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Effect of growth retardants on yield parameters of cowpea (*Vigna unguiculata* L. Walp)

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Abstract
A field experiment was conducted at Central Experimental field, Sam Higginbottom University of Agriculture, Technology and Sciences, during the *rabi* season of 2016-17, to know the effect of growth retardants *viz*, Maliec hydrazide (MH), Cycocil (CCC) and Lichocin on growth characters, seed quality, yield and yield components in cowpea (Cv. Kashi Kanchna). The experiment was laid out in RBD with three replications. Results revealed that the application of growth retardant reduced the plant height. The minimum plant height was recorded in MH (500 ppm).The AGR different significantly at 60-90 days it was highest in Lichocin (1000 ppm) followed by CCC (500 ppm). In all the treatments CGR increased over control and was highest in Lichocin (1000 ppm). At 60 DAS to 90 DAS RGR was significantly more in CCC (500ppm). The yield contributing characters *viz*, seed yield per plant, number of pods per plant, seed per pod, seed index and seed yield (g m^{-2}) increased significantly due to growth retardants. Among the treatments Lichocin (1000 ppm) recorded significantly more seed yield than other treatments.

Keywords: *Vigna unguiculata* (L.) *walp*, growth retardant, growth parameters, yield

Introduction

Pulses occupy an indispensable place in our daily diet as a source of protein. India is a major pulse growing country in the world occupying an area of 43.45 m ha^{-1} producing 17.24 m tons with an average productivity of 660 kg ha^{-1} (FAO, 2012). Cowpea (*Vigna uniguiculata* (L). Walp.) is valuable warm season grain legume in tropical and sub-tropical zones of Africa, Asia and U.S.A it is widely adopted and capable of producing seeds even in lowland and semi-arid regions. However grain yield of this legume varies widely when grown at different locations.

The largest production of cowpea is with over 4.3 million metric tons of annual production while the grain is a good source of human protein while the haulms are valuable source of livestock protein. It is also source of income from many small holder farmers and contributes to the sustainability of cropping system and soil fertility improvement in marginal land through provision of ground cover by plant residue and nitrogen fixation (Tripathi and Singh, 2001). All part of cowpea is useful for food and is nutritious, providing protein, vitamin and mineral. The protein in cowpea seed is richer in amino acid, lysine and others compared to cereal grain (Anonymous, 2010) the cowpea haulm is also great value to farmers it is also use as cover crop, green manure crop, used for feeding animals and also for soil erosion control. Weeds serve as the main constraint to its production which resulted in low yield, poor quality of the crop and also low income to the farmer.

Cowpea (*Vignaunguiculata* L. walp.) is an important and versatile crop cultivated in India, being a drought tolerant crop with better growth in warm climate. Cowpea has the ability to fix nitrogen even in a very poor soil with p^H range 4 - 9.0, organic matter < 0.2 percent and sand content of > 85 percent.

For normal growth and development hormones like, auxins, gibberellins, ethylene, cytokinin and abscisic acid are required in proper proportions and any imbalance leads to the shedding of reproductive organs.

One of the reasons for low productivity of this crop is due to its large scale cultivation under rainfed and low input conditions coupled with non-availability of high yielding varieties. The crop also produces excessive vegetative growth in heavy rain fall areas and under irrigated conditions resulting in to poor yield. The physiological reasons for variation in productivity may be attributed to poor source-sink relationship, poor translocation efficiency at later stages crop growth, shedding of floral parts and low harvest index. (Manivannan *et al.*, 2011) [11]

The pattern of development and behavior of each individual plant is the result of a complex interplay between genetic, hormonal and environmental factors. When growth regulators are used in appropriate concentrations, these substances influence the plant architecture in a typical fashion and improve the yield potential. Substances are now available that modify plant organs differently and influence final plant form. Such substances therefore, are potentially useful in agriculture, because when applied at appropriate concentration increase the yield either by altering dry matter distribution in the plant or by regulating growth. So that the research was conducted to evaluate the growth retardants in cowpea for yield attributes.

Materials and methods

Field experiments were conducted at the Central Experimental field, Sam Higginbottom, University of Agriculture, Technology and Sciences, during the *Rabi* season of 2016-17 to evaluate the growth retardant in Kashi Kanchana varitey of cowpea. The site selected was uniform, cultivable with typical sandy loam soil having good drainage. All the package of practices was followed as per the general agronomic practices for Cowpea crop. Five randomly selected plants were tagged from each treatment for recording the observations on growth and yield. Observations viz, plant height, number of branches, Number of leaves, Absolute growth rate (AGR), Relative growth rate (RGR), Crop growth rate (CGR), number of pods per plant, seed yield per hectare, test weight and number of seed per plant was recorded as per the standard procedures are as follows.

Absolute growth rate (AGR) is the dry matter production per unit time (g day^{-1}) and was calculated by using the following formula given by Radford (1967) [15].

$$AGR=\frac{(W2-W1)}{(t2-t1)}$$

Where,
W_1= Dry weight of the plant at time t_1
W_2= Dry weight of the plant at time t_2

Relative growth rate (RGR) is the rate of increase in the dry weight per unit dry weight (g/g/day) already present (Blackman, 1919) [3] and was calculated by the using the formula.

$$RGR=\frac{(\log e\ w2-\log e\ w1)}{(t2-t1)}$$

Where,
W_1= Dry weight of the plant at time t_1
W_2= Dry weight of the plant at time t_2

Crop growth rate (CGR) is the rate of dry matter production per unit ground area per unit time. It was calculated by using the following formula and expressed as g cm^{-2} day^{-1} (Watson, 1947).

$$CGR=\frac{(W2-W1)}{(t2-t1)}\times\frac{1}{A}$$

Where,
W_1= Dry weight of the plant at time t_1
W_2= Dry weight of the plant at time t_2
A=Land area (cm^2)

Results and discussion

Morphological traits like plant height, number of branches and number of leaves at different stages of cowpea (Kashi Kanchana) were differed significantly with respect to growth retardant application (Table 1). The mechanism of reduction in plant height appears to be due to slowing down of cell expansion due to the application of growth retardent. Significantly higher plant height was recorded in control (63.9 cm) which was followed by followed by CCC 500 ppm (55.9) and MH 250 ppm (53.9 cm) and the minimum plant height was recorded in MH 500 ppm (33.2 cm) followed by CCC 1000 ppm (36.0 cm). It has also been suggested that maleic hydrazide is a anti-auxin like property, the reduced plant height might be due to the retardation of transverse cell division, particularly in stealer cambium which is the zone of the meristamatic activity at the base of the internode and plants affected the vernalization its causes the delay of vegetative growth (Lone *et al*., 2010) [10]. The significantly more number of branches and leaves were recorded in treatment CCC 500 ppm (5.93 and 37.5) and the less number of branches and leaves were noticed in Maleic hydrazide 500 ppm (2.80 and 12.2). The increase in number of branches could be due to inhibition in the auxin activity in the plant due to the application of maleic hydrazide which acts more or less as anti auxin. The treatments could have also suppressed the apical dominance, there by diverting the polar transport of auxin towards the basal nodes leading to increased branching. Similar results were obtained by in pea plants (Reddy *et al.*, 2009 and Gasti, 1994) [16, 6, 7].

The growth parameters like, absolute growth rate, relative growth rate and crop growth rate for various growth periods were differed significantly with respect to the growth retardant application (Table 2). Growth parameters like AGR, CGR and RGR have been extensively used in recent years for better understanding of physiological basis of yield variation in crop plants. The differences in the AGR and CGR values were mainly because of difference in growth rate of genotype with respect to growth retardants. Application of the growth retardant CCC at 1000 ppm showed significantly higher AGR (1.12 g day^{-1}) followed by CCC 500 ppm, Lichocin (1000 and 500 ppm) and malic hydrazide (500 and 250 ppm) over a control. The data on relative growth rate was diffred significant at 30-60 and 60-90 DAS. Application of maleic hydrazide of 250 ppm recorded more RGR (1.01 g g^{-1} day^{-1}) which was followed by maleic hydrazide 500 ppm (0.98) over a control. The crop growth rate completed for various growth periods is presented in table the CGR differed at all the stages. At 60-90 DAS the highest CGR recorded maleic hydrazide 500 ppm (15.5 g cm^{-2} day^{-1}) followed by CCC 1000 ppm (14.7), all the treatments were differed significantly over control, similar results were observed by Rademcher (2000) [14] and Reddy *et al.* (2009) [16].

The yield and yield attributes viz, number of pods per plant, number of seeds per pod, seed per plant seed index seed per m^{-2} were differed significantly by the application of growth retardant. Among the treatments, lichocin 1000 ppm was recorded significantly higher number of pods per plant (14.9), seeds per pod (14.4), seed index (14.1), seed yield per plant (30.6 g $plant^{-1}$) and seed weight per m^{-2} (460 g^{-1}) and lowest number of pods per plant and seeds per pod (13.0) was observed in maleic hydrazide 500 ppm and maleic hydrazide 250 ppm (10.8), respectively. Lowest seed yield per plant and seed yield per meter row length was observed in maleic hydrazide 250 ppm (17.4) and in maleic hydrazide 500 ppm (292), respectively, similar results were observed by Vanangamudi *et al.* (2003) [17].

It is concluded that the application of plant growth retardants decreases the growth by alter the plant architecture appears to be an excellent tool. The effects of growth retardants vary with the plant species, variety, concentration used, frequency of application and various other factors which influence the uptake and translocation of the chemical. Moreover, growth retardants play a significant role in modifying morphology, physiology and reproductive phase of cowpea. It was observed in the present investigation that the application of growth retardants significantly increased the number of pods, number seed per pod, seed index, which are the important yield determining components in cowpea, among various treatments imposed. The percent increase in the yield was more with lichocin 1000 ppm followed by lichocin 500 ppm and CCC 1000 ppm as compared to control. To achieve optimum vegetative growth and to effect better translocation of photosynthates in developing pods, the use of growth retardants which regulate plant growth and finally alter the plant architecture and yield improvement appears to be an excellent tool.

Table 1: Effect of growth retardants on plant height, number of branches an number of leaves at different stages in cowpea

Treatments		Plant height (cm)			Number of Branches per plant			Number of leaves per plant		
		30	60	90	30	60	90	30	60	90
		DAS								
T_0	Control	11.9	46.3	63.9	1.6	4.6	6.5	6.8	18.3	41.0
T_1	Maleic hydrazide (250ppm)	12.3	40.7	53.9	1.8	4.0	5.8	7.6	16.0	36.7
T_2	Maleic hydrazide (500ppm)	12.1	33.2	43.5	1.5	2.6	4.7	6.4	12.2	32.4
T_3	CCC (500ppm)	12	43.1	55.9	1.4	4.2	5.9	6.2	16.6	37.5
T_4	CCC (1000ppm)	11.4	36.9	45.4	1.6	3.3	5.1	7.0	13.7	34.0
T_5	Lichocin (500ppm)	12.8	38.4	51.8	1.4	3.9	5.5	6.4	15.4	36.1
T_6	Lichocin (1000ppm)	12.5	37.2	48.4	1.4	3.5	5.4	6.3	14.4	34.6
Mean		12.1	39.3	51.8	1.5	3.8	5.5	6.6	15.2	36.0
S.Em.±		1.05	1.00	0.80	0.2	0.12	0.09	0.72	0.23	0.46
CD (5%)		NS	2.1	1.73	NS	0.27	0.19	NS	0.50	1.01

Table 2: Effect of growth retardants on absolute growth rate, relative growth rate and crop growth rate at different stages in cowpea

Treatments		AGR (g day^{-1})			RGR (g $gday^{-1}$)			CGR (g cm^{-2} day^{-1})		
		0-30	30-60	60-90	0-30	30-60	60-90	0-30	30-60	60-90
		DAS								
T_0	Control	0.26	0.12	0.08	0.03	0.77	0.42	6.38	5.69	4.9
T_1	Maleic hydrazide (250ppm)	0.36	0.09	0.50	0.03	0.67	1.01	7.30	8.05	14.3
T_2	Maleic hydrazide (500ppm)	0.38	0.58	0.35	0.03	0.73	0.98	7.32	8.40	15.5
T_3	CCC (500ppm)	0.63	0.32	0.98	0.04	0.66	0.92	7.83	10.2	14.0
T_4	CCC (1000ppm)	0.69	0.20	1.12	0.04	0.67	0.89	7.82	10.6	14.8
T_5	Lichocin (500ppm)	0.46	0.26	0.58	0.03	0.65	0.71	7.12	14.2	12.7
T_6	Lichocin (1000ppm)	0.48	0.32	0.75	0.03	0.68	0.79	6.68	15.2	13.8
Mean		0.46	0.27	0.60	0.03	0.68	0.82	7.21	10.1	14.0
S.Em.±		0.03	0.02	0.05	0.00	0.02	0.04	0.61	0.77	0.46
CD (5%)		0.10	0.08	0.16	NS	0.05	0.09	1.32	2.28	1.00

Table 3: Effect of growth retardants on yield and yield parameters of cowpea

Treatments		Number of pods	Number of seed per pod	Seed index	See yield (g $plant^{-1}$)	Seed yield (g m^{-2})
T_0	Control	13.0	10.1	12.2	16.2	244
T_1	Maleic hydrazide (250ppm)	13.2	10.8	12.2	17.4	292
T_2	Maleic hydrazide (500ppm)	13.0	12.1	12.1	19.4	334
T_3	CCC (500ppm)	13.5	12.5	13.1	22.2	308
T_4	CCC (1000ppm)	13.2	11.6	13.2	20.5	364
T_5	Lichocin (500ppm)	14.5	13.3	12.4	24.2	262
T_6	Lichocin (1000ppm)	14.9	14.4	14.1	30.6	460
Mean		13.6	12.1	12.8	21.5	323
S.Em.±		0.50	0.24	0.13	0.74	11.0
CD (5%)		1.10	0.53	0.27	1.60	24.0

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