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Response of plant growth regulators on growth and green pod yield of summer cowpea (*Vigna unguiculata* L.)

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Abstract
The present study entitled "Response of plant growth regulators on growth and green pod yield of summer Cowpea (*Vigna unguiculata* L.)" was carried out during summer season 2024-25 in the research and instructional farm at Bharregaon under Pt. Kishori Lal Shukla College of Horticulture and Research Station, Rajnandgaon (C.G.). The field experiment was conducted in randomized block design with three replications and ten treatments consisting a control with three plant growth regulators *viz*., Control (T_0), NAA @ 20 ppm (T_1), NAA @ 30 ppm (T_2), NAA @ 40 ppm (T_3), Kinetin @ 20 ppm (T_4), Kinetin @ 30 ppm (T_5), Kinetin @ 40 ppm (T_6), Cycocel @ 250 ppm (T_7), Cycocel @ 300 ppm (T_8), Cycocel @ 350 ppm (T_9). The finding of the present investigation clearly indicated that the foliar application of Kinetin 30 ppm gave significantly better performance at vegetative character like maximum plant height (69.32 cm) and NAA @ 20 pmm increased number of branches per plant (6.03). In case of yield parameter like minimum days to first flowering (39.27 cm), minimum days to 50 percent flowering (46.23), no. of green pod per plant (24.21), length of green pod per plant (22.50 cm), no. of cluster per plant (12.21), total weight of green pod per plant (198.24), total weight of green pod per plot (5.55 kg) and total weight of green pod per ha. (146.82 q) found better NAA 30 ppm treated plant. Also increased benefit cost ratio (2.87) found under this treatment. Hence, the treatment T_2 (NAA 30 ppm) was found to be most suitable for higher production of cowpea.

Keywords: Cowpea, plant growth regulators, vegetative character and yield parameter

Introduction
Vegetables are recognized as a rich source of essential nutrients, including vitamins, proteins, minerals, carbohydrates and dietary fiber. Many vegetables are rich in proteins, known as body-building foods, peas, beans and their dry seeds are good sources of proteins and minerals Cowpea (*Vigna unguiculata* L.) is an important warm season legume belongs to family Leguminaceae and sub-family Fabaceae grown by many farmers in the semi-arid tropics for human consumption and for feeding animals. It is a self-pollinated crop having chromosome no. 2n= 22, which originated from Africa (Thorat *et al*. 2017) [26]. It is the most important green podded vegetable crop in the world and commonly known as lobia, chauli, and barbatti it is also considered as a miracle crop in the world. It is a warm-season annual herbaceous legume with erect, prostrate or climbing stems. Within the species, there is a lot of variation. Indeterminate to fairly determinate growth habits are found. It has a well developed tap root system with numerous lateral roots. Stems are cylindrical and slightly ribbed, twisting and glabrous at times. Green or pigmented stems are common. Leaves are trifoliate and alternate. Petioles range in length from 3 to 12 cm and have a swollen pulvinus at the base. The inflorescence is a single-flowered axillary raceme with several flowers at the end of the peduncles.

The nutrient composition of cowpea seed has fat (1.90%), protein (24.8%), carbohydrates (63.6%), fibre (6.3%) and minerals (sodium, calcium, magnesium, iron and phosphorus) and vitamins, viz., riboflavin (0.00042%), thiamine (0.00074%) and niacin (0.00281%) (El-Adawy 2002). It is rich in vitamin A, B_1, B_2, B_3, B_5, B_6, C, folic acid that support healthy cells tissue functioning. Nutritionally, cowpea is very rich vegetable which supplies protein (3.50 g), calcium (72.00 mg), phosphorus (59.00 mg), iron (2.5 mg), carotene (564.00 mg),

thiamine (0.07 mg), riboflavin (0.09 mg) and vitamin 'C' (24.00 mg) per 100 g of edible pods (Laleeta *et al*., 2017) [12].

Cowpea is an important nutritional food in the human diet because of its high protein and carbohydrate content, low fat content and complementary amino acid pattern. The presence of compounds such as soluble and insoluble dietary fibres, phyto chemicals, proteins and peptidesin cowpea. It has anti-diabetic, anti-hypertensive and anti-inflammatory properties (Chathuni *et*. *al*., 2018) [5]

Cowpea covers 14 million ha area with over 8 million metric tonnes annual production in all over world. It is grown all over India but in larger areas in central and peninsular regions as Kharif crop in some regions of Maharashtra, Karnataka, Tamil Nadu, Gujrat, Andhra Pradesh, Rajasthan, Uttar Pradesh and Panjab. In India, peas has occupied an area of 609 thousand ha with a total production of 6631 MT. In Chhattisgarh, Surguja, Rajnandgaon, Khairagarh, Surajpur, Bemetra Raipur, Durg, Raigarh and Korba are particularly important cowpea producing districts. In Chhattisgarh, total area under peas cultivation is 9.131 thousand ha with 12.6874 thousand MT production.

Plant growth regulators are known to regulate and modify various physiological processes within the plant. Thereby they influence their effect on Introduction morphological characters and yield. The production and distribution of photosynthates is related to various physiological and biological processes, which are influenced by the plant growth regulators. Number of techniques for application of plant growth substances has been tried on various vegetable crops. The methods adopted successfully are seed treatment of PGR's, foliar spray and their combined applications for higher production

The growth promoters like NAA and CCC enhance the source-sink relationship and significantly influence the growth and yield of cowpea. An appropriate concentration of NAA and CCC can enhance various growth parameter of cowpea. NAA is one of the most widely used synthetic auxin. It is a plant growth regulator used for the purpose of inducing flowering and preventing shedding of flower buds. It stimulates the cell division, cell enlargement and cell elongation in apical region of the plant. As auxins are concerned, the increase in linear growth of stem is caused by cell elongation. The growth is brought about by auxin due to the uptake of a large quantity of water which leads to enlargement of vacuole. This results in the enlargement of the cell along the longitudinal axis (Thimann and Went, 1934) [25]. Kinetin is substance from the group of cytokinin, which promotes cell division and exerts other growth regulatory functions in the same manner as kinetin. The influence of CCC on the leaf colour can be seen shortly after application, it helps for promoting dwarfness and earliness for pod formation and bushy vegetative growth. Different growth regulators like auxins, ethereal, Cycocel and cytokinin helps to increase yield of cowpea by manipulating its vegetative and reproductive phase. (Sarviya *et al*., 2021) [21].

Materials and Methods

The experiment was carried out in the research and instructional farm, Bharregaon at Pt. Kishori Lal Shukla College of Horticulture and Research Station, Rajnandgaon (C.G.) During summer season 2024-25. The field experiment was conducted in Randomized Block Design with three replications having ten different treatments with three plant growth regulators concentration *i.e*., Control (T_0)**,** NAA @ 20 ppm (T_1), NAA @ 30 ppm (T_2), NAA @ 40 ppm (T_3), Kinetin @ 20 ppm (T_4), Kinetin @ 30 ppm (T_5), Kinetin @ 40 ppm (T_6), Cycocel @ 250 ppm (T_7), Cycocel @ 300 ppm (T_8), Cycocel @ 350 ppm (T_9). The soil was made to fine tilth by continuous harrowing after the area had been carefully ploughed, weeds, stubbles, stones etc., were completely removed. Apply complete doses of chemical fertilizers (NPK) were administered at a rate of 20:50:20 kg/ha in the soil before sowing with urea providing of the nitrogen, single super phosphate providing the whole phosphorus and Murata of potash providing of the potassium as the basal dose. Protective irrigations were done every five to seven days during the cropping period. The desired concentrations of plant growth regulators were prepared and 1st spraying was done at 20 days and 2nd at 40 days after the sowing of cowpea crop. Five plants at random were selected from each plot and tagged in order to record the observations on the plant height, no. of branches per plant, days to first flowering, days to 50% flowering, no. of green pods per plant, length of green pod, no. of cluster per plant, total weight of green pod, total green pod yield per plot and total green pod yield per ha.

Results and Discussion

Vegetative Character

Plant growth regulators Kinetin 20 ppm and NAA 20 ppm gave significantly better performance at plant height and no. of branch per plant. The interpretations were recorded on various vegetative character are presented in Table 1.

Plant height (cm)

The maximum plant height (23.33 cm) was observed in treatment containing Kinetin @ 20 ppm) (T_4) at 30 days after sowing which was statistically at par with treatments Kinetin @ 30 ppm (T_5) (22.46 cm). However, Cycocel @ 350 ppm (T_9) recorded the minimum plant height (15.43 cm) among the others.

The maximum plant height (32.33 cm) was observed in treatment containing Kinetin @ 20 ppm) (T_4) at 60 days after sowing which was statistically at par with treatments Kinetin @ 30 ppm (T_5) (30.78 cm). However, Cycocel @ 350 ppm (T_9) recorded the minimum plant height (23.46 cm) among the others.

The maximum plant height (69.32 cm) was observed in treatment containing Kinetin @ 20 ppm) (T_4) at 90 days after sowing which was statistically at par with treatments Kinetin @ 30 ppm (T_5) (67.83 cm). However, Cycocel @ 350 ppm (T_9) recorded the minimum plant height (52.23 cm) among the others.

Remarkable increase in the plant height at 30, 60 and 90 DAS was observed Kinetin 20 ppm. This might be due to Kinetin induces cell division and increased plant height by promoting cell extension. These results are in conformity with the findings of application of in cowpea by Hala and Bassiouny (2001) [10], Ullah *et al*. (2007) [27], Thaware *et al*. (2008) [24].

No. of branches per plant

The maximum no. of branches (3.78) was observed in treatment containing, NAA @ 20 ppm (T_1) at 30 days which was statistically at par with treatments NAA @ 30 ppm (T_2)

(3.33). However, Control recorded the minimum no. of branches (1.22) among the others.

The maximum no. of branches (5.06) was observed in treatment containing, NAA @ 20 ppm (T_1) at 60 days which was statistically at par with treatments NAA @ 30 ppm (T_2) (4.67). However, Control recorded the minimum no. of branches (2.23) among the others.

The maximum no. of branches (6.03) was observed in treatment containing, NAA @ 20 ppm (T_1) at 90 days which was statistically at par with treatments NAA @ 30 ppm (T_2) (5.43) and Kinetin @ 20 ppm (T_4) (5.34) respectively. However, Control recorded the minimum no. of branches (3.99) among the others.

The increase in number of branches with NAA treatment might be due to auxin would have stimulate metabolic activity influenced axillary bud growth resulting in increased number of branches Similar results also found by Anitha *et al*. (2006) [1] in horse gram, Patel *et al*. (2011) [17] and Sahu and Verma (2020) [20] in yard long bean.

Table 2: Effect of plant growth regulators on vegetative character of cowpea.

Treatment	Concentration of PGR	Plant height (cm)			No. of branches per plant		
		30 days	60 days	90 days	30 days	60 days	90 days
T_0	Control	17.90	25.50	57.53	1.22	2.23	3.99
T_1	NAA @ 20 ppm	18.24	27.40	63.23	3.78	5.06	6.03
T_2	NAA @ 30 ppm	19.30	28.35	63.60	3.33	4.67	5.43
T_3	NAA @ 40 ppm	21.05	29.6	62.68	2.99	3.68	4.97
T_4	Kinetin @ 20 ppm	23.33	32.33	69.32	2.89	4.56	5.34
T_5	Kinetin @ 30 ppm	22.46	30.78	67.83	2.67	4.22	5.21
T_6	Kinetin @ 40 ppm	19.78	28.89	65.43	2.44	3.32	4.94
T_7	Cycocel @ 250 ppm	16.95	25.32	54.21	1.95	2.74	4.34
T_8	Cycocel @ 300 ppm	16.45	24.95	55.82	2.10	2.98	4.76
T_9	Cycocel @ 350 ppm	15.43	23.46	52.23	2.34	3.1	4.93
SE(m±)		0.91	0.99	2.44	0.10	0.10	0.17
C.D. at 5%		2.72	2.91	7.14	0.31	0.31	0.51
CV		8.34	6.23	6.85	7.15	7.15	8.13

Yield parameter

Plant growth regulators NAA 30 ppm gave significantly better performance at days to first flowering, days to 50% flowering, no. of green pods per plant, length of green pod, no. of cluster per plant, total weight of green pod, total green pod yield per plot, total green pod yield per ha. The interpretations were recorded on various vegetative character are presented in Table 2.

Days to first flowering

Application of NAA @ 30 ppm (T_2) resulted in earliness in flowering (39.49 days) which was statically at par NAA @ 20 ppm (T_1) (40.20 days). However, the maximum number of days to first flowering (49.20 days) was recorded in Control.

The earliness in the flowering might be due to the fact that NAA application enhanced the translocation of food for development of floral primordial, which leads to the early flowering. The above result were in conformity with the application of NAA by Mukhtar and Singh (2006) [15] in cowpea, Pandey *et al*. (2004) [16] in pea.

Days to 50 percent flowering

The Minimum days taken for 50% flowering (46.23 days) was observed in the treatment NAA @ 30 ppm (T_2) which was at par with NAA @ 20 ppm (T_1) (48.13) days while the maximum days taken for 50% flowering (55.47 days) was found with the treatment Control.

Days to 50% flowering might be due to the fact that NAA application enhanced the earliness flower of plant which leads to the early flowering. NAA control the plant growth and development processing including flower and fruit development. The above result were in conformity with the application of NAA by Mukhtar and Singh (2006) [15] in cowpea, Pandey *et al*. (2004) [16] in pea.

No. of green pod per plant

The results revealed that the maximum no. of green pod per plant (24.21) was recorded in the treatment NAA @ 30 ppm (T_2) which was statistically at par with treatments NAA @ 40 ppm (T_3) (22.89) and Kinetin @ 40 ppm (T_6) (22.78) respectively. However, Control recorded the minimum no. of green pod per plant (18.55) among the others

The foliar application of NAA increases maximum number of pods per plant. This might be due to exogenous application of PGR stimulating the enzymatic activities for naturally occurring hormones that increase the size of photosynthetic apparatus leaf growth and in terms of foliage weight as well as increases assimilation rate contributed for increased number of pods per plant and clusters per plant. The results are in accordance with the findings of Thaware *et al*. (2006) [23], Patel *et al*., (2011) [17] and Sati *et al*. (2014) [22] in cowpea.

Length of green pod (cm)

The results revealed that the maximum length of green pod (22.50 cm) was recorded in the treatment NAA @ 30 ppm (T_2) (22.50 cm) which was statistically at par with treatments NAA @ 40 ppm (T_3) (21.67 cm). Control recorded the minimum length of green pod (17.58) among the others.

The increase in length of green pod may be due to cell elongation caused by NAA. The result was supported by Mandal and Sanyal (2004) [13] in French bean.

No. of cluster per plant

The results revealed that the maximum number of cluster per plant (12.21) was recorded in the treatment NAA @ 30 ppm (T_2) which was statistically at par with treatments NAA @ 40 ppm (T_3) (11.89), while, it was the minimum (8.82) in Control.

NAA which stimulated the enzymatic activities for naturally occurring hormones that increased size of photosynthetic apparatus in terms of foliage weight as well as increased net assimilation rate contributed for better formation of biological yield and increases retention of flowers and thereby pods per clusters which indirectly the increased number of pods as well as clusters per plant. Mohandoss and Rajesh (2003) [14], Thaware *et al*. (2006) [23] and Emongor (2007) [9] in cowpea.

Total green pod yield per plant (g)

The results revealed that the maximum total green pod yield per plant (198.24 g) was recorded in the treatment NAA @ 30 ppm (T_2) which was closely followed by the treatment NAA @ 40 ppm (T_3) (187.68 g), while, it was the lowest (152.96 g) in Control.

Increase in yield per plant with foliar application of NAA may be because of a reduction in flower drop, fruit abortion, maximum number of pods per cluster as well as clusters per plant in per unit land area. Similar results were found by Desai and Deore (1985) [7] in cowpea, Das and Prasad (2003) [6] in mungbean, Kumar *et al*. (2003) [11] in chick pea, Resmi and Gopalkrishnan (2004) [19] in yard long bean and Patil *et al*. (2005) [18] in green gram Sarvaiya *et al*., (2021) [21] in pea.

Total green pod yield per plot (kg)

The results revealed that the maximum total green pod yield per plot (5.55 kg) was recorded in the treatment NAA @ 30 ppm (T_2) which, was statistically at par with treatments NAA @ 40 ppm (T_3) (5.26 kg) and Kinetin @ 40 ppm (T_6) (5.23 kg) respectively, while, it was the lowest (4.28 kg) in Control.

The increase in yield was mainly due to increased number of branches per plant, no. of cluster per plant and number of pod per plant. These results are in accordance with the findings of application of NAA in cowpea by Resmi and Gopalakrishnan (2004) [19], Thaware *et al*. (2008) [24] and Sarvaiya *et al*., (2021) [21] in cowpea.

Total green pod yield per ha (q)

The maximum green pod yield per ha (146.82 q) was recorded in the treatment NAA @ 30 ppm (T_2) which was statistically at par with treatment NAA @ 40 ppm (T_3) (139.15 q) and (Kinetin @ 40 ppm) (T_6) (138.35 q), while it was the lowest (113.22 q) in Control.

Increase in yield per hectare with foliar application of NAA was because of a maximum number of pods per cluster, clusters per plant, reduction in flower drop and fruit abortion and increased yield (kg/plot). Similar results were also found by Desai and Deore (1985) [7] in cowpea, Das and Prasad (2003) [6] in mungbean, Kumar *et al*. (2003) [11] in chickpea, Resmi and Gopalkrishnan (2004) [19] in yard long bean, Patil *et al*. (2005) [18] in greengram, Sati *et al*. (2014) [22] and Sahu and Verma (2020) [20], Sarvaiya *et al*., (2021) [21] in cowpea.

Table 1: Effect of plant growth regulators on yield parameter of cowpea.

Treatment	Concentration of PGR	Days to first flowering	Days to 50 percent flowering	No. of green pod per plant	Length of green pod (cm)	No. of cluster per plant	Total green pod yield per plant (g)	Total green pod yield per plot (kg)	Total green pod yield per ha (q)
T_0	Control	49.20	55.47	18.55	17.58	8.82	152.96	4.28	113.22
T_1	NAA @ 20 ppm	40.20	48.13	21.23	20.62	10.90	174.40	4.88	129.10
T_2	NAA @ 30 ppm	39.49	46.23	24.21	22.50	12.21	198.24	5.55	146.82
T_3	NAA @ 40 ppm	42.23	49.22	22.89	21.67	11.89	187.68	5.26	139.15
T_4	Kinetin @ 20 ppm	47.23	52.22	20.10	18.90	9.86	165.36	4.63	122.48
T_5	Kinetin @ 30 ppm	46.55	49.65	20.56	19.21	10.81	169.04	4.73	125.13
T_6	Kinetin @ 40 ppm	44.43	48.43	22.78	21.23	11.58	186.80	5.23	138.35
T_7	Cycocel @ 250 ppm	43.20	47.45	19.23	18.23	9.21	158.40	4.44	117.46
T_8	Cycocel @ 300 ppm	46.87	49.23	20.53	19.10	10.29	168.80	4.73	125.13
T_9	Cycocel @ 350 ppm	45.22	51.45	19.44	18.81	9.35	160.08	4.48	118.51
	SE(m±)	1.97	2.35	0.96	0.86	0.52	6.17	0.20	5.56
	C.D. at	5.87	6.98	2.87	2.56	1.54	18.03	0.60	16.23
	CV	7.69	8.18	8.01	7.55	8.60	6.21	7.39	7.39

Conclusion

In light of the present experimental findings summarized above, it may be concluded that the application of plant growth regulators enhanced the plant growth, pods yield and the benefit cost ratio influenced significantly in various plant growth regulator treatments. The study of comparison of various treatments revealed that the application of Kinetin showed the better response with respect to the plant height. NAA Showed the maximum no. of branches per plant, days to first flowering, days to 50% flowering, no. of green pods per plant, length of green pod, no. of cluster per plant, total weight of green pod, total green pod yield per plot, total green pod yield per ha. The B:C ratio was found better with T_2 (NAA 30 ppm) than all the treatments.

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