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Effect of Pinching and Different Plant Growth Regulators on Growth, Yield and Quality of Vegetable Cowpea

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ABSTRACT: Pinching and application of growth regulators are known to influence the plant characteristics in several ways. Prior to performing pinching operations, it is crucial to determine the optimal growth stage, timing, and extent for better results; while plant growth regulators can be highly beneficial, their correct usage is essential, as misuse can potentially harm plants, and their application should be timed in accordance with developmental stages. Therefore present investigation entitled "Effect of pinching and different plant growth regulators on growth, yield and quality of vegetable cowpea" was conducted in the year 2022-23, at Instructional Farm, Department of Vegetable Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola with the objective to study the effect of pinching and plant growth regulators and to find out the suitable plant growth regulator with concentration and pinching for growth, yield and quality of vegetable cowpea cv. PDKV Rutuja. The experiment was laid out in Factorial Randomized Block Design (FRBD) with fourteen treatment combinations. First factor of pinching with two levels *viz*., with pinching (at 30 DAS) and without pinching and second factor of different plant growth regulators with seven levels *viz*., GA_3 20ppm, GA_3 40ppm, 6BA 20ppm, 6BA 40ppm, CCC 100ppm, CCC 200ppm and control. The treatments were replicated thrice. The results of present investigation revealed that, the growth parameters in terms of plant height, branches per plant, number of leaves was increased with the spraying of GA_3 at 40ppm. Whereas pinching at 30 DAS increased all growth parameters except plant height. The yield and yield contributing characters *viz*., days to flower initiation, number of green pods per plant, pod length, seeds per pod, average weight of green pod, green pod yield were increased with application of GA_3 at 40ppm and also with pinching at 30 DAS. The quality parameters such as protein content per pod, chlorophyll index of leaves was increased due to spraying of GA_3 40 ppm and also with pinching at 30 DAS. As regards to the interaction effect of pinching and different growth regulators, the treatment combination P_1H_2 *viz*., cowpea plants pinched at 30 DAS and sprayed with GA_3 at 40ppm produced maximum number of branches per plant, number of green pods per plant, average weight of green pod, green pod yield and also protein content per pod.

Keywords: Cowpea, Pinching, Plant growth regulators, Growth, Yield, Quality.

INTRODUCTION

Cowpea, (*Vigna unguiculata*), belongs to family *Leguminaceae* and sub-family *Fabaceae*having chromosome number 2n=22, forms an important component of farming systems from the arid to the humid tropics. Cowpea has its origins in Africa and there are three primary subspecies of *V. unguiculata*, namely ssp. *unguiculata*, ssp. *cylindrica* and ssp. *sesquipedalis*. All these varieties are harvested for consumption, either as vegetables (including shoots, leaves, and immature pods) or as dry, mature seeds (Allen, 2013). Cowpea is recognized in its dry grain state as black-eyed pea, southern bean, China pea, and marble pea. In its fresh pod form, it is known as yard-long bean, asparagus bean, body bean, and snake bean (Jayathilake *et al*., 2018; Sikora *et al*., 2018).

Cowpea protein is rich in essential amino acids, lacking only in cysteine and methionine. Referred to as "vegetable meat", it boasts a high biological value when measured on a dry weight basis. Moreover, cowpea grain is a source of micronutrients like zinc and iron, crucial for maintaining a healthy lifestyle (Boukar *et al*., 2010). It consists of approximately 53% carbohydrates and around 2% fat (FAO, 2012). The green leaves of cowpea contain protein levels ranging from 23% to 32%, while the immature pods have protein content ranging from 4% to 5% (Belane and Dakora 2009). Cowpea contributes significantly to soil nutrient cycling and functions as a green manure by facilitating biological nitrogen fixation (BNF) (Gomes *et al*., 2020). Moreover, another key benefit is that it requires a considerably shorter growing season, enabling the crop to evade the impacts of climate changes and better adapt to various abiotic stresses (Herniter *et al*., 2020; Ntatsi *et al*., 2018).

Pinching, a type of pruning, entails the removal of terminal buds from herbaceous plants to stimulate branching. After the removal of the terminal bud, multiple buds along the stem begin to unfold and develop into new shoots. Timely pinching enhances the number of leaves, branches, and ultimately, the yield of the plant. Plant growth regulators are recognized for their ability to control and alter diverse physiological processes within the plant. Plant growth substances have been employed to achieve various positive outcomes, including the stimulation of shoot and root growth, increased number of branches per plant, enhanced pod count per plant, elongation of pods, greater number of grains per pod, improved yield, and enhanced grain quality (Singh, 2010). Combining pinching and the application of plant growth regulators is one of the best considerations to increase the production and quality of cowpea in commercially growing areas.

MATERIAL AND METHODS

The present investigation was conducted at field of instructional farm, Department of Vegetable Science, Dr. PDKV Akola, during the kharif season of the year 2022-23. The seed material used was cowpea cv. PDKV Rutuja, sown at a spacing of 60cm × 45cm.The statistical design adopted for the experiment was factorial randomized block design (FRBD) with fourteen treatment combinations. The first factor involved pinching at two levels, namely, with pinching at 30DAS (P_1) and without pinching (P_2). The second factor encompassed various plant growth regulators at seven levels: GA_3 20ppm (H_1), GA_3 40ppm (H_2), 6BA 20ppm (H_3), 6BA 40ppm (H_4), CCC 100ppm (H_5), CCC 200ppm (H_6), and control (H_7). The treatments were replicated three times.

The apical growth buds of all plants subjected to the pinching treatment were carefully and manually removed at 30 days after sowing, ensuring no harm was inflicted on the plants in the process. Growth regulator solutions for various treatment were prepared two times for spraying at 30 and 60 DAS. Observations are recorded for growth, yield and quality parameters by selecting five plants at random from each treatment plot. The parameters included plant height (cm), number of branches per plant, number of leaves per plant, days to flower initiation, number of green pods per plant, pod length (cm), number of seeds per pod, average weight of green pod (g), green pod yield per plant (g), green pod yield per plot (Kg), protein content per pod (%) and chlorophyll index (SPAD unit).

The data gathered during the investigation for various characteristics were analysed using statistical methods suggested by Panse and Sukhatme (1967). Standard error and critical difference (CD) at a 5 percent level of significance were calculated to compare the means of different treatments.

RESULTS AND DISCUSSION

Plant height (cm). Pinching operation and application of different plant growth regulators significantly influences the plant height of cowpea. The treatment without pinching (P_2) found significantly superior (60.27 cm) plant height over the treatment with pinching at 30 DAS (P_1) (54.76 cm). This may be attributed to the uninterrupted and continuous top growth of cowpea in the treatment without pinching, allowing the crop to attain its maximum plant height. Similar results were also reported by Vasudevan *et al*. (2008) in fenugreek and Veeranna *et al*. (2020) in pigeonpea. By the application of different plant growth regulators, highest plant height (63.43 cm) was observed in the treatment with GA_3 40ppm (H_2). Whereas the lowest plant height (51.35 cm) was noticed in the treatment with control (H_7). The increase in plant height associated with GA_3 application may be a consequence of its impact on the elongation of internodes as reported by Krishnamoorthy (1981). It is confirmed with the results of Emonger (2002) in common bean, Emongor (2007); Nabi *et al*. (2014) in cowpea and Sharma *et al*. (2020) in mung bean. The interaction effect of pinching and different plant growth regulators on plant height of cowpea was found to be statistically non-significant.

Number of branches plant^{-1}. Table 2 clearly shows that both pinching and the application of plant growth regulators have a substantial impact on the number of branches per plant. Regarding pinching levels, the treatment involving pinching (P_1) demonstrated the highest number of branches (5.02) compared to the treatment without pinching (P_2) (4.53). This likely occurs because, in the pinching treatment, the removal of the apical part from main branches releases auxiliary buds from the correlative suppression of apical dominance. This redirection of plant metabolites from vertical to horizontal growth results in increased lateral branches, as photosynthates and hormones are translocated to leaf axils as reported by Sailaja and Panchbhai (2014). The current findings are in line with findings of Aziz (2000) in chickpea and Sharma *et al.* (2003) in pigeonpea. Among the various plant growth regulators applied, the treatment with GA_3 at 40ppm exhibited the maximum number of branches (5.52), while the control treatment (H_7) resulted in the minimum number of branches (3.55). Similar findings are also reported by Krishnaveni *et al*. (2014) in fenugreek and Sumathi *et al*. (2018) in pigeonpea. When the interaction effect of pinching and plant growth regulators is considered the treatment combination with pinching and application of GA_3 at 40ppm (P_1H_2) recorded maximum number of branches (5.87). However, the minimum number of branches (3.47) recorded in the treatment without pinching and control (P_2H_7).

Number of leaves plant^{-1}. Regarding pinching levels, the treatment with pinching (P_1) exhibited the highest number of leaves (33.70) compared to the treatment without pinching(P_2) (31.88). The above results are similar with the research findings of Reddy (2005) in cowpea. When different plant growth regulators were applied, the treatment using GA_3 at 40ppm resulted in the maximum number of leaves (35.27). Conversely, the treatment with control (H_7) showed the minimum number of leaves (28.95). These results are in line with the findings of Kokare *et al*. (2006) in okra, Sharma and Lashkari (2009) in cluster bean and Rajani *et al*. (2016) in French bean. The combined influence of pinching and various plant growth regulators did not show statistically significant interaction effect for number of leaves per plant.

Days to flower initiation. Individual effect of pinching and different plant growth regulators on days to flower initiation (Table 1) in cowpea was found to be statistically significant. Plants that are not pinched (P_2) gave early flower initiation (42.81 days) over the plants that are pinched at 30 DAS (P_1) (44.33 days). The delay of flowering in plants subjected to pinching may arise from the removal of the apical bud, which serves as the primary source of indole acetic acid (IAA). With a significant reduction in IAA concentration, the initiation of lateral branches occurs, necessitating additional time for these branches to mature sufficiently and trigger the flowering process as reported by Ali *et al.* (2021). Similar reports were made by Sharma *et al*. (2003) in pigeonpea and Reddy (2005) in cowpea. In case of plant growth regulators, GA_3 40ppm (H_2) gave minimum days to flower initiation (41.17 days). Whereas the maximum days (48 days) were taken for initiation of flowering in treatment H_7 (control). The early flowering resulting from GA_3 application is likely attributed to its ability to stimulate the redistribution of photosynthates, regulating sink-source relationships. Specifically, GA_3 promotes the transport of photosynthetic products from leaves to buds, as noted by Iqbal *et al*. (2011), thereby inducing early flowering in cowpea plants. Similar results were also reported by Krishnaveni *et al.* (2014) in fenugreek and Sharma *et al.* (2020) in mung bean. There was no significant interaction effect observed between pinching and various plant growth regulators.

Yield parameters. The plants pinched at 30 DAS (P_1) produced maximum number of green pods per plant (27.68), average weight of green pod (6.31 g), green pod yield per plant (190.80 g) and green pod yield per plot (3.13 Kg). While the plants without pinching (P_2) produced minimum number of green pods per plant (25.00), average weight of green pod (5.73 g), green pod yield per plant (175.63 g) and green pod yield per plot (2.61 Kg). The act of pinching generally increases both the number of branches and pods, thereby enhancing overall crop yield. Additionally, it promotes the development of additional pod-bearing branches with robust foliage, leading to more photosynthetic activity. This increased photosynthetic efficiency results in the accumulation of more photosynthates, ultimately contributing to higher-quality produce and increased yield as reported by Thakral *et al.* (1991). These findings are in line with the results of Argall and Stewart (1984) in cowpea, Olfati and Malakouti (2013) in faba bean and Abdel-Aziz and Ismail (2023) in broad bean.

Among different plant growth regulators treatment, GA_3at 40ppm (H_2) produced maximum number of green pods per plant (30.30), average weight of green pod (6.88 g), green pod yield per plant (206.40 g) and green pod yield per plot (3.50 Kg).

Table 1: Effect of pinching and plant growth regulators on Plant height (cm), Number of leaves per plant, Days to flower initiation, Pod length (cm), Number of seeds per pod and Chlorophyll index (SPAD unit).

Treatments	Plant height (cm)	Number of leaves per plant	Days to flower initiation	Pod length (cm)	Number of seeds per pod	Chlorophyll index (SPAD unit)
Pinching (P)						
P_1 (With pinching)	54.76	33.70	44.33	26.10	15.04	55.42
P_2 (Without pinching)	60.27	31.88	42.81	25.34	14.30	53.24
F test	Sig	Sig	Sig	Sig	Sig	Sig
SE(m)±	0.63	0.37	0.51	0.23	0.21	0.61
CD at 5%	1.83	1.08	1.48	0.67	0.62	1.77
Plant growth regulators (H)						
H_1 (GA_3 20ppm)	62.15	34.40	41.67	26.95	15.48	54.25
H_2 (GA_3 40ppm)	63.43	35.27	41.17	27.42	16.07	55.29
H_3 (6BA 20ppm)	59.22	31.10	42.83	26.15	14.87	57.75
H_4 (6BA 40ppm)	60.49	31.93	42.50	26.60	15.25	58.80
H_5 (CCC 100ppm)	51.35	33.63	44.17	24.65	13.98	52.57
H_6 (CCC 200ppm)	51.97	34.23	44.67	25.22	14.58	53.20
H_7 (Control)	54.00	28.95	48.00	23.08	12.47	48.46
F test	Sig	Sig	Sig	Sig	Sig	Sig
SE(m)±	1.18	0.69	0.95	0.43	0.40	1.14
CD at 5%	3.43	2.01	2.76	1.25	1.16	3.32
Interaction (P×H)						
F test	NS	NS	NS	NS	NS	NS
SE(m)±	1.67	0.98	1.34	0.61	0.56	1.61
CD at 5%	-	-	-	-	-	-

Table 2: Effect of pinching and plant growth regulators on number of branches per plant, Number of green pods per plant, Average weight of green pod (g), Green pod yield per plant (g), Green pod yield per plot (Kg), Protein content per pod (%).

Treatments	Number of branches per plant	Number of green pods per plant	Average weight of green pod (g)	Green pod yield per plant (g)	Green pod yield per plot (Kg)	Protein content per pod (%)
Pinching (P)						
P_1 (With pinching)	5.02	27.68	31.74	190.80	3.13	4.48
P_2 (Without pinching)	4.53	25.00	32.00	175.63	2.61	4.13
F test	Sig	Sig	28.90	Sig	Sig	Sig
SE(m)±	0.06	0.30	30.20	1.86	0.05	0.02
CD at 5%	0.19	0.86	24.53	5.41	0.15	0.05
Plant growth regulators (H)						
H_1 (GA_3 20ppm)	5.35	30.08	6.52	200.30	3.43	4.73
H_2 (GA_3 40ppm)	5.52	30.30	6.88	206.40	3.50	4.83
H_3 (6BA 20ppm)	4.33	27.12	6.17	190.57	3.09	4.52
H_4 (6BA 40ppm)	4.47	28.60	6.43	196.43	3.31	4.64
H_5 (CCC 100ppm)	5.03	24.37	5.65	168.30	2.41	3.92
H_6 (CCC 200ppm)	5.17	24.57	5.87	171.90	2.57	4.07
H_7 (Control)	3.55	19.35	4.65	148.62	1.80	3.44
F test	Sig	Sig	Sig	Sig	Sig	Sig
SE(m)±	0.12	0.55	0.16	3.48	0.10	0.03
CD at 5%	0.35	1.61	0.46	10.12	0.30	0.10
Interaction (P×H)						
P_1H_1	5.73	31.74	6.97	211.70	3.86	4.90
P_1H_2	5.87	32.00	7.60	220.27	3.92	5.05
P_1H_3	4.50	28.90	6.40	203.40	3.30	4.71
P_1H_4	4.53	30.20	6.83	206.33	3.71	4.84
P_1H_5	5.33	24.53	5.77	171.00	2.57	4.10
P_1H_6	5.53	24.60	5.83	174.00	2.76	4.25
P_1H_7	3.63	21.77	4.80	149.00	1.82	3.50
P_2H_1	4.97	28.42	6.07	189.53	3.00	4.55
P_2H_2	5.17	28.60	6.17	192.53	3.07	4.60
P_2H_3	4.17	25.33	5.93	177.73	2.88	4.32
P_2H_4	4.40	27.00	6.03	186.53	2.92	4.44
P_2H_5	4.73	24.21	5.53	165.60	2.24	3.75
P_2H_6	4.80	24.53	5.90	169.27	2.38	3.88
P_2H_7	3.47	16.93	4.50	148.23	1.78	3.39
F test	Sig	Sig	Sig	Sig	Sig	Sig
SE(m)±	0.17	0.78	0.22	4.92	0.15	0.05
CD at 5%	0.49	2.27	0.65	14.31	0.43	0.14

Furthermore, the plants with control treatment (H_7) produced minimum number of green pods per plant (19.35), average weight of green pod (4.65 g), green pod yield per plant (148.62 g) and green pod yield per plot (1.80 Kg). The external application of GA_3 may have triggered enzymatic activities, amplifying the impact on naturally occurring hormones that expedited and altered the growth and development of plants as reported by Patel *et al.* (2011). These results are supported by the findings of Mukhtar and Singh (2006) in cowpea Patel *et al.* (2018) in cluster bean, Rathod *et al.* (2015) in french bean, Hoque and Haque (2002) in mung bean and Nabi *et al.* (2014) in cowpea.

The interaction between pinching and plant growth regulators found significant for yield parameters. The maximum number of green pods per plant (32.00), average weight of green pod (7.60 g), green pod yield per plant (22.27 g) and green pod yield per plot (3.92 Kg) were recorded in the treatment combination P_1H_2(with pinching and application of GA_3 at 40ppm). On the other hand, the minimum number of green pods per plant (16.93), average weight of green pod (4.50 g), green pod yield per plant (148.23 g) and green pod yield per plot (1.78 Kg) were observed in the treatment combination P_2H_7(without pinching and control).

Pod length (cm). The maximum length of pod (26.10 cm) was noted in the treatment with pinching (P_1) over the treatment without pinching (P_2) (25.34 cm). The positive impacts of pinching on pod length may be linked to the production and movement of nutrients from the source to the sink. Patel *et al*. (2015) in cluster bean and Sowmya *et al.* (2017) in fenugreek also reported similar results. When various concentrations of plant growth regulators are taken into account, application of GA_3 40ppm (H_2) produced maximum pod length (27.42 cm). The minimum pod length recorded in the treatment H_7 (control). The increase in pod length through the use of GA_3 can be attributed to the capacity of GA_3 to stimulate both cell division and cell elongation as reported by Shahid *et al*. (2013). The present findings were similar to Emonger (2007); Nabi *et al.* (2014) in cowpea. The Interaction effect of pinching and plant growth regulators on pod length was found to be non-significant.

Number of seeds per pod. Maximum number of seeds per pod (15.04) was recorded with pinching at 30 DAS (P_1) while the treatment without pinching (P_2) recorded minimum number of seeds per pod (14.30). The increased number of seeds per pod in pinched plants could be attributed to the modulation of vegetative growth phases, directing the diversification of photosynthetic resources towards the source; pods and seeds, during optimal growth stages. These findings are in accordance with those of Patel *et al.* (2015) in cluster bean, Veeranna *et al.* (2020) in pigeonpea and Majoka *et al.* (2021) in cowpea. With regard to different plant growth regulators, GA_3 40ppm (H_2) produced maximum number of seeds per pod (16.07) and treatment with control (H_7) produced minimum number of seeds per pod (12.47). Similar results are also reported by Mohandoss and Rajesh (2003) in cowpea and Rahman *et al*. (2004) in soyabean. Here interaction effect was non-significant.

Protein content per pod (%). The effect of pinching and different plant growth regulators on protein content per pod significantly influences both factors and interaction at different levels also. The treatment with pinching at 30 DAS (P_1) found significantly superior (4.48 %) over the treatment without pinching (4.13 %) (P_2) for protein content per pod. Similar findings are reported by Dhaka *et al*. (2020) in pigeonpea. Among different levels of plant growth regulators, application of GA_3 at 40ppm (H_2) recorded higher protein content per pod (4.83 %). Contrary to this, control (H_7) treatment receded lowest protein content per pod (3.44 %). In case of interaction effect, highest (5.05 %) protein content per pod obtained in the treatment combination P_1H_2(with pinching and application of GA_3 at 40ppm) and lowest in P_2H_7(without pinching and control) (3.39 %).

Chlorophyll index (SPAD unit). Pinching significantly influences the chlorophyll index. Treatment with pinching at 30 DAS (P_1) showed significantly the highest (55.42 SPAD unit) chlorophyll index compared to the plants without pinching (P_2) (53.24 SPAD unit). These results are in agreement with the findings of Alsawaf *et al.* (2023) in broad bean.6BA at 40ppm (H_4) recorded highest chlorophyll index (58.80SPAD unit) while, the lowest chlorophyll index (48.46SPAD unit) noted in control (H_7) treatment. The increase in chlorophyll index observed in plants treated with 6BA might result from the application of exogenous cytokinin, which could enhance chlorophyll levels in aging leaf tissues by retarding the breakdown of this pigment and delaying the senescence process. Similar results are also observed by Costa *et al*. (2005) in broccoli. There was no significant interaction observed between pinching and various plant growth regulators on chlorophyll index.

CONCLUSIONS

Based on the findings of the present investigation, it can be concluded that pinching and application of different plant growth regulators significantly influences the growth, yield and quality of cowpea. Among the various treatments, the combination of pinching at 30 days after sowing and foliar spray with GA_3 at 40 ppm at 30 and 60 DAS demonstrated notable advantages, resulting in enhanced growth, increased green pod yield, and improved quality.

FUTURE SCOPE

The combination of pinching and the application of plant growth regulators stands out as a highly favourable approach for boosting both the production and quality of cowpea in commercially cultivated regions. The insights gained from this study hold valuable benefits for farmers and researchers in finding the suitable growth regulators and pinching for better production.

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Conflict of Interest. None.

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