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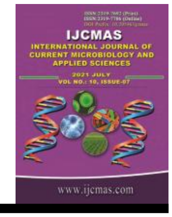

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Response of Vegetable Cowpea [*Vigna unguiculata* (L.) Walp.] to Foliar Application of PGRs

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A B S T R A C T

A field experiment was carried out, at the Vegetable Research Farm, RHRS of the NAU, Navsari during Summer 2020 on cv. AVCP 1. The experiment was conducted in randomized block design (RBD) with three replications, which included 13 treatments. The results revealed that application of CCC 300 µl l^{-1} recorded higher values for growth parameters namely, days to 50 % flowering (57.33 days), leaf area (7058.87 cm^2), leaf area index (5.23), days to first picking(67.67 days), number of primary branches plant^{-1} at final picking(8.53), fresh weight of plant at final picking (0.643 kg), number of cluster plant^{-1}(35.27). Whereas higher values for number of leaves plant^{-1} (57.07) was recorded with the application of NAA 20 mg l^{-1}. Application of CCC 400 µl l^{-1}recorded higher values for plant height at final picking (57.93 cm) and number of pods cluster^{-1}(3.31). Foliar application of CCC 300 µl l^{-1} recorded significantly higher values for pod characters namely, pod length (14.10 cm), number of marketable pods plant^{-1} (112.93) and marketable pod yield (10.44 t ha^{-1}). From the economic point of view and based on green pod yield, for securing maximum return, foliar application of CCC 300 µl $l^{-1}$was found superior with highest B:CR value of 2.2 followed by T_{11} (B:CR value of 2.1).

Introduction

Vegetables are integral part of a balanced diet. Amongst horticultural crops, vegetables have gained importance not only in providing better per unit returns but also in providing nutritional security. The role of vegetables as a major source of phytonutraceuticals like vitamins, minerals, antioxidants and fibers are being well recognized in a balanced diet. Vegetables are important part of healthy dietary and provide source of income to farmers, seed producers, processors and traders (Sable *et al.*, 2020). India is the second largest producer of vegetable in the world after China producing around 188 million tonne from just 10.5 million hectare area. Though pulses are grown in both *Kharif* and *Rabi* seasons, *Rabi* pulses contribute more than 60 per cent of the total production. In India total area under cowpea cultivation is 1.5 million hectare whereas, in Gujarat it is cultivated commercially in an area of 0.5 lakh hectare (Anonymous, 2020).

Cowpea (*Vigna unguiculata* (L.) Walp.), 2n=2x=22 belongs to family Fabaceae, popularly known as *chauli* is an important legume vegetable crop. It is grown in tropics for its tender green pods and shelled immature seeds used as vegetable and dry seeds used as pulse. It is grown for immature pods and mature grains. The haulms are also fed to livestock. Cowpea is known as drought hardy nature, its wide and droopy leaves keeps soils and soil moisture conserved due to shading effect. It is also known as black-eyed pea or southern pea *etc*. and has multiple uses like food, feed, forage, fodder, green manuring and vegetable (Saravaiya *et al.,* 2014).

Though, the PGRs have great potential, its application and accurate assessments *etc.* have to be judiciously planned in terms of optimal concentration, stage of application, species specificity and seasons. In their wide spectrum of effectiveness on every aspect of plant growth, even a modest increase of 10-15 per cent could bring about an increment in the gross annual productivity by 10-15 t ha^{-1} (Sharma and Lashkari, 2009).

These synthetic PGRs are put into several uses in horticulture, one of them is to increase crop yield and improve quality. The growth behavior of many plants could be modified or controlled by applying small amount of plant growth regulators, either by seed soaking, root dipping or whole plant spray.

Among several growth substances, gibberellins and auxins are very promising and these are being used on large scale in number of vegetable crops. The growth promoters like NAA and 2,4-D enhance the source-sink relationship and modified translocation of photosynthates, which will help in better retention of flowers and fruits and seed filling at the later stages of crop growth. The influence of CCC on the leaf colour can be seen shortly after application. The change in colour is due to a higher chlorophyll-synthesis. To achieve optimum vegetative growth and better translocation of phytosynthates in developing pods, the use of growth regulators appears to be an excellent tool which regulate plant growth and finally alter the plant architecture and yield improvement. However, very rare information is available on this aspect; therefore, the aim of the present study was to investigate the response of foliar application of PGRs on growth, yield and quality of vegetable cowpea.

Hence, the research study entitled "Response of vegetable cowpea [*Vigna unguiculata* (L.) Walp.] to foliar application of PGRS*"*using cultivar 'AVCP 1' was carried out at Vegetable Research Farm, Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari with the following objectives:

To evaluate the effect of foliar application of PGRs*viz*., NAA, PCPA, 2,4-D and CCC on growth parameters of vegetable cowpea

To evaluate the effect of foliar application of PGRs *viz*., NAA, PCPA, 2,4-D and CCC on yield parameters of vegetable cowpea

Materials and Methods

A field experiment entitled "Response of vegetable cowpea [*Vigna unguiculata* (L.) Walp.] to foliar application of PGRS" was laid out on cowpea during 2020 at Vegetable

Research Farm, Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari.

According to agro-climatic conditions of Gujarat state, Navsari falls under 'South Gujarat Heavy Rainfall Zone, AES-III'. The climate of this zone is typically tropical and monsoonic. An average rainfall of the tract is about 1500 mm and is normally receive by second fortnight of June and cease by September end.

There were thirteen treatment *viz*. T_1 : Control (No spray), T_2 : NAA 10 mg l^{-1}, T_3 : NAA 15 mg l^{-1}, T_4 : NAA 20 mg l^{-1}, T_5 : PCPA 10 mg l^{-1}, T_6 : PCPA 15 mg l^{-1}, T_7 : PCPA 20 mg l^{-1}, T_8 : 2,4-D 0.5 mg l^{-1}, T_9 : 2,4-D 1.0 mg l^{-1}, T_{10} : 2,4-D 1.5 mg l^{-1}, T_{11} : CCC 200 µl l^{-1}, T_{12} : CCC 300 µl l^{-1} and T_{13} : CCC 400 µl l^{-1}.

Observations were recorded for different parameters. The number of days from the date of sowing to date on which 50 per cent of the plants flowers in net plot was recorded as days to 50 per cent flowering for each treatment.

Plant height was measured in centimeter (cm) from ground level to tip of the main stem with the help of measuring tape at final picking. First picking of immature pod for vegetable purpose was started as the pods get marketable size.

The days to first picking were counted from the date of sowing to date of first harvest of individual experimental plot. The days to last picking were counted from date of sowing to date of last picking of each respective plot and it was recorded.

The number of primary branches per plant was counted at the time of final picking and average was worked out. From the five randomly selected pods, the length of pod was measured in centimeter from the stalk to the apex by thread and mean values were worked out. Leaf area was measured with the help of leaf area meter at final picking and average value was worked out. Number of cluster per plant were counted from five tagged plants at the time of each picking and average was worked out.

Results and Discussion

Influence on growth parameters

Growth parameters *viz*., days to 50 % flowering, number of leaves plant^{-1}, leaf area, LAI, plant height, days to first picking, days to last, picking number of primary branches plant^{-1}, fresh weight of plant, number of cluster plant^{-1} and number of pods cluster^{-1} were significantly influenced by the foliar application of PGRs.

CCC 300 µl l^{-1} found best and recorded the minimum days to 50 % flowering (57.33 days). NAA 20 mg l^{-1} found best and recorded the maximum number of leaves plant^{-1} (57.07). CCC 300 µl l^{-1}found best and recorded the maximum leaf area (7058.87 cm^2). CCC 300 µl l^{-1} found best and recorded the maximum leaf area index (5.23).

CCC 400 µl l^{-1}found best and recorded the minimum plant height at final picking (57.93 cm). CCC 300 µl l^{-1} found best and recorded the minimum days to first picking(67.67). PCPA 20 mg l^{-1}found best and recorded the maximum days to last picking(136). CCC 300 µl l^{-1}found best and recorded the maximum number of primary branches plant^{-1} at final picking(8.53). CCC 300 µl l^{-1}found best and recorded the maximum fresh weight of plant at final picking (0.643 kg). CCC 300 µl l^{-1}found best and recorded the maximum number of cluster plant^{-1}(35.27). CCC 400 µl l^{-1}found best and recorded the maximum number of pods cluster^{-1}(3.31).

Table.1 Effect of foliar application of PGRs on different traits of cow pea cv. AVCP 1.

Treatments	Days to 50 % flowering	Number of leaves plant^{-1}	Leaf area (cm^2)	Leaf area index	Plant height (cm)	Days to first picking	Days to last picking	Number of primary branches plant^{-1}
T_1 : Control	63.00	47.80	5333.32	3.95	62.10	74.67	126.33	6.73
T_2 : NAA 10 mg l^{-1}	61.00	48.00	5801.21	4.30	69.27	72.00	119.67	7.60
T_3 : NAA 15 mg l^{-1}	60.33	56.33	6951.77	5.15	69.60	71.33	116.00	7.93
T_4 : NAA 20 mg l^{-1}	60.00	57.07	6879.44	5.10	70.80	71.00	117.00	8.00
T_5 : PCPA 10 mg l^{-1}	66.00	41.53	4735.00	3.51	62.20	77.67	128.67	7.07
T_6 : PCPA 15 mg l^{-1}	66.00	43.00	4806.98	3.56	60.83	78.33	130.33	7.00
T_7 : PCPA 20 mg l^{-1}	67.67	44.87	5180.40	3.84	59.87	79.00	136.00	6.67
T_8 : 2,4-D 0.5 mg l^{-1}	61.33	45.13	5047.09	3.74	58.70	71.33	124.00	7.13
T_9 : 2,4-D 1.0 mg l^{-1}	62.00	46.87	5417.95	4.01	62.77	71.33	122.33	7.53
T_{10} : 2,4-D 1.5 mg l^{-1}	61.67	52.67	6277.59	4.65	66.03	72.33	120.67	7.20
T11 : CCC 200 µl l^{-1}	58.67	56.93	6957.67	5.15	61.33	69.67	117.67	7.67
T12 : CCC 300 µl l^{-1}	57.33	56.27	7058.87	5.23	59.70	67.67	115.33	8.53
T13 : CCC 400 µl l^{-1}	58.00	52.47	6457.25	4.78	57.93	68.33	116.67	8.07
S.Em.±	2.15	3.79	464.94	0.34	2.74	2.49	4.32	0.28
C.D. at 5 %	6.26	11.05	1356.85	1.01	7.99	7.26	12.60	0.81

Table.2 Effect of foliar application of PGRs on different traits of cow pea cv. AVCP 1.

Treatments	Fresh weight of plant (kg)	Number of cluster plant^{-1}	Number of pods cluster^{-1}	Pod length (cm)	Number of marketable pods plant^{-1}	Marketable pod yield (t ha^{-1})
T_1 : Control	0.434	30.27	2.89	12.34	86.98	6.04
T_2 : NAA 10 mg l^{-1}	0.591	32.00	2.92	13.53	93.30	9.06
T_3 : NAA 15 mg l^{-1}	0.599	33.07	3.09	13.66	101.45	9.56
T_4 : NAA 20 mg l^{-1}	0.606	33.47	3.18	13.56	106.07	9.65
T_5 : PCPA 10 mg l^{-1}	0.374	31.13	2.28	12.94	70.68	4.93
T_6 : PCPA 15 mg l^{-1}	0.423	30.40	2.32	12.40	70.30	4.71
T_7 : PCPA 20 mg l^{-1}	0.421	28.67	2.41	13.11	68.84	4.57
T_8 : 2,4-D 0.5 mg l^{-1}	0.438	29.53	3.04	12.79	88.87	7.17
T_9 : 2,4-D 1.0 mg l^{-1}	0.436	31.53	2.95	12.71	92.93	7.35
T_{10} : 2,4-D 1.5 mg l^{-1}	0.506	29.27	3.30	12.91	96.33	8.37
T_{11} : CCC 200 µl l^{-1}	0.590	33.73	3.07	14.07	103.58	10.08
T_{12} : CCC 300 µl l^{-1}	0.643	35.27	3.20	14.10	112.93	10.44
T_{13} : CCC 400 µl l^{-1}	0.600	33.53	3.31	13.75	110.98	9.79
S.Em.±	0.06	1.34	0.16	0.37	3.73	0.55
C.D. at 5 %	0.16	3.92	0.48	1.08	10.89	1.61

Table.3 Economics of different treatments (₹ ha^{-1})

Treatments	Pod yield (t ha^{-1})	Treatment Cost	Operational Cost	Total Cost	Gross Return	Net Return	B:CR
T_1 : Control	6.04	0	76765	88090	181200	93110	**1.1**
T_2 : NAA 10 mg l^{-1}	9.06	396	76765	94148	271800	177652	**1.9**
T_3 : NAA 15 mg l^{-1}	9.56	440	76765	95130	286800	191670	**2.0**
T_4 : NAA 20 mg l^{-1}	9.65	484	76765	95343	289500	194157	**2.0**
T_5 : PCPA 10 mg l^{-1}	4.93	344	76765	86353	147900	61547	**0.7**
T_6 : PCPA 15 mg l^{-1}	4.71	362	76765	85958	141300	55342	**0.6**
T_7 : PCPA 20 mg l^{-1}	4.57	380	76765	85714	137100	51386	**0.6**
T_8 : 2,4-D 0.5 mg l^{-1}	7.17	310	76765	90518	215100	124582	**1.4**
T_9 : 2,4-D 1.0 mg l^{-1}	7.35	311	76765	90857	220500	129643	**1.4**
T_{10} : 2,4-D 1.5 mg l^{-1}	8.37	312	76765	92770	251100	158330	**1.7**
T_{11} : CCC 200 µl l^{-1}	10.08	375	76765	96040	302400	206360	**2.1**
T_{12} : CCC 300 µl l^{-1}	10.44	419	76765	96759	313200	216441	**2.2**
T_{13} : CCC 400 µl l^{-1}	**9.79**	**442**	**76765**	**95563**	**293700**	**198137**	**2.1**

NAA and CCC enhanced the early flowering and pod setting. Cycocel application might help the plants to make resistance to drought and could, which is main cause of flower drop and poor pod setting.

These also caused delay in senescence hence increased net period for pod development. Similar results were also found by Kumar *et al.,* (2003) in chickpea; Desai and Deore (1985) in cowpea and Patil *et al.,* (2005) in green gram.

With increasing concentrations of cycocel, there was increase in number of leaves and number of branches. These might be due to the beneficial effect of cycocel. CCC application increased the synthesis of certain endogenous growth substances, which triggers metabolic processes and narrows down the carbon-nitrogen ratio in the plant, stimulating flowering and fruit set. Similar results were also found by Resmi and Gopalakrishnan (2004) in yard long bean as well as Sharma and Lashkari (2009) in cluster bean. PCPA at all levels delayed flowering and fruit harvest. Similar results were also found by Resmi and Gopalakrishnan (2004) in yard long bean.

Influence on pod characters

CCC 300 µl l^{-1}recorded the maximum pod length among all the treatments. This might be due to faster cell division and enlargement and increase of photosynthetic pigments thereby increase assmilation of all substances and bioconstituents and there translocation from leaf and different plant organs (source) to pod (sink) which ultimately increased the pod length. Similar results were also found by Kumar *et al.,* (2003) in chick pea; Resmi and Gopalakrishnan (2004) in long yard bean; Sharma and Lashkari (2009) in cluster bean.

Number of pods $plant^{-1}$ was maximum in treatment T_{12} (CCC 300 µl l^{-1}). This might be due to reduced flower and immature pod drop. The growth regulators prevented formation of abscission layer which resulted the formation of more pods and their retention on plant.

Similar results were also found by Desai and Deore (1985) in cowpea; Patil *et al.*, (2005) in green gram. Das and Prasad (2003) in mung bean also observed a significant increase in number of pods $plant^{-1}$ was due to increased number of branches and fruiting points, which lead to better utilization of sunlight.

CCC 300 µl l^{-1}recorded the maximum pod yield among all the treatments. Increased yields in these treatments can be explained based on the enhanced vegetative growth, increased fruit sizes and higher fruit numbers. Exogenous application of plant growth regulators might be causes a greater accumulation of carbohydrates owing to photosynthesis which accelerate the overall growth of plant result in more number of pods and increase size of seeds ultimately more yield with good quality.

In particular, all concentrations of NAA and CCC showed increased fruit numbers and per plant yield, which may be because of a reduction in flower drop and fruit abortion thereby bring about an improvement in yield potential. Similar results were also found by Resmi and Gopalakrishnan (2004) in yard long bean; Sharma and Lashkari (2009) in cluster bean; Kumar *et al.*, (2003) in chickpea; Das and Prasad (2003) in mung bean; Desai and Deore (1985) in cowpea and Patil *et al.*, (2005) in green gram.

Influence on Economics

CCC 300 µl l^{-1} registered the highest net profit 2,16,441 ₹ ha^{-1} with B:CR value of 2.2 as compared to rest of the treatment, followed by T_{11} (B:CR of 2.1). Whereas, treatment T_6 (PCPA 15 mg l^{-1}) and T_7 (PCPA 20 mg l^{-1})

recorded the lowest net realization 55,341.85 and 51,386.35 ₹ ha^{-1} respectively, with lowest B:CR value of 0.6**.**

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