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EFFECT OF NIPPING AND GROWTH RETARDANTS ON TENDRIL MANAGEMENT, GROWTH DYNAMICS AND CANOPY DEVELOPMENT IN COWPEA (*VIGNA UNGUICULATA*)

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ABSTRACT

A field experiment was conducted during the late *Kharif* season of 2024 at Main Agricultural and Horticultural Research Station, Iruvakki, Shivamogga, Karnataka located in hilly zone (Zone 9) to investigate the "Effect of nipping and growth retardants on tendril management, growth dynamics and canopy development in cowpea (*Vigna unguiculata*). The study evaluated three nipping stages; no nipping, nipping at tendril initiation (30 DAS) and nipping two weeks after tendril initiation (45 DAS), combined with five foliar application of growth retardant treatments; water spray (control), Chlormequat chloride (CCC) at 500 and 1000 ppm, Maleic hydrazide (MH) at 500 and 1000 ppm. Results showed that nipping at 30 DAS combined with CCC at 1000 ppm significantly reduced number of tendrils per plant (1.80), mean length (31.23 cm) and plant height (78.56 cm) at harvest, while enhancing the number of branches (25.90 branches plant^{-1}), leaves (77.01 plant^{-1}), leaf area (2144 cm^2) and total dry matter (44.58 g plant^{-1} at harvest) over the control (6.50, 90.63 cm, 124.79 cm, 12.01, 30.01, 1211.24 cm^2, 28.02 g respectively). Physiological growth indices such as leaf area index, absolute growth rate and crop growth rate also improved (3.83, 0.50 g plant^{-1} day^{-1} and 11.01 g m^{-2} day^{-1}, respectively). Chlorophyll content increased from 40.77 (control) to 61.87 SPAD units at 60 DAS indicating enhanced photosynthetic capacity and nitrogen assimilation. Maleic hydrazide treatments showed moderate effects on growth parameters compared to Chlormequat chloride. The findings confirm that timely nipping integrated with optimal growth retardant application effectively regulates excessive vegetative growth and optimises canopy structure, leading to improved canopy function and photosynthetic efficiency in cowpea. This combined agronomic approach offers a practical strategy for enhancing tendril management and cowpea productivity.

***Keywords*: Cowpea, nipping, growth retardant, tendril, Chlormequat chloride, Maleic hydrazide.

Introduction

Cowpea (*Vigna unguiculata*) is recognised as versatile leguminous crop, widely cultivated in tropical and subtropical regions, it contributes significantly to food security, soil fertility restoration and sustainable livelihoods (Allen, 2013; Jayathilake *et al.*, 2018; Sikora *et al.*, 2018). In addition to serving as a staple grain and fresh vegetable, cowpea plays a pivotal role in mixed farming systems as animal fodder and green manure. Its edible seeds, leaves, pods and even roots provide substantial nutritional value, featuring high protein levels, essential micronutrients and complex carbohydrates (Belane and Dakora, 2009; Anon. 2012). Moreover, the effective symbiosis between cowpea and *Rhizobium* species enables fixation of up to 150 kg of atmospheric nitrogen per hectare, thus enhancing soil health and reducing synthetic fertiliser reliance (Chattopadhyay *et al*., 2007).

Cowpea yields are often limited by excessive vegetative growth and tendril formation, which reduce floral initiation and pod set, especially in bush-type cultivars (Rahianath, 2010). Pruning or shoot removal can curb vegetative biomass and enhance reproductive allocation, increasing pod and seed yield (Kilbaren *et al*., 2023). Similarly, growth regulators like cycocel (CCC) suppress internode elongation and promote pod development (Kumari *et al*., 2025). Excess nitrogen further stimulates vegetative growth at the expense of reproduction (Bobade *et al*., 2024). Thus, canopy management through pruning, nipping or growth retardants is essential to balance vegetative, reproductive growth and stabilize yields.

Among agronomic interventions, nipping the manual removal of shoot apex has demonstrated significant benefits in numerous legumes, including cowpea (Reddy *et al*., 2009; Majoka *et al*., 2021). By limiting apical dominance, nipping encourages greater lateral branching, increases the number of pod-bearing sites and improves canopy architecture for enhanced light interception and photosynthate allocation. The practice is also economically accessible, requiring no specialised tools and is particularly advantageous to small and marginal farmers (Dhital *et al*., 2017).

Complementary to nipping, the use of plant growth retardants such as Chlormequat chloride (CCC) and Maleic hydrazide (MH) has recently been investigated as an effective strategy to suppress excessive stem elongation and promote compact plant architecture without impairing reproductive development. CCC application significantly reduces plant height and internode length while enhancing assimilate partitioning toward yield attributes in cowpea (Mavdiya *et al*., 2023). Under water-stress conditions, CCC sprays were also found to improve chlorophyll content and dry matter accumulation, highlighting their role in maintaining physiological stability (Menon, 2024). Likewise, nipping in combination with hormonal sprays has been reported to improve branching, leaf number, dry matter production and seed yield in cowpea.

Materials and Methods

The field experiment was executed during the late *Kharif* season of 2024 at the Main Agricultural and Horticultural Research Station, Iruvakki, Shivamogga, Karnataka. The region falls under the hilly agro-climatic Zone 9 of Karnataka. During the period from September to December 2024, the total rainfall received was 449 mm, temperatures ranged from 17.8 °C to 32.2 °C, relative humidity varied between 71 to 93 per cent, with daily sunshine hours (4.8 to 6.5 hrs). Initial soil analysis classified the site as sandy clay loam (USDA system), with acidic pH (5.56), high organic carbon (11.7 g kg^{-1}, Walkley and Black, 1934) and medium levels of available nitrogen (321.05 kg ha^{-1}), low phosphorus (20.2 kg P_2O_5 ha^{-1}) and medium in potassium (184.13 kg K_2O ha^{-1}), estimated using standard protocols (Piper, 1966; Jackson, 1973; Subbaiah and Asija, 1956).

The experiment was laid out in a Factorial Randomised Complete Block Design were fifteen treatments combinations replicated thrice. The first factor involved nipping at three levels *viz*., No nipping (N_1), Nipping at tendril initiation (30 DAS) (N_2) and Nipping at 2 weeks after tendril initiation (45 DAS) (N_3). The second factor encompassed various plant growth regulators *viz*., Water spray (control), Chlormequat chloride (500 and1000 ppm), Maleic Hydrazide (500 and 1000 ppm). The crop selected was cowpea variety 'KBC 9', featuring erect growth, purple flowers, grey pubescence and light-yellow seeds, with a maturity period of 80-85 days and resistant to common local pests and pod borer, diseases like dry root rot.

Plot layout included a gross plot size of 3.6 m × 3.0 m and net plot size of 1.8 m × 2.6 m, with inter-row and intra-row spacing of 45 cm × 10 cm, respectively. The seed rate was 30 kg ha^{-1} and cultural practices were followed uniformly to all the treatments. The entire dose of recommended fertilizers (25:50:25 kg N: P_2O_5:K_2O ha^{-1} using urea, DAP and MOP) and 7.5 t ha^{-1} farmyard manure (FYM) was applied basally. Nipping and growth retardants spray Chlormequat chloride at 500 and 1000 ppm (1 and 2 ml per L water, respectively; 500 L ha^{-1}), Maleic hydrazide at 500 and 1000 ppm (0.5 and 1 g per L water, respectively; 500 L ha^{-1}) was taken at 30 and 45 days after sowing.

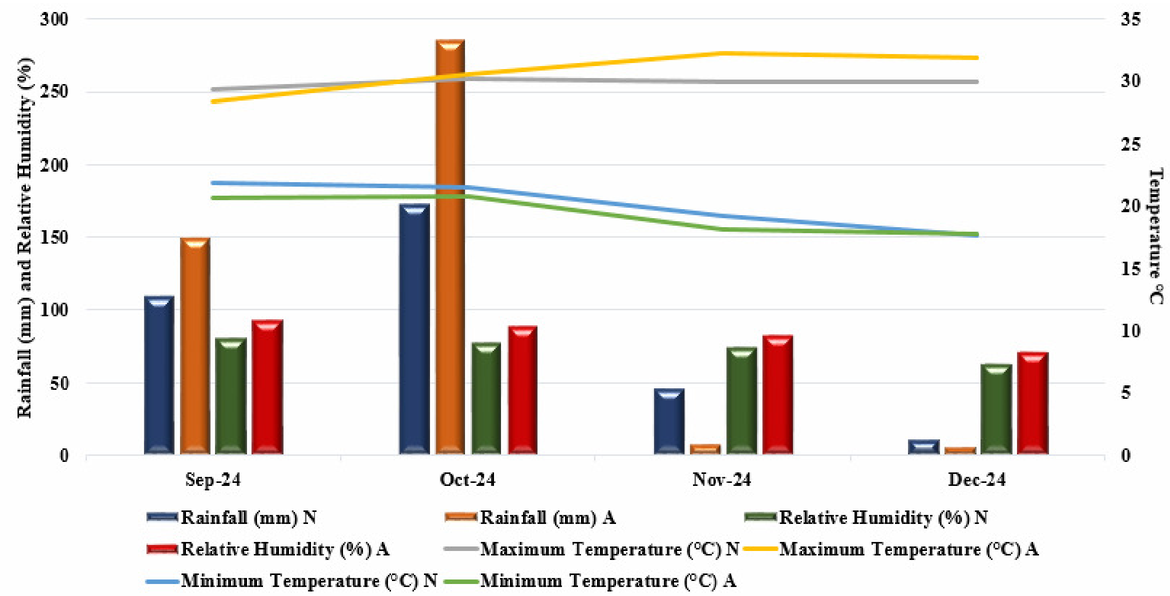

Fig. 1 : Monthly meteorological data for the experimental period (September to December 2024) against normal (1993-2023) at MAHRS, Iruvakki, Shivamogga

Tendril and Growth Parameters: Five plants per net plot were randomly tagged for periodical evaluation. Number of tendrils per plant, mean length of tendril (cm), dry weight of tendril (g plant^{-1}), mean weight per unit length (mg cm^{-1}) and percent of tendril weight over total dry weight (%) were recorded at 30 and 60 DAS. Growth parameters includes plant height (cm), number of branches (plant^{-1}), number of leaves (plant^{-1}), leaf area (plant^{-1}) and total dry matter (plant^{-1}-oven-dried at 65°C) were recorded at 30,60 and at harvest.

Physiological Growth Indices

Leaf Area Index (LAI): Leaf area index is the ratio of leaf area to ground area occupied by the crop plant. Leaf area index (LAI) was worked out using the following formula given by Watson, (1952).

$$LAI = \frac{Leaf\ area\ per\ plant\ (cm)^2}{Ground\ area\ covered\ by\ the\ plant\ (cm)^2}$$

Absolute Growth Rate (AGR): Absolute growth rate (AGR) indicates the dry weight increase per unit time and expressed in g plant^{-1} day^{-1}. It was calculated by using the following formula given by Radford (1967).

$$AGR = \frac{W_2 - W_1}{t_2 - t_1}$$

Where,

W_1 and W_2 are dry weight of plant at time t_1 and t_2, respectively.

Crop Growth Rate (CGR): Crop growth rate (CGR) is defined as rate of dry matter production per unit ground area per unit time. It is expressed in g m^{-2} day^{-1} and calculated by the formula.

$$CGR = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{1}{A}$$

Where,

W_1 and W_2 are dry weight of plant at time t_1 and t_2, respectively.

A = Spacing (m^2) or land area

Biochemical Analysis: Chlorophyll content was measured using a SPAD meter on fully expanded trifoliate leaves at 30 and 60 DAS to estimate potential variations in pigment concentration and photosynthetic efficiency.

Statistical Analysis: All data sets were subjected to analysis of variance (ANOVA) as described by Gomez and Gomez (1984). Mean separation was accomplished using the appropriate critical difference (CD) or standard error of the mean (S.Em) at the 5 per cent probability level, allowing for rigorous assessment of treatment effects.

Results and Discussion

Tendril parameters

The tendril parameters of cowpea were significantly influenced by both nipping and foliar application of growth retardants (Table 1).

Among the nipping treatments, nipping at tendril initiation stage (30 DAS) significantly reduced the number of tendrils (3.50 plant^{-1}), mean length of tendril (35.6 cm), dry weight of tendril (1.68 g), mean weight per unit length of tendril (47.19 mg cm^{-1}) and percent of tendril weight over total dry weight of plant (6.20

%) followed by nipping at 2 weeks after tendril initiation. Highest was recorded in no nipping (8.52, 90.52 cm, 5.02 g, 55.46 mg cm^{-1} and 25.15 % respectively). This may be attributed to the fact that apical dominance in non-nipped plants promoted uninterrupted elongation of terminal shoots and stimulated the initiation of tendrils. In contrast, nipping of the apical portion reduced auxin flow and altered assimilate partitioning, thereby suppressing tendril initiation and elongation reported by Reddy (2005) in cowpea, (Kumar, 2018) in field bean**,** Kumar *et al.* (2019) in cowpea. Reduced tendril growth under nipping treatments has also been reported by Jat *et al.* (2013) in clusterbean and Kumawat *et al.* (2020) in cowpea, where growth regulation reduced unproductive dry matter.

Regarding growth retardants, Chlormequat chloride at 1000 ppm (R_3) resulted in the fewest tendrils (3.80), it significantly minimized tendril length (54.00 cm), dry weight of tendril (2.12 g), mean weight per unit length of tendril (39.26 mg cm^{-1}) and percent of tendril weight over total dry weight of plant (8.57 %) followed by Chlormequat chloride at 500 ppm (R_2). The highest values were observed in the water spray treatment (R_1-6.52, 89.03 cm, 4.08 g, 45.83 mg cm^{-1} and 18.91 % respectively). Reddy (2005) reported that application of Cycocel in cowpea effectively curtailed vegetative vigour, which included suppression of tendril formation and resulted in improved pod yield.

The combined effect of treatments revealed that nipping at tendril initiation stage (30 DAS) coupled with chlormequat chloride at 1000 ppm (N_2R_3) produced the lowest number of tendrils (1.80), shortest tendril length (31.23 cm), dry weight of tendril (1.30 g), mean weight per unit length of tendril (41.63 mg cm^{-1}) and percent of tendril weight over total dry weight of plant (4.93 %) which was followed by nipping at tendril initiation stage (30 DAS) + Chlormequat chloride at 500 ppm (N_2R_2). Conversely, the highest number and length of tendrils were found in the no nipping with water spray combination (N_1R_1-1.80, 90.63 cm, 5.90 g, 65.10 mg cm^{-1} and 26.88 % respectively). This may be attributed to the fact that apical dominance in non-nipped plants promoted uninterrupted elongation of terminal shoots and stimulated the initiation of tendrils. In contrast, nipping of the apical portion reduced auxin flow and altered assimilate partitioning, thereby suppressing tendril initiation and elongation. These results are in agreement with the findings of Ramesh *et al*., (2001) in blackgram, Reddy (2005) in cowpea.

Growth parameters

The growth parameters of cowpea were significantly influenced by both nipping and foliar application of growth retardants (Table 2).

Among different nipping stages, nipping at tendril initiation stage (30 DAS) had significantly reduced plant height at harvest (92.32 cm) and increased the number of branches (21.93 $plant^{-1}$), leaves and leaf area (66.16, 1893.29 cm^2 at 60 DAS, respectively), total dry matter (40.67 g), leaf area index (4.21), absolute growth rate (0.77 g $plant^{-1}$ day^{-1}) and crop growth rate (17.07 g m^{-2} day^{-1}) which was followed by nipping 2 weeks after tendril initiation stage (45 DAS) compared to the no nipping (118.63 cm, 15.06, 35.73, 1252.09 cm^2, 29.97 g, 2.78, 0.54 g $plant^{-1}$ day^{-1} and 11.93 g m^{-2} day^{-1}, respectively). The reduction in plant height observed with terminal bud pinching is likely due to the loss of apical dominance, which results in a bushier plant morphology (Sahu & Biswal, 2017) and Mounika and Singh (2021).

Foliar application of growth retardants such as Chlormequat chloride at 1000 ppm recorded in significantly reduction of plant height (99.12 cm at harvest) and increased the number of branches (20.66 $plant^{-1}$), leaves and leaf area per plant (56.10, 1658.84 cm^2 at 60 DAS), total dry matter (37.10 g), leaf area index (3.69), absolute growth rate (0.69 g $plant^{-1}$ day^{-1}) and crop growth rate (15.32 g m^{-2} day^{-1}) followed by CCC at 500 ppm. Least was recorded in water spray (113.18 cm, 16.02, 41.79, 1421.42 cm^2, 32.38 g, 3.16, 0.59 g $plant^{-1}$ day^{-1} and 13.12 g m^{-2} day^{-1}). It is due to growth retardants are known to inhibit gibberellin biosynthesis, which plays a major role in stem elongation. This reduction in cell elongation and internodal length resulted in compact plants with restricted height. Similarly, Kumar and Singh (2003) reported reduced stem elongation in carnation under growth retardant application, resulting in more compact plant architecture. Cycocel spray at 1000 ppm at knee hight stage in sorghum significantly reduced plant height observed by Rani *et al.* (2020). The reduction in plant height could be attributed to the suppression of transverse cell division, especially in the stelar cambium, which represents the primary meristematic zone responsible for internodal elongation reported by Kumar *et al*. (2024) in cowpea.

The interaction of nipping at tendril initiation stage (30 DAS) with foliar application of Chlormequat chloride at 1000 ppm (N_2R_3) had the most pronounced effect on growth parameters in cowpea. Significantly reduced plant height at harvest (78.56 cm) and increased the number of branches (25.90 $plant^{-1}$), leaves and leaf area (77.01, 2144.57 cm^2 at 60 DAS, respectively), total dry matter (44.58 g), leaf area index (4.77), absolute growth rate (0.85 g plant^{-1} day^{-1}) and crop growth rate (18.92 g m^{-2} day^{-1}) which was followed by nipping at tendril initiation stage with Chlormequat chloride at 500 ppm (N_2R_2). Least was recorded in no nipping with water spray (N_1R_1) (124.79 cm, 12.01, 30.01, 1211.24 cm^2, 28.02 g, 2.69, 0.50 g plant^{-1} day^{-1} and 11.01 g m^{-2} day^{-1}, respectively). It is due to the combined action of apical bud removal (reducing auxin dominance) and retardant application (suppressing gibberellin activity) resulted in enhanced plant height and branching with restricted vertical growth. Sahu and Biswal (2017), who emphasized that pinching and canopy modification improve plant architecture by balancing hormonal distribution and restricting unnecessary elongation.

Biochemical parameters

Chlorophyll content in leaves was significantly recorded higher at 60 DAS (Table 3 -SPAD readings) under nipping at tendril initiation stage (30 DAS) (54.81) fallowed by nipping at 2 weeks after tendril initiation (45 DAS) (49.56) the lowest chlorophyll content was observed in no nipping (45.03) as nipping encouraged more leaf retention and improved leaf area index, thereby enhancing photosynthetic pigments by delaying senescence and stabilizing chlorophyll molecules. Among growth retardants, application of Chlormequat chloride at 1000 ppm recorded higher chlorophyll content (52.67), followed by Chlormequat chloride at 500 ppm (50.83) and lowest was recorded in water spray (47.23). The combination of both nipping at 30 DAS and foliar application of Chlormequat chloride at 1000 ppm recoded highest (61.87) whereas no nipping with water spray recorded lowest (40.77). This increase in chlorophyll helped in sustaining photosynthetic activity for longer duration. Similar results were reported by Patil *et al.* (2002) in cowpea and Singh *et al.* (2023) in cowpea, where CCC application improved chlorophyll content and leaf longevity.

Conclusion

This investigation demonstrates that nipping at the tendril initiation stage (30 DAS), combined with foliar application of Chlormequat chloride at 1000 ppm, effectively regulates vegetative growth, optimises canopy architecture in cowpea and minimizes tendril formation. Such integrative management enhances key growth parameters, including branching, leaf area, dry matter accumulation and photosynthetic efficiency, as evidenced by increased LAI, AGR, CGR and chlorophyll content. The poised regulation of excessive vegetative growth through these practices promotes improved resource allocation, ultimately fostering higher productivity potential. These results substantiate that nipping and growth retardants regulate excessive vegetative growth and optimise canopy structure, leading to improved growth indices and enhanced photosynthetic efficiency in cowpea.

Table 1: Number of tendrils (plant^{-1}), Mean length of tendril (cm), Dry weight of tendril (g plant^{-1}), Mean weight per unit length (mg cm^{-1}) and Percent of tendril weight over total dry weight (%) of cowpea as influenced by nipping and growth retardants application

Treatments	Number of tendrils (plant^{-1})	Mean length of tendril (cm)	Dry weight of tendril (g plant^{-1})	Mean weight per unit length (mg cm^{-1})	Percent of tendril weight over total dry weight (%)
Factor A (Nipping stages)					
N_1	8.52	90.52	5.02	55.46	25.15
N_2	3.50	35.6	1.68	47.19	06.20
N_3	5.02	78.50	4.23	53.89	18.77
S. Em. (±)	0.09	0.08	0.05	0.52	0.32
CD at 5%	0.27	0.25	0.12	1.56	0.96
Factor B (Growth retardants)					
R_1	6.52	89.03	4.08	45.83	18.91
R_2	4.20	58.02	2.45	42.23	09.53
R_3	3.80	54.00	2.12	39.26	08.57
R_4	4.80	69.56	4.35	62.54	13.75
R_5	4.60	66.00	3.25	49.24	10.25
S. Em. (±)	0.12	0.10	0.07	0.80	0.38
CD at 5%	0.36	0.30	0.18	2.4	1.15
Interaction (NXR)					
N_1R_1	6.50	90.63	5.90	65.10	26.88
N_1R_2	6.00	88.03	5.35	60.77	23.62
N_1R_3	5.80	86.12	5.28	61.31	23.28
N_1R_4	6.20	90.42	5.72	63.26	24.27

N_1R_5	6.10	89.65	5.55	61.91	23.90
N_2R_1	4.20	38.00	2.10	55.26	08.47
N_2R_2	3.20	34.46	1.45	42.08	06.43
N_2R_3	1.80	31.23	1.30	41.63	04.93
N_2R_4	3.80	38.25	1.85	48.37	08.37
N_2R_5	3.30	36.12	1.70	47.07	06.43
N_3R_1	5.10	80.48	5.10	63.37	23.09
N_3R_2	4.50	75.25	3.48	46.25	14.64
N_3R_3	4.40	73.02	3.20	43.82	13.87
N_3R_4	4.80	78.65	4.89	62.17	21.88
N_3R_5	4.70	77.03	4.30	55.82	19.30
S. Em. (±)	0.22	0.18	0.12	1.62	1.15
CD @ 5%	0.66	0.55	0.25	4.86	3.45

Note: RDF 25:50:25 kg N: P_2O_5: K_2O ha^{-1} and FYM 7.5 t ha^{-1} is applied for all the treatments
Foliar spray of each retardant at 30 and 45 DAS (Days after sowing); Volume of water required for foliar spray is 500 lit ha^{-1}
N_1: No Nipping, N_2: Nipping at tendril initiation (30 DAS), N_3: Nipping at 2 weeks after tendril initiation (45 DAS), R_1: Only water spray, R_2: Chlormequat chloride (500 ppm), R_3: Chlormequat chloride (1000 ppm), R_4: Maleic hydrazide (500 ppm), R_5: Maleic hydrazide (1000 ppm)

Table 2: Plant height (cm), Number of branches (plant^{-1}), Number of leaves (plant^{-1}), Leaf area (cm^2 plant^{-1}) and Total dry matter (g plant^{-1}) of cowpea as influenced by nipping and growth retardants application

Treatments	Plant height (cm) At harvest	Number of branches (plant^{-1}) At harvest	Number of leaves (plant^{-1} 60 DAS)	Leaf area (cm^2 plant^{-1} 60 DAS)	Total dry matter (g plant^{-1}) At harvest
Factor A (Nipping stages)					
N_1	118.63	15.06	35.73	1252.09	29.97
N_2	92.32	21.93	66.16	1893.29	40.67
N_3	107.62	17.17	45.81	1449.41	33.82
S. Em. (±)	1.97	0.24	0.65	21.35	0.64
CD at 5%	5.92	0.72	1.97	64.86	1.95
Factor B (Growth retardants)					
R_1	113.18	16.02	41.79	1421.42	32.38
R_2	104.13	19.05	53.48	1587.96	35.90
R_3	99.12	20.66	56.10	1658.84	37.10
R_4	108.39	16.57	45.12	1475.27	33.92
R_5	106.12	17.97	49.67	1514.50	34.81
S. Em. (±)	2.55	0.31	0.84	27.57	0.82
CD at 5%	7.83	0.96	2.57	84.71	2.52
Interaction (NXR)					
N_1R_1	124.79	12.01	30.01	1211.24	28.02
N_1R_2	116.86	14.85	39.68	1263.71	30.54
N_1R_3	114.66	15.00	40.59	1301.97	31.89
N_1R_4	118.99	13.01	33.01	1235.81	29.01
N_1R_5	117.86	14.05	35.33	1247.71	30.20
N_2R_1	103.29	19.26	54.01	1676.07	37.22
N_2R_2	89.49	22.75	71.74	2007.97	41.50
N_2R_3	78.56	25.90	77.01	2144.57	44.58
N_2R_4	97.06	20.31	59.01	1787.77	39.22
N_2R_5	93.19	22.41	69.01	1850.07	40.82
N_3R_1	111.46	15.05	41.33	1376.94	32.09
N_3R_2	106.06	17.32	49.02	1492.21	34.62
N_3R_3	104.16	18.30	50.69	1529.97	35.66
N_3R_4	109.12	15.40	43.33	1402.24	33.41
N_3R_5	107.32	16.45	44.66	1445.71	33.53
S. Em. (±)	4.41	0.54	1.45	47.75	1.42
CD @ 5%	13.79	1.67	4.35	148.33	4.27

Note: RDF 25:50:25 kg N: P_2O_5: K_2O ha^{-1} and FYM 7.5 t ha^{-1} is applied for all the treatments
Foliar spray of each retardant at 30 and 45 DAS (Days after sowing); Volume of water required for foliar spray is 500 lit ha^{-1}
N_1: No Nipping, N_2: Nipping at tendril initiation (30 DAS), N_3: Nipping at 2 weeks after tendril initiation (45 DAS), R_1: Only water spray, R_2: Chlormequat chloride (500 ppm), R_3: Chlormequat chloride (1000 ppm), R_4: Maleic hydrazide (500 ppm), R_5: Maleic hydrazide (1000 ppm)

Table 3: Leaf area index, Absolute growth rate (g plant^{-1} day^{-1}), Crop growth rate (g m^{-2} day^{-1}) and Chlorophyll content (SPAD readings) of cowpea as influenced by nipping and growth retardants application

Treatments	Leaf area index	Absolute growth rate (g plant^{-1} day^{-1})	Crop growth rate (g m^{-2} day^{-1})	Chlorophyll content
Factor A (Nipping stages)				
N_1	2.78	0.54	11.93	45.03
N_2	4.21	0.77	17.07	54.81
N_3	3.22	0.62	13.81	49.56
S. Em. (±)	0.05	0.01	0.31	0.64
CD at 5%	0.15	0.04	0.93	1.86
Factor B (Growth retardants)				
R_1	3.16	0.59	13.12	47.23
R_2	3.53	0.67	14.78	50.83
R_3	3.69	0.69	15.32	52.67
R_4	3.28	0.62	13.89	48.78
R_5	3.37	0.64	14.25	49.47
S. Em. (±)	0.06	0.02	0.40	0.83
CD at 5%	0.19	0.06	1.24	2.55
Interaction (NXR)				
N_1R_1	2.69	0.50	11.01	40.77
N_1R_2	2.81	0.55	12.22	45.93
N_1R_3	2.89	0.57	12.93	47.02
N_1R_4	2.75	0.52	11.52	44.74
N_1R_5	2.77	0.54	11.99	45.13
N_2R_1	3.72	0.69	15.39	51.01
N_2R_2	4.46	0.79	17.46	56.82
N_2R_3	4.77	0.85	18.92	61.87
N_2R_4	3.97	0.74	16.41	51.94
N_2R_5	4.11	0.77	17.19	52.38
N_3R_1	3.06	0.58	12.96	47.90
N_3R_2	3.32	0.63	14.10	49.73
N_3R_3	3.40	0.66	14.66	50.31
N_3R_4	3.12	0.61	13.59	48.31
N_3R_5	3.21	0.62	13.72	49.66
S. Em. (±)	0.11	0.03	0.70	1.44
CD @ 5%	0.34	0.09	2.10	4.17

Note: RDF 25:50:25 kg N: P_2O_5: K_2O ha^{-1} and FYM 7.5 t ha^{-1} is applied for all the treatments
Foliar spray of each retardant at 30 and 45 DAS (Days after sowing); Volume of water required for foliar spray is 500 lit ha^{-1}
N_1: No Nipping, N_2: Nipping at tendril initiation (30 DAS), N_3: Nipping at 2 weeks after tendril initiation (45 DAS), R_1: Only water spray, R_2: Chlormequat chloride (500 ppm), R_3: Chlormequat chloride (1000 ppm), R_4: Maleic hydrazide (500 ppm), R_5: Maleic hydrazide (1000 ppm)

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