@ 50 ppm at flowering), T3- RDF + foliar spray of GA3@ 50 ppm at pod development, T4- RDF + foliar spray of GA3@ 50 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@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering, T9- RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at pod development and T10-RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering and pod development. Highest seed yield (2083.90 kg ha-1) and stover yield (5796.08 kg ha-1) were recorded with the application of T10 which were at par with the application of T8. Application of RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering and pod development (T10) and RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering (T8) were at par with each other in all the aspects and resulted significant increase in different growth, yield attributes, yield. Although T10 and T8 gave the similar results, the B:C ratio of T8 was higher as the cost of cultivation for it is lower than that of T10. So, T8 (RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering) is regarded as the best treatment.

Keyword: Foliar spray, GA_3 humic acid and yield

***Correspondence**

Author: Mahaveer Prasad Ola

Email: mahaveerprasadola37@gmail.com

Introduction

In the world, Indian mustard, or *Brassica juncea* (L.) Czernj. & Cosson, ranks third in importance for edible oils, behind oil palm and soybeans [1]. One of the main oilseed crops grown in India for rabi is Indian mustard (*Brassica juncea*). Indian mustard (*Brassica juncia* L.) is the most important oilseed crop of India, occupying the first rank in area and second in production next to China. In India, mustard is cultivated on an area of 8.06 million hectares with production of 11.75 million tonnes and productivity of 1458 kg/ha [2]. Rajasthan is leading state particularly Indian mustard, it occupies 3.94 million hectares area and produces 6.26 million tonnes yield with productivity of 1587 kg/ha [3].

Being a significant crop of Rabi oilseed and benefiting from soil moisture retention during the monsoon, it has a greater potential to raise the amount of edible oil produced domestically that is available. Due to a variety of biotic and abiotic stresses as well as India's domestic price support programme, rapeseed-mustard production and yield have been found to be unstable in India, despite the crop's superior quality oil and meal as well as its broad adaptability for a variety of agro-climatic conditions. On the other hand, the crop could ensure nutritional security and support livelihood security. Mustard is the crop which is grown mostly under cool temperate climates. It is also cultivated as a cold weather crop in some of the tropical and subtropical regions.

Gibberellic acid is a crucial phytohormone that is required in small amounts and at low concentrations to accelerate the growth and development of plants. It is one of these plant growth regulators that work with different crops to control different growth and development phenomena. GA_3 promotes stem elongation and increases plant growth activities. It is sprayed on crops, orchards, and ornamental plants, where it contributes to the following processes: flowering [4], stem elongation [5], abiotic stress response, barley malting [6], and other physiological effects that arise from its interaction with other phytohormones. A number of researchers emphasised the advantages of applying humic acid to higher plants [7]. Additionally, humic acids lessen the harmful effects of salts on dicots, such as rapeseed, and monocots. It is also widely known that applying humic acid to plants increases their uptake of nutrients [8]. Similarly, its application has been shown to increase the yield of numerous crops, such as potatoes, onions, tomatoes, brassica, and other leafy vegetables. The problem of mustard crop is seed shattering. In order to prevent the loss due to seed shattering and improve the yield, the hormones are sprayed in the form of foliar spray.

Material and Methods

A field experiment was conducted during Rabi 2023-24 at Research farm, Vivekananda Global University, Jaipur, the study area is located at 74^0 89’ East longitudes, at 29^0 22’ North latitude on vertisol having pH 8.10 and EC 0.25 dS m-1. The soil organic carbon content was low to medium (0.27 %) and available P_2O_5 (16.3 kg ha-1), and available N is low (137.8 kg ha-1) with high available K_2O content (250.12 kg ha-1). There are 10 treatments combinations were laid out in Randomized Block Design with 3 replications and Treatments details of experiment are presented in **Table 1**.

Table 1 Details of treatments

Treatments	Symbols
RDF	T_1
RDF + foliar spray of GA3@ 50 ppm at flowering	T_2
RDF + foliar spray of GA3@ 50 ppm at pod development	T_3
RDF + foliar spray of GA3@ 50 ppm at flowering and pod development	T_4
RDF + foliar spray of humic acid @ 1.5% at flowering	T_5
RDF + foliar spray of humic acid @ 1.5% at pod development	T_6
RDF + foliar spray of humic acid @ 1.5% at flowering and pod development	T_7
RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering	T_8
RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at pod development	T_9
RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering and pod development	T_{10}
Note - recommended dose of N, P and K are applied to all treatment except control.	

Treatments application

The dose of nitrogen (N), phosphorus (P) and potash (K) were applied as per treatment recommendations (60:40:40 N, P_2O_5, K_2O kg ha-1) as basal application at the time of sowing.

Gibberellic acid

The trade name of the chemical used is TAG-GIBB. It is a white powder with a composition of 90% w/w of gibberellic acid and 10% of related impurities Gibberellic acid was sprayed @ 50 ppm at flowering and pod development.

Humic acid

Humic acid contains 51% to 57% C, 4% to 6% N and 0.2% to 1% P and other micronutrients in minute amounts. A granular commercial product was obtained from the market with 58% humic acid. Humic acid was sprayed @ 1.5% at flowering and pod development stages. Seeds of mustard variety “DRMRIJ-31” were sown manually at rate of 5.0 kg ha-1 maintaining row to row distance of 30 cm and plant to plant distance of 10 cm placed at depth of 3-4 cm and sowing was done at 20^{th} October 2023. The growth, yield attributes and yield observations were recorded from the net plots and seed yield was converted to hectare basis in quintal. The economics of each treatment was computed with prevailing market prices of the corresponding year. Standard method of "Analysis of variance" was used for analysing the data [9].

Result and Discussion

Growth parameters

Growth parameters viz., plant height and dry matter accumulation were significantly influenced by spray of GA3 and humic acid at 90 DAS and harvest (Table 2). Highest plant height (at 60 DAS- 101.20 cm, at 90 DAS-170.25 cm and at harvest stage- 187.55 cm), number of primary branches plant-1 (7.13), secondary branches plant-1and dry matter accumulation (at 60 DAS- 126.83 g m-2, at 90 DAS-195.88 g m-2 and at harvest stage- 218.18 g m-2) were recorded with the application of T10 (RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering and pod development) which were on par with the application of T8-RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering in most of the cases. On the whole, the highest plant height at 90 DAS and harvest was recorded with the application of GA_3 and humic acid. GA_3 is known to promote growth by improving nutrient absorption, nitrogen utilization efficiency, and cell development by inducing the breakdown of proteins that inhibit growth. The findings are consistent with the [10] and [11]. The main source of the nutrients N, P, and K is humic acid. When these nutrients are applied topically, the plant's vegetative parts absorb them fast and remobilize them to other parts of the plant. The use of GA_3 and humic acid during flowering and pod development resulted in the highest value of dry matter at 60 DAS, 90 DAS, and harvest. The effect of GA3 on various plant processes has affected the source-sink relationship [12]; in mustard, an increase in the sources-ink relationship was the primary factor contributing to the GA_3-mediated increase in the photosynthesis process [13].

Table 2 Effect of GA3 and humic acid spray on plant population, plant height and dry matter accumulation of mustard

Treatments	**Plant population per meter row length**		**plant height (cm)**			**Dry matter accumulation (g m^{-2})**		
	20 DAS	**At harvest**	**60 DAS**	**90 DAS**	**At harvest**	**60 DAS**	**90 DAS**	**At harvest**
T_1 RDF	8.09	8.04	97.21	145.10	175.50	122.84	170.73	201.13
T_2 RDF + foliar spray of GA3@ 50 ppm at flowering	8.35	8.28	98.50	158.25	178.50	124.13	183.88	204.13
T_3 RDF + foliar spray of GA3@ 50 ppm at pod development	8.34	8.30	96.20	146.50	177.20	121.83	172.13	202.83
T_4 RDF + foliar spray of GA3@ 50 ppm at flowering and pod development	8.40	8.20	99.90	159.25	182.80	125.53	184.88	208.43
T_5 RDF + foliar spray of humic acid @ 1.5% at flowering	8.40	8.32	96.00	159.25	178.60	121.63	184.88	204.23
T_6 RDF + foliar spray of humic acid @ 1.5% at pod development	8.50	8.30	96.40	146.25	178.10	122.03	171.88	205.73
T_7 RDF + foliar spray of humic acid @ 1.5% at flowering and pod development	8.45	8.42	97.40	161.25	179.80	123.03	185.88	215.43
T_8 RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering	8.60	8.50	100.89	168.59	182.70	126.52	190.22	210.33
T_9 RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at pod development	8.60	8.54	97.54	147.62	183.55	123.17	173.25	212.18
T_{10} RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering and pod development	8.70	8.55	101.20	170.25	187.55	126.83	195.88	218.18
S.Em.±	0.34	0.36		2.540	2.914	2.976	4.25	4.538
C.D. at 5%	NS	NS		NS	6.12	6.25	NS	9.53

Yield and yield attributes parameters

It is evident the results (Table 3) that effect of foliar application of GA_3 and humic acid was significant on yield and yield attributes like number of siliquae per plant, seed yield, stover yield and biological yield. The maximum siliquae plant per plant (198) seeds per siliquae (10.28), test weight (3.83 g), seed yield (2083.90 kg ha-1), stover yield (5796.08 kg ha-1) and biological yield (7879.98 kg ha-1) was obtain under treatment of T_{10} - RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering and pod development, however most of the traits show at par with treatment of T_8-RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering.

Table 3 Effect of GA3 and humic acid spray on branches per plant, yield contributing traits and yields of mustard

Treatments		branches per plant		Yield contributing traits			Yields			
		Primary branches per plant	**Secondary branches per plant**	**Number of siliquae per plant**	**Number of seeds per siliqua**	**Test weight (g)**	**Seed yield (kg/ha)**	**Stover yield (kg/ha)**	**Biological yield (kg/ha)**	**Harvest index (%)**
T_1	RDF	5.78	10.87	160.38	9.82	3.27	1419.91	3943.20	5363.11	26.48
T_2	RDF + foliar spray of GA3@ 50 ppm at flowering	6.03	11.15	171.58	9.89	3.37	1571.86	4379.92	5951.78	26.41
T_3	RDF + foliar spray of GA3@ 50 ppm at pod development	5.90	11.01	164.68	9.85	3.35	1485.03	4201.84	5686.87	26.11
T_4	RDF + foliar spray of GA3@ 50 ppm at flowering and pod development	6.52	11.87	186.25	9.99	3.54	1781.28	5293.64	7074.92	25.18
T_5	RDF + foliar spray of humic acid @ 1.5% at flowering	6.40	11.44	180	9.96	3.49	1718.71	4315.26	6033.97	28.48
T_6	RDF + foliar spray of humic acid @ 1.5% at pod development	6.27	11.30	173.40	9.93	3.46	1625.49	4149.90	5775.39	28.15
T_7	RDF + foliar spray of humic acid @ 1.5% at flowering and pod development	6.64	12.16	187.50	10.04	3.61	1847.67	4427.62	6275.29	29.44
T_8	RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering	7.13	12.73	195.25	10.13	3.76	2000.90	5623.30	7624.20	26.24
T_9	RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at pod development	6.89	12.30	191.20	10.08	3.68	1908.97	5461.12	7370.09	25.90
T_{10}	RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering and pod development	7.13	12.73	198	10.28	3.83	2083.90	5796.08	7879.98	26.45
S.Em.±		0.34	0.586	0.586	17.141	5.7	0.23	89.643	268.381	360.771
C.D. at 5%		NS	1.23	1.23	35.9964	NS	NS	188.25	563.60	757.62

The highest number of siliquae was observed with the application of GA3 and humic acid at flowering and pod development. Gibberellic acid is very important PGR that improves the growth cascades of plants by stimulating the stem and internode elongation, enzyme activation, and the fruit setting. Thus, it improves the siliquae [14]. The application of GA_3 and humic acid during flowering and pod development resulted in the highest seed yield. The actual yield is increased by the plant growth regulators, which direct photosynthates away from the harvested product [15]. Increased uptake of mineral nutrients has been linked to humic acid's stimulating effect on yield and yield attributes. This could also be explained by the fact that humic acid contains a wealth of minerals that are vital to plant growth, increasing both the quality and quantity of yield. Plant growth is impacted by humic acid in both direct and indirect ways. It is increased due to collective effect of yield attributing characters, enhanced photosynthetic efficacy and enhancement in the capacity of the reproductive sinks to utilize the incoming assimilates due to the spray application of GA3. Similar results were observed by [16-17]. It was found that applying GA_3 and humic acid during flowering and pod development produced the maximum stover yield. Due to its auxin activity, hormone-induced effect on respiratory catalytic activity, increased permeability of cells, and enhanced nutrient uptake, humic acid may have increased plant height and dry matter accumulation, which in turn increased stover yield. Similar findings that humic acid application increases biological yield were reported by [18-20]. The results showed that the application of RDF + foliar spray of GA_3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering and pod development (T_{10}) obtained significantly higher net returns, gross return and benefit cost ratio over the control. 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 (Table 4). This might be due to achieved higher productivity as well as lower cost of cultivation owing to increased economic returns. These results are in accordance with the findings of [21-22].

Table 4 Effect of GA_3 and humic acid spray on economics of mustard

Treatments		Cost of cultivation (Rs ha-1)	Gross Income (Rs ha-1)	Net Income (Rs ha-1)	B:C Ratio
T_1	RDF	29300	72,967	43,017	2.44
T_2	RDF + foliar spray of GA3@ 50 ppm at flowering	30278	80,783	48,877	2.53
T3	RDF + foliar spray of GA3@ 50 ppm at pod development	30278	76,352	44,446	2.39
T_4	RDF + foliar spray of GA3@ 50 ppm at flowering and pod development	31260	91,711	57,841	2.71
T_5	RDF + foliar spray of humic acid @ 1.5% at flowering	31383	88,093	53,977	2.58
T_6	RDF + foliar spray of humic acid @ 1.5% at pod development	31383	83,349	49,233	2.44
T_7	RDF + foliar spray of humic acid @ 1.5% at flowering and pod development	33470	94,597	56,307	2.47
T_8	RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering	32361	102,857	66,785	2.85
T_9	RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at pod development	32361	98,179	62,107	2.72
T_{10}	RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering and pod development	35430	107,093	64,883	2.54
S.Em.±		-	3535.857	1582.238	0.086
K8C.D. at 5%		-	7425.30	3322.70	0.18

Conclusion

Application of RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering and pod development (T10) and RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering (T8) were at par with each other in all the aspects and resulted significant increase in different yield attributes, yield. Although T10 and T8 gave the similar results, the BC ratio of T8 was higher as the cost of cultivation for it is lower than that of T10. So, T8 (RDF + foliar spray of GA3@ 50 ppm fb humic acid @ 1.5% with 2 days interval at flowering) is regarded as the best treatment.

Reference

[1] Global Production: USDA, India's Production: DVVOF, Exporters & Importers: Comtrade. Commodity Profile of Edible Oil for September 2019; USDA: Washington, DC, USA, 2019.

[2] Anonymous, 2022. Directorate of Economics and Statistics, Department of Agriculture Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India.

[3] Anonymous, 2024. Crop-wise Area, Production and Yield of Various Principal Crops (3rd Advance Estimates of Rabi 2023-24). Commissonerate of Agriculture, Jaipur, Rajasthan, pp: 1

[4] R. R. Sharma and R. Singh. Gibberellic acid influences the production of malformed and button berries, and fruit yield and quality in strawberry (Fragaria × ananassa Duch.). Scientia Horticulturae, 2009, 119: 430–433.

[5] H. Colebrook, G. Stephen, L. Andrew and P. Hedden. The role of gibberellin signalling in plant responses to abiotic stress. The Journal of Experimental Biology, 2014, 217: 67-75.

[6] D. E. Briggs. Bio chemistry of barely germination action of gibberellic acid on barely endosperm. Journal of Institute of Brewing, 1963, 69:13-19.

[7] K. Susilawati, H.A Osumanu, M. Nik, K.Y. Mohd and B.J. Mohamadu. Reduction of ammonia loss by mixing urea with liquid humic and fulvic acids isolated from tropical peat soil. American Journal of Agricultural and Biological Sciences, 2009, 4(1): 18-23.

[8] C. L. Mackowiak, P. R. Grossl and B. G. Bugbee. Beneficial effects of humic acid on micronutrient availability to wheat. Soil Science Society of America Journal, 2001, 56:1744-1750.

[9] V. G. Panse and P. V. Sukhatme. Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research Publication, 1985, 87-89.

[10] P. B. Leena, R. D. Deotale, S. M. Raut, N. S. More and A. D Banginwar. Physiological responses of foliar application of humic acid through vermicompost wash on morpho-physiological, yield and yield contributing parameters of mustard (Brassica juncea). Association of soils and crops research scientists, 2013, 23(2): 292-298.

[11] G. Harshitha, C. B. B. Rao, T. R. Prakash and S. A. Hussain. Effect of Hormones on Yield and Economics of Mustard (Brassica juncea L.) under Southern Telangana Agro-Climatic Conditions. International Journal of Environment and Climate Change, 2021, 11(7): 89-94.

[12] H. Marschner. Mineral Nutrition of Higher Plants. 2nd edition. Academic Press, New York. 2002.

[13] N. A. Khan, M. Mobin and Saimullah. The influence of gibberellic acid and sulfur fertilization rate on growth and S-use efficiency of mustard (Brassica juncea). Plant and soil, 2005, 270(1): 269-274.

[14] T. A. Dar, M. Uddin, M. M. A. Khan, A. Ali, N. Hashmi and M. Idrees. Cumulative effect of gibberellic acid and phosphorus on crop productivity, biochemical activities and trigonelline production in Trigonella foenumgraecum L. Cogent Food & Agriculture, 2015, 1: 1- 14.

[15] H. A. Abdelgadira, A. K. Jager, S. D. Johnson and J.V. Stadena. Influence of plant growth regulators on flowering, fruiting, seed oil content, and oil quality of Jatropha curcas. South African Journal of Botany, 2010, 76: 440–446.

[16] R. G. Upadhyay and R. Ranjan. Effect of growth hormones on morphological parameters, yield and quality of soybean (Glycine max L.) during changing scenario of climate under midhill conditions of Uttarakhand. International Journal of Tropical Agriculture, 2015, 33:1899-1904.

[17] H. S. Vishal, R. D. Deotale, A. P. Dhongade, S. E. Pise and D. A. R. A. Blesseena. Morpho-physiological traits and yield in safflower as influenced by foliar application of humic acid and NAA. Journal of Soils and Crops, 2019, 29 (2): 348- 353.

[18] Z. Wang, Y. Miao and S. Li. Effect of ammonium and nitrate nitrogen fertilizers on wheat yield in relation to accumulated nitrate at different depths of soil in dry lands of China. Journal of Field Crop Research, 2015, 183: 211-22.

[19] M. G. Shahraki, H. R. Ganjali and S. M. Javadzadeh. Effect of manure and foliar application of humic acid on yield and yield component of Nigella sativa. International Journal of Agriculture and Biosciences, 2016, 6(1): 25-27.

[20] B. Fatemeh, E. M. Hervan, A. H. S. Rad and G. N. Mohamadi. Effect of sowing date and humic acid foliar application on yield and yield components of canola cultivars. Journal of Agricultural Sciences, 2018, 25(1): 70-78.

[21] F. S. Abd, M. R. Shafeek, A. A. Ahmed and A.M Shaheen. Response of growth and yield of onion plants to potassium fertilizer and humic acid. Journal of Agriculutral Sciences, 2005, 30(1): 441-452.

[22] L. Jannin, M. Arkoun, A. Ourry, P. Laine, D. Goux, M. Garnica, M. Fuentes, S. San Francisco, R. Baigorri, F. Cruz and F. Houdusse. Microarray analysis of humic acid effects on Brassica napus growth: involvement of N,

C and S metabolisms. Plant and soil, 2012, 359(1): 297-319.

Publication History

Received	08.09.2024
Revised	28.09.2024
Accepted	30.09.2024
Online	15.11.2024