Growth responses of castor to application of selected growth retardants

Abstract

The perennial growth habit of castor plants (*Ricinus communis* L.) limits mechanical harvest because the plant grows very tall, when the environmental conditions are favorable and produces green flush interfering with mechanical harvesting. In order to prevent excessive growth plant growth, retardant are applied to modifying crop architecture. Present investigation was designed to study the effect of growth retardants on growth and yield parameters. The experiment was conducted at the regional agricultural research station, Palem farm of Professor Jayashankar Telangana Agricultural University, Nagarkurnool district, Telangana, taking locally available tall variety PCH-111. The experiment was laid out in Randomized Block Design with three replicates in *Kharif*, 2019. Treatments comprises of water spray, ethrel@500 ppm, ethrel@1000 ppm, CCC@1.5ml/lit, CCC@2.0 ml/lit and CCC@2.5 ml/lit and sprayings were done at expanding leaf in the 6^{th} node of the primary stem, expanding leaf on the 8^{th} node of the primary stem, appearance of the first inflorescence, one expanding leaf in a secondary stem after the appearance of the first inflorescence, and appearance of the second inflorescence. Results revealed that, plant growth retardants are effective in reducing plant height, whereas no spray recorded significant superior value for plant height (70.73 cm). For leaf number, there is no much deviations though ethrel treatment enhanced senescence in older leaves, newly developed leaves compensated the number but there was reduction in LAI, which was (1.70) and (2.18) respectively, in ethrel spray of 1000 ppm and 500 ppm. The yield reduction is lower in ethrel treatment due to lower capsule formation and lower spike length at higher concentration of ethrel. Hence, it is concluded that, retardant accelerates natural senescence and thus, acting as defoliants overcoming difficulties in mechanical harvesting.

Key words: AGR, castor, LAI, PGR, growth retardants, yield

Introduction

Castor (*Ricinus communis* L.) is a non-edible oilseed crop, belongs to Euphorbiaceae family and takes about at least 30 and 75 days for fifty percent flowering and maturity of primary raceme, respectively and 5 to 10 months duration for remunerative seed yield. Oil extracted from castor has been used over centuries as medicine and lubricants, for hair dressing and as a laxative. In the recent past, castor oil and its derivatives have been used in the manufacturing of about 250 industrial products ranging from hydraulic oil, jet engines, in soap, varnish and paint, nylon threads industries *etc*. Castor oil and its derivatives like hydroxystearic acid, dehydrogenated castor oil *etc*. are mainly exported (5.5 to 6.5 lakh tonnes worth of 4000-6000 crores) to the U.S.A., European Common Market and Japan.

The area under castor (*Ricinus communis*) crop is about 10 lakh hectares in India and it accounts for about 70 per cent of its global area and 90 per cent of its production. The production of castor is limited due to the lack of technology for a fully mechanized harvesting (Severino *et al*., 2012). Castor plant grows very tall and exhibits perennial nature, challenges the mechanical harvesting due to presence of green leaves and immature fruits at harvest time and persistent habit when environmental conditions are favorable. The problem with plant height can be partially overcome with the adoption of dwarf castor varieties and hybrids, but growth retardants are also necessary when environmental conditions are excessively favorable to plant growth or when cultivars with the dwarf trait are not available.

In order to overcome difficulties in mechanical harvest, plant growth retardants (PGR) are largely employed in agriculture to influence specific aspects of plant growth and development, and harvest aids are used to induce a faster defoliation, desiccation, fruit maturation, and regrowth suppression (**Logan and Gwathmey, 2002**). Most growth retardants act by interfering with hormone concentrations, such as inhibiting gibberellins biosynthesis or auxin transport (Rademacher, 2000; Burton et al., 2008). Hence, present investigation has been suggested to understand mechanism of growth response of castor to application of selected retardants such as chlormequat chloride, ethereal and cyclocel.

Material and methods

The experiment was conducted at the at the regional agricultural research station, Palem farm of Professor Jayashankar Telangana Agricultural University, Nagarkurnool district, Telangana taking locally available tall variety PCH-111.The experiment was laid in Randomized Block Design with three replicates in *Kharif*, 2019 with plot size of 5x6 m and spacing adopted 90x60 cm$^{2.}$ Treatments comprises of water spray, ethrel@500 ppm, ethrel@1000 ppm, CCC@1.5 ml/lit, CCC@2.0 ml/lit and CCC@2.5 ml/lit and spraying were done at the following stages of development: (i) expanding leaf in the 6th node of the primary stem, (ii) expanding leaf on the 8th node of the primary stem, (iii) appearance of the first inflorescence, (iv) one expanding leaf in a secondary stem after the appearance of the first inflorescence, and (v) appearance of the second inflorescence. The management practices were followed to raise the healthy crops. Observations were recorded on traits such as plant height, number of nodes, internodes length. number of leaves, leaf area index and absolute growth rate were recorded at monthly intervals upto 4 months stage, whereas, parameters like spike length, number of capsules per plant and seed yield were recorded on average basis.

Results and discussion

The increase in plant height (Table 1) was noticed up to 4 months stage of the crop,which remains constant, thereafter, among the treatments, growth retardants ethylene is most affective in suppressing the growth followed by Chlormequat chloride. Application of Ethrel spray @1000 ppm is most effective in controlling plant height (49 cm) followed by treatments Ethrel @500 ppm (49.80cm), Chlormequat chloride@1.5 ml/lit (58.80 cm), Chloromequat chloride

@2.5ml/lit (59.60cm) and Chlormequat chloride @2.0 ml/lit (60.80 cm). The control plant maintained highest plant height of 70.73 cm. Plant growth retardant extensively used as an inhibitor of gibberellins biosynthesis, which is a hormone that promotes cell elongation. With reduced concentration of gibberellins, there is less elongation of cells in the stem, and the vertical growth is reduced (Rademacher, 2000).

The number of leaves (Table 1) increased up to 120 DAS and declined at later stages due to acceleration of senescence process. The control treatment recorded highest number of leaves (14) at 120 DAS, where as the growth retardants can effectively control the vegetative growth and leaf number. Among the retardants, Chloromequet chloride and ethylene were effective in controlling leaf number. The phytohormone ethylene controls growth and senescence of plants. Ethylene is regarded as a multifunctional phytohormone that regulates both growth, and senescence. It promotes or inhibits growth and senescence processes depending on its concentration, timing of application in the plant species. The application of ethephon, an ethylene releasing compound enhanced ethylene evolution and increased leaf area of mustard at a lower concentration, while inhibited at higher concentration was reported by Khan, 2005 and Khan *et al.,* 2008. The Chloromequet chloride suppresses vegetative growth and favors the diversion of photo assimilates in reproductive parts.

The parameter Leaf Area Index (Table 2) increased up to 90 DAS and decline there after due to mobilization of food materials from source to sink. Among the treatment Ethrel @1000 ppm maintained lowest Leaf area Index of 0.90, which is at par with Ethrel@500 ppm (1.03), Chlormequat chloride@2.5 ml/lit (1.40) and Chlormequat chloride@1.5 ml/lit(1.77) at 120 DAS. Plant growth retardants delay longitudinal growth, increase aboveground branching structure, and reduce transpiration by reducing leaf area (Karimi *et al.,* 2019). Similar results are reported by Francescangeli *et al.,* 2007 in *Syzygium campanulatum* and Lilium sp. by treating with paclobutrazol. This is possibly due to the effect of paclobutrazol as a gibberellin biosynthesis inhibitor at the level of leaf cell elongation thus causing limited elongation in the leaf cells.

Increase in inter nodal length (Table 2) was noticed up to 120 DAS and remained constant afterwards. During 120 DAS, Ethrel treatments (spraying with 500 & 100 ppm) were proven to be effective in controlling inter nodal length showing antagonistic effect to hormone, GA. Among the Ethrel treatments, Ethrel@1000 ppm is effective in controlling intermodal length (3.24 cm), which is at par with Ethrel@500 ppm (3.66 cm). The growth of internodes was short mainly due to restriction of cell division and elongation in the apical meristem. Bhagure and Tambe (2013) reported the similar findings with respect to CCC in okra.

Absolute Growth Rate increase (Table 3) initially up to 90 DAS and there after, it declines. At 90 DAS, Ethrel @500 ppm followed by Ethrel@1000 ppm recorded lowest absolute growth rate of 0.38 and 0.49 values, respectively.

The character spike length (Table 3), enhanced length were recorded by application of growth retardant Chlormequat chloride dosage @ 2.0ml/lit followed by Chlormequat chloride@1.5 ml/lit and Chloromequat chloride@2.5ml/litre recorded at par with the values of 37.07cm, 34.40cm and33.40, respectively and control treatment recorded highest value of 38.33cm for spike length. Whereas, for number of capsule per plant (Table 3), treatment Chlormequat chloride@2.0 ml/lit showed highest value of 46.9, which is at par with control (46.2), Chloromequat chloride @2.5ml/lit (44.9), Chlormequat chloride-1.5 ml/lit (42.1), Ethrel@1000 ppm (28.8) and Ethrel@500 ppm (27.9). In respect of seed yield (kg/plot) (Table 3), Chloromequat chloride @2.5 ml/litre recorded highest value of 3.02 kg/plot, which is at par with Chloromequat chloride @ 2.0ml/litre (2.87 kg/plot), control (2.81kg/plot) and Chlormequat chloride @1.5 ml/lit (2.32/plot). Results revealed that Chloromequat chloride is effective in diversion of assimilates in economic produces as a result there is enhancement of yield. Similar results are observed in sesamum crop by Kamran *et al.*, 2018 and Kuai *et al.*, 2015.

Conclusion

Growth retardants, Chlormequat chloride and ethrel are effective in controlling unnecessary vegetative growth, plant height, number of leaves, LAI, absolute growth rate and internodal length in castor by acting antagonistic to GA. They are effective in mobilizing the nutrients to sink as a result, when applied at specific growth stage enhances the yield and yield related parameters. Further, it is concluded that retardant accelerates natural senescence and thus, acting as defoliants overcoming difficulties in mechanical harvesting.

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Table 1: Effect of selected plant growth regulators on plant height (cm) and number of nodes in castor

Treatment	**Plant height (cm)**				**Number of leaves**			
	Initial data	**2 months**	**3 months**	**4 months**	**Initial data**	**2 months**	**3 months**	**4 months**

Control	11.37	25.00	59.00	70.73	5.47	10.80	12.00	14.00
Chlormequat chloride (1.5 ml/litre)	10.63	23.40	50.00	58.80	5.33	10.20	10.77	12.33
Chlormequat chloride (2.0 ml/litre)	9.13	24.73	53.33	60.80	5.73	10.40	11.00	12.53
Chloromequat chloride (2.5ml/litre)	10.20	24.60	49.00	59.60	5.87	10.40	11.67	12.40
Ethrel (500 ppm)	11.27	23.93	35.33	49.80	5.40	10.27	10.90	12.40
Ethrel (1000 ppm)	11.73	25.80	40.67	49.00	5.53	9.67	10.67	13.00
C.D.	2.26	3.31	13.41	17.79	0.73	1.38	1.64	1.94
SE(m)	0.81	1.04	4.20	5.57	0.23	0.43	0.51	0.61
SE(d)	1.15	1.47	5.94	7.87	0.33	0.61	0.72	0.86
C.V.	13.16	7.30	15.19	16.58	7.16	7.25	7.94	8.22

Table 2: Effect of selected plant growth regulators on inter nodal length (cm) and leaf area index in castor

Treatment	**Inter nodal length (cm)**				**Leaf area index**			
	Initial data	**2 months**	**3 months**	**4 months**	**Initial data**	**2 months**	**3 months**	**4 months**

Control	0.68	3.32	3.80	4.48	0.06	1.68	2.60	2.40
Chlormequat chloride (1.5 ml/litre)	0.68	3.05	3.73	4.27	0.07	1.24	2.34	1.77
Chlormequat chloride (2.0 ml/litre)	0.68	3.09	3.64	4.13	0.06	1.61	2.78	2.22
Chloromequat chloride (2.5ml/litre)	0.82	3.39	3.94	4.63	0.06	1.79	3.10	1.40
Ethrel (500 ppm)	0.90	3.28	3.45	3.66	0.06	1.28	2.18	1.03
Ethrel (1000 ppm)	0.93	2.28	2.73	3.24	0.07	1.23	1.70	0.90
C.D.	0.17	1.02	0.69	0.67	0.03	0.76	1.05	0.76
SE(m)	0.05	0.32	0.22	0.21	0.01	0.24	0.33	0.24
SE(d)	0.08	0.45	0.31	0.30	0.01	0.34	0.46	0.34
C.V.	11.65	17.99	10.59	8.89	27.20	28.00	23.15	25.61

Table 3: Effect of selected plant growth regulators on spike length (cm) and number of capsules, seed yield (kg/plot) and absolute growth rate in castor

Treatment	**Spike length (cm)**	**No. of capsules**	**Seed yield (t/ha)**	**Absolute Growth Rate**		
				30-60 DAS	**60-90 DAS**	**90-120 DAS**

Control	38.33	46.2	2.81	0.45	1.13	0.39
Chlormequat chloride (1.5 ml/litre)	34.40	42.1	2.32	0.43	0.89	0.29
Chlormequat chloride (2.0 ml/litre)	37.07	46.9	2.87	0.52	0.95	0.25
Chloromequat chloride (2.5ml/litre)	33.40	44.9	3.02	0.48	0.81	0.35
Ethrel (500 ppm)	26.27	27.9	1.76	0.42	0.38	0.48
Ethrel (1000 ppm)	24.07	28.8	1.09	0.47	0.49	0.28
C.D.	7.45	20.89	1.00	0.17	0.40	0.41
SE(m)	2.33	6.54	0.31	0.05	0.13	0.13
SE(d)	3.30	9.25	0.44	0.08	0.18	0.18
C.V.	12.53	28.70	23.50	20.02	27.90	65.53