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Response of bioregulators and irrigation on plant height of Indian mustard (*Brassica juncea* L.)

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Abstract

The field experiment was carried out during the 2014-15 and 2015-16 in *Rabi* season to evaluate the response of bioregulators and irrigation on growth parameters of Indian mustard (*Brassica juncea* L.). The treatments consisted three irrigation levels (no irrigation, one irrigation and two irrigation) and seven foliar spray of bioregulators (control (water spray), thiourea @1000ppm, thiourea @ 500ppm, salicylic acid @ 100ppm, salicylic acid @ 50ppm, glycinebetaine @ 100ppm and glycinebetaine @ 50ppm). The result indicated that in the irrigated plots significantly improved the plant height of Indian mustard. The application of two irrigation recorded highest plant height at 80 DAS (132.7, 119.9 and 126.3 cm), 100DAS (173.6, 168.5 and 171.1 cm) and at harvest (176.4, 171.9 and 174.2 cm) followed by the application of one irrigation in both years and pooled analysis, respectively. Moreover, the application of bioregulators significantly improves the plant height of the Indian mustard. The application of thiourea @ 1000ppm gave highest plant height at 80 DAS (130.5, 118.2 and 124.4 cm), 100DAS (172.4, 166.8 and 169.6 cm) and at harvest (175.3, 170.9 and 173.1 cm). However, the application of thiourea @ 500 ppm was statistically at par with thiourea @ 1000ppm in both years and pooled analysis, respectively. Furthermore, combined result of bioregulators and irrigation levels were observed significant on plant height of Indian mustard. The application of two irrigation+ foliar spray of thiourea @1000ppm recorded the highest plant height at 100DAS (190.2, 182.3 and 186.3 cm) and at the time of harvest (194.2, 187.6 and 190.9 cm) over control. The application of two irrigation+ foliar spray of thiourea @ 500ppm was statistically at par at 100 DAS (189.4, 181.6 and 185.5 cm) and at harvest (193.3, 186.7 and 190.0 cm) with two irrigation+ foliar spray of thiourea @1000ppm in both years and pooled analysis, respectively. The present study highlighted the practical importance of the irrigation levels and foliar spray of bioregulators combination response on plant height of Indian mustard.

Key words: *Bioregulators, growth, Indian mustard, irrigation, plant height, thiourea*

Introduction

India is one of the leading oilseeds producing country in the globe. Oilseeds crop are the succeeding largest agricultural commodity after cereals. Indian mustard [*Brassica juncea* (L.) Czern & Coss.] is the second important edible oilseed crop after groundnut, meeting the fat requirement of about 50 per cent population in all the northern states (Shivran *et al.,* 2019). The mustard oil cake contains 5.1per cent nitrogen, 1.8 per cent phosphorus and 1.2 percent potassium and it rich sources of protein (40 per cent) and it grown in area of about 68.57 lakh ha with production of 69.74 lakh tones (DES, 2018). Due to scarcity of winter rainfall mustard shows better response to irrigation. This crop is more sensitive to water fluctuation and more or less at critical growth stages, which adversely influenced the yield (Meena *et al.,* 2013). The irrigation at critical stages increased the yield of the Indian mustard this might due to the more availability of the nutrient and more efficient metabolic activities of the plant (Mehta, 2004). Moreover, it is universally accepted that limited irrigation water can be best be utilized more efficiently be scheduling irrigation at critical growth stages of the crop (Saud *et al.,* 2016).

Rapeseed and mustard is generally, affect by irrigation water. The rapeseed-mustard is the crop that has fewer requirements of the water (Aujla *et al.,* 2005, Meena et al. 2017). To alleviate the harmful effect of drought stress, bioregulators may be used to change the different metabolic and physiological activities of the plant for increasing the yield of mustard crop (Jat, 2007). Thiourea containing one SH group and it's is a sulphydryl compound. The SH group has been implicated in photosynthetic translocation in plants (Giaquinta, 1976). It is simply concerned in light activation of photosynthetic enzymes (Salisbury and Ross, 1986). The exogenous application of Salicylic acid (SA) has been reduced the negative effect of water stress (Khan *et al.,* 2015, Meena *et al.,* 2018) and spray of SA improve the growth of the

plant (Hayat *et al.,* 2010). Glycinebetaine an important ammonium compound, it considered to be one of the most pre-dominant and effective osmoprotectants. The exogeneous application of glycinebetaine improved the drought tolerance in plants (Mahmood *et al.,* 2009). Hence, the study was conducted to see the effect of bioregulators on dry matter accumulation of Indian mustard under different levels of irrigation.

Materials and Methods

An experiment was conducted during the *rabi* (winter) seasons of 2014-15 and 2015-16 at the Agricultural Research Farm, Banaras Hindu University, Varanasi. The experimental field has clay loam soil. The ploughing layer of soil has pH (7.58 and 7.60) organic carbon (0.44% and 0.46%), available nitrogen (217.3 and 224.1 kg ha^{-1}), available phosphorus (20.28 and 22.85 kg ha^{-1}), available potassium (219.2 and 226.4 kg ha^{-1}) and available sulphur (20.90 and 21.85 mg kg^{-1} ha^{-1}) during both the years, respectively. The field experiment was laid out in split plot design. The experiment have 21 treatments combinations *viz.,* Main plot treatment– three irrigation levels (zero irrigation, one irrigation and two irrigation) and Sub-plots treatment– seven bioregulators spray (control, thiourea @1000ppm, thiourea @ 500ppm, salicylic acid @ 100ppm, salicylic acid @ 50ppm, glycinebetaine @ 100ppm and glycinebetaine @ 50ppm) and irrigation will apply at pre-flowering and pod formation stage @ 6 cm by V-notch method and Foliar spray done at 50 per cent flower initiation and 50 per cent pod formation stage. Furrows were opened at a spacing of 45×15 cm for the sowing of Indian mustard variety 'Ashirwad' with seed rate of 5 kg ha^{-1}. NPK and S were applied as 100, 50, 50 and kg ha^{-1} by basal application. Nitrogen and phosphorus were applied through diammonium phosphate and urea, potash and sulphur through murate of potash and elemental sulphur, respectively. The data were analyzed as per the standard procedure for "Analysis of Variance" (ANOVA) (Gomez and Gomez, 1976).

Results and Discussion

Response of irrigation

The revealed of the data present in table 1 indicated that the application of irrigation levels significantly increased the plant height of the Indian mustard over control. The maximum plant height (132.7, 119.9 and 126.3 cm at 80 DAS; 173.6, 168.5 and 171.1 cm at 100DAS cm and 176.4, 171.9 and 174.2 cm at harvest) was recorded with the application of two irrigation (at pre flowering and pod formation stage) in both the years and pooled analysis. This might be due to the adequate soil moisture increase the availability of the nutrient in the soil for the plant to increase in growth parameters by cell elongation and cell division this ascribed due to higher activity of auxin in plant tissues and photosynthesis activity of plant so they produced more food (Mandal *et al.,* 2006). The similar result recognized by Lal *et al.* (2000), Sharma *et al.* (2006), Nagdive *et al.* (2007), Mandal *et al.* (2010) and Meena *et al.* (2018a).

Response of bioregulators

The data present in table 1 showed that the application of bioregulators significantly increased the plant height of the Indian mustard. The higher value of plant height at 80 DAS (130.5, 118.2 and 124.4 cm), 100DAS (172.440, 166.8 and 169.6 cm) and at harvest (175.3, 170.9 and 173.1 cm) was recorded with the thiourea @1000ppm and it's found statically at par with the application of thiourea @500ppm in both the years and pooled analysis. This may be ascribed due to the foliar application of thiourea motivating the photosynthetic carbon fixation mechanism that enhanced the canopy of the plant (Mehta and Sumeria, 2001; Meena *et al.,* 2019). Thiourea exhibits cytokinin activity (Deshveer and Singh, 2003) and cytokinin delaying the leaf senescence of the plant (Solanki, 2003). The similar result reported by Sahu *et al.* (2005), Srivastava *et al.* (2010), Singh *et al.* (2017) and Meena *et al.* (2020).

Interaction

The examination of data in table 2 and 3 indicated that the Interaction effect of levels of irrigation and foliar spray of bioregulators were observed significant on plant height of Indian mustard. Result showed that two irrigation was recorded maximum plant height at 100 days after sowing (190.2, 182.3 and 186.3 cm) and at the time of harvest (194.2, 187.6 and 190.9 cm) with the application of thiourea @1000ppm and its was statistically at par with two irrigation with thiourea @ 500ppm at 100 DAS (189.4, 181.6 and 185.5 cm) and at harvest (193.3, 186.7 and 190.0 cm) during both the years and pooled analysis. While, the minimum plant height at 100 DAS (84.8, 81.2 and 82.9 cm) and at harvest (85.8, 82.0 and 83.9 cm) was recorded in zero irrigation + water spray during both the years and pooled analysis, respectively. The similar result reported by Muhl et al., (2014), Muhl and Solanki (2015), Hassanein *et al.* (2012), Meena (2020) and Meena (2020a).

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Table 1. Effect of irrigation levels and foliar spray of bio-regulators on plant height of Indian mustard

Treatment	Plant height (cm)														
	40 DAS			60 DAS			80 DAS			100 DAS		At harvest			
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Irrigation levels															
Zero irrigation	53.5	50.6	52.1	78.1	73.0	75.5	103.2	93.0	98.1	129.3	128.7	129.0	131.5	131.1	131.3
One irrigation	53.7	50.8	52.2	78.3	73.2	75.8	126.6	113.9	120.3	163.8	160.5	162.1	166.1	162.9	164.5
Two irrigation	55.0	52.0	53.5	80.2	75.0	77.6	132.7	120.0	126.3	173.6	168.5	171.1	176.4	171.9	174.2
SEm±	1.1	1.0	0.7	1.5	1.4	1.1	2.6	2.9	1.9	1.8	1.6	1.2	2.0	1.8	1.3
CD (p=0.05)	NS	NS	NS	NS	NS	NS	10.1	11.4	6.3	7.1	6.3	3.9	7.8	7.0	4.4
Foliar spray of bio-regulators															
Control (water spray)	53.4	50.5	52.0	77.9	72.9	75.4	98.7	89.0	93.9	118.3	119.5	118.9	120.6	119.6	120.1
Thiourea @ 500 ppm	54.6	51.6	53.1	79.6	74.4	77.0	128.3	117.8	123.0	171.3	165.8	168.6	174.1	169.8	171.9
Thiourea @ 1000 ppm	54.7	51.7	53.2	79.8	74.6	77.2	130.5	118.2	124.4	172.4	166.8	169.6	175.3	170.9	173.1
Salicylic acid @ 50 ppm	53.9	51.0	52.5	78.7	73.6	76.1	121.5	109.7	115.6	159.9	156.4	158.2	162.1	159.4	160.7
Salicylic acid @ 100 ppm	54.4	51.4	52.9	79.4	74.2	76.8	127.9	115.9	121.9	165.4	161.2	163.3	168.3	164.9	166.6
Glycinebetaine @ 50 ppm	53.4	50.5	52.0	78.0	72.9	75.4	110.7	99.8	105.3	146.1	145.0	145.6	147.8	147.0	147.4
Glycinebetaine @ 100 ppm	54.0	51.0	52.5	78.8	73.6	76.2	116.4	104.4	110.4	153.5	151.1	152.3	155.6	153.8	154.7
SEm±	1.4	1.3	0.9	2.0	1.9	1.4	1.6	1.7	1.2	0.9	0.8	0.6	1.1	0.9	0.7
CD (p=0.05)	NS	NS	NS	NS	NS	NS	4.6	4.7	3.2	2.7	2.3	1.7	3.2	2.6	2.0

Table 2. Interactive effect of foliar spray of bioregulators and irrigation levels on plant height (cm) of Indian mustard at 100DAS

Treatment	2014-15			2015-16			pooled		
	No irrigation	One irrigation	Two irrigation	No irrigation	One irrigation	Two irrigation	No irrigation	One irrigation	Two irrigation
Control (water spray)	84.8	128.3	141.9	81.2	135.3	142.2	83.0	131.8	142.1
Thiourea @ 500 ppm	147.6	179.9	189.4	145.7	173.2	181.6	146.6	176.6	185.5
Thiourea @ 1000 ppm	149.1	180.9	190.2	146.9	174.1	182.3	148.0	177.5	186.3
Salicylic acid @ 50 ppm	135.2	167.4	177.3	134.5	163.0	171.7	134.8	165.2	174.5
Salicylic acid @ 100 ppm	140.2	173.3	182.7	138.9	168.2	176.5	139.6	170.8	179.6
Glycinebetaine @ 50 ppm	120.7	155.1	162.5	124.4	152.1	158.6	122.5	153.6	160.6
Glycinebetaine @ 100 ppm	127.6	161.4	171.3	129.0	157.7	166.5	128.3	159.6	168.9
SEm±	1.6			1.4			1.1		
CD (p=0.05)	4.6			3.96			2.98		

Table 3. Interactive effect of foliar spray of bioregulators and irrigation levels on plant height (cm) of Indian mustard at harvest

Treatment	2014-15			2015-16			Pooled		
	No irrigation	One irrigation	Two irrigation	No irrigation	One irrigation	Two irrigation	No irrigation	One irrigation	Two irrigation
Control (water spray)	85.8	133.6	142.5	82.0	134.5	142.3	83.9	134.0	142.4
Thiourea @ 500 ppm	149.5	182.4	193.3	148.4	177.2	186.7	149.0	179.8	190.0
Thiourea @ 1000 ppm	151.2	183.5	194.2	149.9	178.2	187.5	150.5	180.9	190.9
Salicylic acid @ 50 ppm	136.4	169.3	180.5	137.0	165.7	175.6	136.7	167.5	178.1
Salicylic acid @ 100 ppm	142.2	176.0	186.7	142.0	171.6	181.0	142.1	173.8	183.9
Glycinebetaine @ 50 ppm	124.7	155.2	163.7	126.7	153.4	160.8	125.7	154.3	162.2
Glycinebetaine @ 100 ppm	130.7	162.4	173.8	131.9	159.7	169.6	131.3	161.1	171.7
SEm±	1.96			1.6			1.3		
CD (p=0.05)	5.6			4.5			3.5		

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