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Effect of agro-chemicals on yield attributes, yield and economics of late sown Indian mustard under rainfed condition (*Brassica juncea* L.)

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ABSTRACT

A field experiment was conducted at Agronomy Research Farm of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) during the Rabi season of 2023- 24. The soil of field experimental field was silty loam in texture, pH 8.25, organic carbon (0.32%), E.C. (0.35 dSm-1) and initial available nitrogen (173.91 kg ha⁻¹), phosphorus (14.45 kg ha⁻¹) and potassium (295.25 kg ha⁻¹). The experiment comprised of ten treatments and replicated thrice in Randomized Block Design viz. T₁, Control (RDF); T₂, Water spray at 50% flowering and at siliquae formation; T₃, Salicylic acid @ 200 ppm at 50% flowering; T₄, Salicylic acid @ 200 ppm at siliquae formation; T₅, Salicylic acid @ 200 ppm at 50% flowering and at siliquae formation; T₆, Thiourea @ 0.5% at 50% flowering; T₇, Thiourea @ 0.5% at siliquae formation; T₈, Thiourea @ 0.5% at 50% flowering and siliquae formation; T₉, Thiourea @ 0.5% at 50% flowering + Salicylic acid @ 200 ppm at siliquae formation and T₁₀, Salicylic acid @ 200 ppm at 50% flowering + Thiourea @ 0.5% at siliquae formation. Mustard variety RH-725 was used under the experiment. The experimental results revealed that among all the treatments, Salicylic acid @ 200 ppm at 50% flowering + Thiourea @ 0.5% at siliquae formation (T₁₀) showed Significant effect maximum on growth parameters, yield attributes, yield, quality and nutrient uptake of Indian Mustard (*Brassica juncea*).

Keywords: Mustard, Thiourea, Salicylic acid, Growth Yield Attributes, Yield, Economics

Introduction

As a major oil producer, importer, exporter, and grower, India is one of the four main stakeholders in the world oilseed or vegetable oil market (De and Sinha, 2011). Oilseed crops have formed the core of many agricultural economic theories from ancient times and are important to global trade and agricultural enterprises. Oilseeds are cultivated all over India and are regarded as a significant crop group because of their high economic importance. The oil derived from these products is finding more and more uses in industry, agriculture, and human health. The main oilseed crop that can assist in resolving India's edible oil demand-supply imbalance is rapeseed-mustard. Holding over 14% of the world's oilseed area, 8% of its oilseed production, and a second-place ranking in rapeseed-mustard production, the nation is one of the greatest vegetable oil economies in the world. This crop is India's main edible oilseed crop, producing almost one-third of the nation's oil (Kumar and Chauhan, 2005). The area, production, and productivity of oil rapeseed-mustard in India have been varying because of a number of biotic and abiotic stressors, despite the oil's high quality and broad adaptation to different agroclimatic conditions. Rapeseed-mustard is the most extensively grown oilseed crop worldwide. It is the primary oilseed crop in Rajasthan's *rabi* season and is mostly grown under irrigated and conserved moisture conditions. Humans in the country use it in a variety of ways, particularly edible oil. Crop Brassicas include a wide variety of plants that are cultivated as vegetables, fodder, or as sources of sauces and oils. One of the most highly profitable agricultural products is the oleaceous *Brassica* species, also referred to as rapeseed or mustard. Eight distinct types of rapeseed-mustard viz. Indian mustard, toria, yellow sarson, brown sarson, gobhi sarson, karan rai, black mustard, and taramira are grown in 53 countries worldwide. Rai is primarily a rainfed crop that can withstand drought and is somewhat tolerant of soil acidity, favoring a pH between 5.5 and 6.8. It grows best in regions with hot days and cool nights. Sandy loam soil that drains properly is necessary for mustard. The low water requirements of rapeseed-mustard (240–400 mm) make it a good choice for rainfed cropping systems. In addition to being the primary need, balanced fertilizer use is a prerequisite for increasing the effectiveness of main nutrients that are typically supplied and other secondary inputs that improve mustard yield and quality. Harvesting a good yield is dependent on environmental stressors and soil moisture. Therefore, appropriate management techniques should be used to maximize water holding capacity, reduce environmental stress, and save moisture of the soil. Salicylic acid (SA), a plant growth regulator has been found to generate a wide range of metabolic and physiological responses in plants thereby affecting their growth and development (Hayat *et al.*, 2010).

Salicylic Acid enhanced drought tolerance in mustard, inhibition of ethylene synthesis under drought stress, also influencing proline metabolism and photosynthesis resulted in efficient translocation of metabolism toward sink. When the two chemicals were applied together there was an additive effect on growing plants since hydrogel improve soil moisture level and SA minimizes environmental stress simultaneously. All the major nutrient viz. Nitrogen, phosphorus and Sulphur play important role in increasing the yield and quality of mustard. Nitrogen is known to activate most of metabolic activities and transformation of energy. Phosphorus is essential role of cell division and meristematic growth of tissue. The foliar applications of thiourea at critical crop stages particularly at 50% flowering and 50% siliquae formation, supplemental Sulphur and improve the photosynthetic efficiency partitioning chlorophyll contents, shoot dry matter and 1,000-seed weight (Jagetiya and Kaur, 2006).

Method and materials

The present investigation entitled “Effect of Agro-chemicals on yield attributes, yield and economic of late sown Indian Mustard (*Brassica juncea* L.) under rainfed condition” was conducted at Agronomy Research Farm of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) during the Rabi season of 2023-24. The farm is located at 42 km away from Ayodhya city on Ayodhya-Raebareli Road at 26.47° N latitude, 82.12° E longitude and an altitude of about 113 meters above the mean sea level. The soil of field experimental field was silty loam in texture, pH 8.25, organic carbon (0.32%), E.C. (0.35 dSm⁻¹) and initial available nitrogen (173.91 kg ha⁻¹), phosphorus (14.45 kg ha⁻¹) and potassium (295.25 kg ha⁻¹). The experiment comprised of ten treatments and replicated thrice in Randomized Block Design viz. T₁, Control (RDF); T₂, Water spray at 50% flowering and at siliquae formation; T₃, Salicylic acid @ 200 ppm at 50% flowering; T₄, Salicylic acid @ 200 ppm at siliquae formation; T₅, Salicylic acid @ 200 ppm at 50% flowering and at siliquae formation; T₆, Thiourea @ 0.5% at 50% flowering; T₇, Thiourea @ 0.5% at siliquae formation; T₈, Thiourea @ 0.5% at 50% flowering and siliquae formation; T₉, Thiourea @ 0.5% at 50% flowering + Salicylic acid @ 200 ppm at siliquae formation and T₁₀, Salicylic acid @ 200 ppm at 50% flowering + Thiourea @ 0.5% at siliquae formation. Mustard variety RH-725 was used under the experiment. Recommended dose on NPK is 60:40:40. N is given by Urea while P is given by SSP and K is given by MOP. The data were analyzed as per the standard procedure for “Analysis of Variance” (ANOVA) (Gomez and Gomez 1976).

Results and discussion

Yield attributes and yield

Yield and its attributes are a complex character which involves the interaction of several intrinsic and external factors. It largely depends upon the production and mobilization of carbohydrates, uptake of water and nutrients from the soil, in addition to several environmental factors to which plant is exposed during the growing period. Table 1 reveals that in all the combinations T₁₀: Salicylic acid @ 200 ppm at 50% flowering + Thiourea @ 0.5% at siliquae formation enhanced the Yield Attributes i.e. No. of Siliquae plant⁻¹ (426.67), No. of seed siliquae⁻¹ (22.33), Length of siliquae (5.43 cm), Test Weight (5.60 g) and found superior over all the treatment combinations, which was statistically at par with T₉: Thiourea @ 0.5% at 50% flowering + Salicylic acid @ 200 ppm at siliquae formation. The lowest yield attributes were observed under control. Thiourea helps in improvement

in the source and sink strength, efficient loading and translocation of photo assimilate are also required for maximizing the level of sink. The significant increase in the apoplastic loading volume and sucrose translocation (Srivastava *et al.*, 2008).

Yields

A perusal of the data on seed and stover yield presented in table 2 reveals that application of T₁₀: Salicylic acid @ 200 ppm at 50% flowering + Thiourea @ 0.5% at siliquae formation produced the maximum seed yield (28.51) q ha⁻¹ and stover yield (57.03) q ha⁻¹ and found superior over all the treatment combinations, which was statistically at par with T₉: Thiourea @ 0.5% at 50% flowering + Salicylic acid @ 200 ppm at siliquae formation. The lowest yields were observed under control. A non-physiological thiol called thiourea has increased the stress tolerance and productivity of crops like maize and mustard (Amin *et al.*, 2013, Yadav *et al.*, 2020). Thiourea was applied topically to boost biological and economic yield, and it was also linked to a rise in the movement of sucrose metabolites from source to sink (Pandey *et al.*, 2013). Effect of thiourea on plant growth and flowering might be due to its bio-regulatory effect chiefly through mobilization of dry matter and translocation of photosynthate to sink (Mishra *et al.*, 2011).

Economics

Table 3 shows that the maximum gross returns (Rs. 110833 ha⁻¹), net returns (Rs. 76117 ha⁻¹), B:C (2.19) was recorded in T₁₀ Salicylic acid @ 200 ppm at 50% flowering + Thiourea @ 0.5% at siliquae formation as compared to the other treatments, which was statistically at par with T₉: Thiourea @ 0.5% at 50% flowering + Salicylic acid @ 200 ppm at siliquae formation. The lowest economic was observed under control. Our results confirm the findings of Premi *et al.* (2004) [1], Singh *et al.* (2016) [2] and Shashidhar *et al.* (2020). In this study, the combined application of foliar application of Salicylic acid at flowering and Thiourea at siliqua formation is augmented the growth, yield, and quality of Indian mustard under water-deficit conditions. Hence it has the direct influence in improving economic efficiency and benefit: cost ratio. This technique can be popularized among the farmers in improving the economic efficiency of the Indian mustard cultivation in the region through large-scale demonstrations.

Conclusion

In conclusion, spray of Salicylic acid @ 200 ppm at 50% flowering + Thiourea @ 0.5% at siliquae formation gives significant improvement in quantitative (seed and stover yield), yield attributes and economics as compared to other treatments.

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Table 1. Effect of Agro-chemicals on yield attributes of late sown Indian mustard under rainfed condition (*Brassica juncea* L.)

Sr.No	Treatments	Yield Attributes			
		No of Siliquae plant ⁻¹	No of seed siliquae ⁻¹	Length of siliquae (cm)	Test Weight (g)
T ₁	Control (RDF)	340.00	16.00	3.67	3.57
T ₂	Water spray at 50 % flowering and at siliquae formation.	343.33	16.33	3.87	3.88
T ₃	Salicylic acid @ 200 ppm at 50% flowering.	410.67	17.93	4.83	4.10
T ₄	Salicylic acid @ 200 ppm at siliquae formation	412.67	18.17	4.93	4.33
T ₅	Salicylic acid @ 200 ppm at 50% flowering and at siliquae formation.	421.33	19.33	5.17	4.47
T ₆	Thiourea @ 0.5% at 50% flowering.	396.00	16.47	4.73	4.00
T ₇	Thiourea @ 0.5% at siliquae formation.	408.33	16.99	4.67	3.93
T ₈	Thiourea @ 0.5 at 50% flowering and at siliquae formation.	414.00	18.87	5.07	4.37
T ₉	Thiourea @ 0.5% at 50% flowering + Salicylic acid @ 200 ppm at siliquae formation.	424.00	21.67	5.10	4.68
T ₁₀	Salicylic acid @ 200 ppm at 50% flowering + Thiourea @ 0.5% at siliquae formation.	426.67	22.33	5.43	5.60
	SEm (+-)	11.07	0.56	0.19	0.14
	CD at (0.05%)	32.88	1.67	0.56	0.43

Table 2. Effect of Agro-chemicals on yield of late sown Indian mustard under rainfed condition (*Brassica juncea* L.)

Sr.No	Treatments	Yield			
		Seed Yield (q ha ⁻¹)	Biological Yield (q ha ⁻¹)	Stover Yield (q ha ⁻¹)	Harvesting index (%)
T ₁	Control (RDF)	15.10	48.63	33.53	31.20
T ₂	Water spray at 50 % flowering and at siliquae formation.	17.85	53.53	35.69	33.34
T ₃	Salicylic acid @ 200 ppm at 50% flowering.	19.43	58.28	38.86	33.34
T ₄	Salicylic acid @ 200 ppm at siliquae formation	20.81	62.41	41.60	33.33
T ₅	Salicylic acid @ 200 ppm at 50% flowering and at siliquae formation.	25.01	75.03	50.02	33.33
T ₆	Thiourea @ 0.5% at 50% flowering.	19.03	57.09	38.06	33.38
T ₇	Thiourea @ 0.5% at siliquae formation.	19.35	58.04	38.7	33.33
T ₈	Thiourea @ 0.5 at 50% flowering and at siliquae formation.	24.79	74.38	49.59	33.07
T ₉	Thiourea @ 0.5% at 50% flowering + Salicylic acid @ 200 ppm at siliquae formation.	27.80	83.40	55.61	32.40
T ₁₀	Salicylic acid @ 200 ppm at 50% flowering + Thiourea @ 0.5% at siliquae formation.	28.51	85.53	57.03	33.32
	SEm (+-)	0.59	1.90	1.2	0.34
	CD at (0.05%)	1.75	5.53	3.55	NS

Table 3. Effect of Agro-chemicals on economics of late sown Indian mustard under rainfed condition (*Brassica juncea* L.)

Sr.No	Treatments	Economics			
		COP Rs ha ⁻¹	Gross Return Rs ha ⁻¹	Net Return Rs ha ⁻¹	B:C Ratio
T ₁	Control (RDF)	27887	57072	29185	1.04
T ₂	Water spray at 50 % flowering and at siliquae formation.	28086	66450	38364	1.37
T ₃	Salicylic acid @ 200 ppm at 50% flowering.	30865	75313	44448	1.44
T ₄	Salicylic acid @ 200 ppm at siliquae formation	31030	81621	50591	1.63
T ₅	Salicylic acid @ 200 ppm at 50% flowering and at siliquae formation.	33073	96979	63906	1.93
T ₆	Thiourea @ 0.5% at 50% flowering.	30908	73461	42553	1.38
T ₇	Thiourea @ 0.5% at siliquae formation.	30655	72199	41545	1.35
T ₈	Thiourea @ 0.5 at 50% flowering and at siliquae formation.	32730	94641	61911	1.89
T ₉	Thiourea @ 0.5% at 50% flowering + Salicylic acid @ 200 ppm at siliquae formation.	34596	105875	71279	2.06
T ₁₀	Salicylic acid @ 200 ppm at 50% flowering + Thiourea @ 0.5% at siliquae formation.	34715	110833	76117	2.19

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