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Effect of growth retardants on physiological parameters of mustard (*Brassica juncea* (L.) Czern & Cross)

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Abstract
The present investigation undertaken at field No. 04 at Agronomy Farm, S.K.N. College of Agriculture, Jobner. The experiment was conducted on one genotype in randomized block design with three replications and seven treatments. The genotype of *Brassica juncea* namely pusa jay kisan (Bio-902) were grown under rainfed condition. It is found from the data that highest relative water content at flowering was noted in treatment MC- 250 ppm (71.50 %) closely followed by other treatment CCC- 250 ppm (64.60%). The highest total chlorophyll content at flowering was noted in treatment MC-750 ppm (2.47mg/g) and at pod formation stage the highest chlorophyll content was recorded with MC-750 ppm followed by CCC-750 ppm. The highest membrane stability index, specific leaf weight, Number of leaf per plant and leaf area were also recorded with CCC-750 ppm.

Keywords: Mustard, growth retardants, MSI, SLW and chlorophyll

Introduction
Mustard (*Brassica juncea* (L.) Czern & Cross) is an important *rabi* oilseed crop which belongs to family Cruciferous (Brassicaceae) and genus *Brassica*. Indian mustard or brown mustard is natural amphidiploids having chromosome no. (2n=36) with its origin place is China. Rapeseed, mustard contributes 32% of the total oilseed production in India and it is the second largest indigenous oilseed crop. Mustard is cool season crop, which requires temperature range from 6 to 27°C, mustard follows C3 pathway for carbon assimilation and at this temperature the plant achieve maximum CO2 assimilation rate. In recent years a new class of organic chemicals has appeared with the special characteristics that they can retard or defer growth processes in plants, and those were termed growth retarding chemicals or growth retardants (Cathey, 1964) [1]. The movement of photoassimilates from the site of synthesis in leaf tissues (source) to the site of net accumulation in different tissues (sink) is under the potential control of numerous factors. Regulation of net flow of photo assimilates is an integrated process. The concentration gradient and ability of sink to assimilate between the source and sink is the primary determinant of the current rate of transport and pattern of partitioning. Growth retardants are known to reduce the intermodal growth, reducing the plant height and thereby influence the source sink relationship and stimulate the translocation of photosynthates toward sink. The growth retardants cycocel and mepiquet chloride were more beneficial in terms of the translocation of photo assimilates towards developing reproductive parts compared to growth promoter (Pankaj Kumar *et al.*, 2006) [8]. Application of growth retardants may also enhance the chlorophyll contents of leaves which help to increase the functional life of source for a longer period leading to improved partioning efficiency and increased productivity. Reduced plant height and increase in the functional life of source for a longer period especially during grain filling stage in mustard is essential for its higher productivity. Keeping all this in view the present study has been under taken.

Materials and methods
The experiment was conducted on field No. 04 at Agronomy Farm, S.K.N. College of Agriculture, Jobner. Geographically, Jobner is situated 45 km west of Jaipur at 26° 05’ North latitude, 75° 28’ East longitude and at an altitude of 427 metres above mean sea level.

The experiment was conducted on one genotype in randomized block design with three replications and seven treatments.

Treatments

Control
CCC-250 ppm
CCC-500 ppm
CCC-750 ppm
MC-250 ppm
MC-500 ppm
MC-750 ppm

The genotype of *Brassica juncea* namely pusa jay kisan (Bio-902) were grown under rainfed condition. The observations like Relative water content (RWC), Chlorophyll a, b and total chlorophyll, Membrane stability index, Specific leaf weight, Number of leaf per plant, Leaf area were taken at two stages *viz* flowering and pod formation stages.

The experimental data recorded for growth were statistically analysed by Panse and Sukhatme (1954). Appropriate standard error for each of the factor was worked out. Significance of differences among treatment effects was tested by "F" test. Critical difference (CD) was worked out wherever the difference was found to be significant at 5 or 1 per cent level of significance.

Results and discussion

Relative water content

The results presented in table 1 shows that different treatment differ significantly both at flowering and pod formation stages. The relative water content increased significantly with cycocel and mapiquat chloride under rainfed condition. The highest relative water content at flowering was noted in treatment MC- 250 ppm (71.50 %) closely followed by other treatment CCC- 250 ppm (64.60%). The relative water content increased significantly with growth retardant cycocel and mepiquat chloride. Highest increase was reported with MC-250 ppm followed by CCC-250 ppm. The relative water content is an important physiological attribute which determine the tolerance plant in drought stress (Sanchez-Blanco *et al*, 2002).

Chlorophyll a, b and total chlorophyll

The chlorophyll content increased significantly with cycocel and mapiquat chloride. The highest total chlorophyll content at flowering was noted in treatment MC-750 ppm (2.47mg/g) closely followed by other treatment CCC-750 ppm (2.41mg/g) and CCC-500 ppm (2.08mg/g) at flowering stage (Table 1). The chlorophyll content decreased with advancement of stages. At pod formation stage the highest chlorophyll content was recorded with MC-750 ppm followed by CCC-750 ppm (Table 1). The high chlorophyll content with the application of cycocel and mepiquat chloride was attributed to the protection of chlorophyll molecule from photo oxidation and increased chlorophyll synthesis. Further, Jeyakumar and Thangaraj, (1998) [6], explain that application of mepiquat chloride to groundnut crop result in high chlorophyll content due to delay chlorophyll degradation.

Membrane stability index (MSI)

The membrane stability index increased significantly with cycocel and mepiquat chloride. Under the rainfed condition the highest membrane stability index at flowering was noted in treatment CCC-750 ppm (74.00) closely followed by other treatment MC-750 ppm (71.45) and CCC- 500 ppm (70.00) and at pod formation stage, highest membrane stability index was noted in treatment CCC-750 ppm (77.92) closely followed by other treatment MC-750 ppm (71.85) and MC-500 ppm (68.50) (Table 2). The result shows that different treatment differ significantly both at flowering and pod formation stages. Higher MSI with high relative water content under rainfed condition suggest the role of cycocel and mepiquat chloride in drought tolerance in mustard. Cycocel (2-chloro ethyl trimethyl ammonium chloride) is the most usual an ionic plant growth regulator (Emam and Moaied, 2000) [4]. Ma and Smith, (1991) [7]. reported that an ionoic compound treated plant were tolerant to drought condition compare to untreated plant.

Specifi leaf weight

Table 2 Shows that the specific leaf weight increased significantly with cycocel and mapiquat chloride. Under the rainfed condition the highest specific leaf weight at flowering was noted in treatment CCC-750 ppm (9.10g/cm2) closely followed by other treatment MC-750 ppm (8.90 g/cm2) and MC-500 ppm (8.30 g/cm2) and at pod formation stage highest specific leaf weight was noted in treatment CCC-750 ppm (7.70 g/cm2) closely followed by other treatment MC-750 ppm (7.20 g/cm2) and CCC- 500 ppm (7.10 g/cm2). The result shows that different treatment differ significantly both at flowering and pod formation stages. The specific leaf weight an indicator of leaf thickness increased with growth retardant cycocel and mepiquat chloride at both flowering and pod formation stages. Rajamohan, (1989) [9] and Shinde and Jadhav, (1995) [9] also reported the increased SLW in soyabean and cowpea.

Number of leaf per plant

The number of leaf per plant increased significantly with cycocel and mapiquat chloride. The highest number of leaf per plant at flowering was noted in treatment CCC-750 ppm (20.00) closely followed by other treatment MC-250 ppm (18.60) and MC-500 ppm (15.50) and at pod formation stage highest number of leaf per plant was noted in treatmet CCC-750 ppm (29.60) closely followed by other treatment MC-250 ppm (27.70) and CCC-500 ppm (27.00). (Table 2)The result shows that different treatment differ significantly both at flowering and pod formation stages.

Leaf area

It is revealed from table 2 that the leaf area increased significantly with cycocel and mapiquat chloride At flowering stage the highest leaf area was noted in treatment CCC-750 ppm (215 cm2/plant) closely followed by other treatment CCC-250 ppm (121.50 cm2/plant) and CCC-500 ppm (165.10 cm2/plant) and at pod formation stage highest leaf area was noted in treatment CCC-750 ppm (296.00 cm2/plant) closely followed by other treatment MC-750 ppm (280.00 cm2/plant) and MC-500 ppm (275.00 cm2/plant). The leaf area an ideal parameter to regulate photo synthetic activity increased with growth retardant in mustard at both stages.

Table 1: Effect of growth retardant on relative water content, chlorophyll content-a, chlorophyll content –b and total chlorophyll content.

	Relative water content (%)		Chlorophyll content –a (mg/g)		Chlorophyll content –b (mg/g)		Total chlorophyll content(mg/g)	
Treatments	**Flowering**	**Pod formation**	**Flowering**	**Pod formation**	**Flowering**	**Pod formation**	**Flowering**	**Pod formation**
Control	48.60	47.50	1.15	0.91	0.49	0.38	1.64	1.29
CCC-250 ppm	64.60	62.00	1.33	0.95	0.52	0.45	1.85	1.40
CCC-500 ppm	55.40	54.50	1.43	1.07	0.65	0.51	2.08	1.58
CCC-750 ppm	54.60	53.60	1.63	1.32	0.78	0.57	2.41	1.89
MC-250 ppm	71.50	70.20	1.15	0.94	0.58	0.46	1.73	1.40
MC-500 ppm	55.20	53.30	1.34	0.98	0.62	0.48	1.96	1.46
MC-750 ppm	54.50	52.40	1.72	1.38	0.75	0.59	2.47	1.97
CD (p=0.05)	5.58	5.47	0.14	0.11	0.06	0.05	0.20	0.15

Table 2: Effect of growth retardant on membrane stability index, specific leaf weight, number of leaf per plant and leaf area

	Membrane stability index (%)		Specific leaf weight (SLW)		No. of leaf per plant		Leaf area (cm^2/plant)	
Treatments	**Flowering**	**Pod formation**	**Flowering**	**Pod formation**	**Flowering**	**Pod formation**	**Flowering**	**Pod formation**
Control	64.60	62.30	7.50	6.60	12.80	23.50	112.00	235.00
CCC-250 ppm	66.00	66.75	8.20	6.90	13.50	24.40	121.50	240.00
CCC-500 ppm	70.00	66.95	8.30	7.10	13.60	27.00	165.10	274.00
CCC-750 ppm	74.00	77.92	9.10	7.70	20.00	29.60	215.00	296.00
MC-250 ppm	65.60	66.65	8.10	6.70	18.60	27.70	141.50	240.5
MC-500 ppm	66.80	68.50	8.30	6.90	15.50	25.90	156.50	275.00
MC-750 ppm	71.45	71.85	8.90	7.20	14.80	25.60	200.00	280.00
CD (p=0.05)	6.09	7.01	0.83	0.63	1.48	2.72	15.45	27.35

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