International Journal of
Life Sciences
International Peer Reviewed Open Access Refereed Journal

Int. J. of Life Sciences, 2022; 10 (4): 331-340
ISSN:2320-7817(p) | 2320-964X(o)

Research Article Open Access

Stimulatory effect of exogenous application of Gibberellin and Kinetin on the root and shoot growth patterns of a Gram species (*Cicer arietinum*): A comparative study

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Manuscript details:
Received: 01.11.2022
Accepted: 08.12.2022
Published: 31.12.2022

Cite this article as:
Sanjeev lal, Reena & Vipin Chandra (2022) Stimulatory effect of exogenous application of Gibberellin and Kinetin on the root and shoot growth patterns of a Gram species (*Cicer arietinum*): A comparative study, *Int. J. of Life Sciences*, 10 (4): 331-340.

Available online on http://www.ijlsci.in
ISSN: 2320-964X (Online)
ISSN: 2320-7817 (Print)

ABSTRACT

The present investigation is being carried out the promotory effects of some plant growth hormone cocentrations on the stem and root growth patterns of *Cicer arietinum* (Chick pea). The selected species of *leguminous* crop such as *Cicer arietinum* were investigated by the application of different concentrations of plant growth hormones such as Kn (10^{-2} M) to Kn (10^{-7} M) in *Cicer arietinum* were applied and increased the growth of the stem & root growth pattens and compared to the control plot. When these concentrations of the GA & Kn were applied on the *Cicer arietinum,* the maximum stem and root growth (cm) were recorded. Out of these concentrations, the best result was observed on the stem and root length (cm) were noted with the concentration of GA_3 (10^{-6} M) and Kn (10^{-2} M) on the *Cicer arietinum* as compared to the control.

Keywords: Gibberellin, Kinetin, *Cicer arietinum,* Stem & Root.

INTRODUCTION

Gibberellins are the organic compounds which tend to regulate several metabolic processes in the plants. They play an important role in the enhancement of efficiency of fruit crops in terms of growth, quality and yield. GAs is naturally synthesized by the higher plants but in insufficient amounts. Therefore, the exogenous applications of GA at different concentrations and at different stages of growth drastically increase the seed germination, stem elongation, shoot initiation, flower induction, flower inhibition, fruit set, fruit development and modifyseveral other vital processes in the fruit crops.

Since their discovery, natural and synthetic plant growth regulators have been increasingly used in agriculture and in horticulture to

modify crop plants by controlling plant developmental processes such as germination, vegetative growth, reproductive development, maturity, senescence, and postharvest preservation as was noted by Rouphael *et al.* (2010).

Among these, gibberellins (GAs) are essential endogenous hormones found in plants and fungi controlling plant development by regulating several physiological mechanisms (Basra, 2000). GAs can stimulate stem and root elongation, leaf expansion, flowering, fruit senescence, seed germination or dormancy (Hooley *et al.,* 1994). They induce transcription of genes involved in cell elongation and cell division occurring during growth (Hooley *et al.,* 1994); moreover, they can also stimulate the expression of hydrolytic enzymes involved in the conversion of starch to sugar (Moncada *et al.,* 2013). By controlling starch accumulation and use, gibberellin can influence overall plant growth. Thus, the GA signal in plant tissue can be converted into alterations in gene expression, plant physiology and morphology (Hooley *et al.,* 1994). Exogenous applications of gibberellins were shown to actively influence various physiological activities such as vegetative growth, flowering and flower morphology, earliness, fruit set, ion transport & leaf area expansion, internode elongation and can also increase biomass production, fruit weight and dry matter (Sun *et al.,* 2004).

These effects can vary greatly depending on hormone requirement, relative concentrations and plant responses at different growth stages (Wareing *et al.,* 1981). GAs has been commercially applied to control the vegetative growth of many horticultural crops. They might increase seed yield in firm-headed lettuce, enhance growth and sugar accumulation in sugar cane, accelerate peduncle elongation and bud development in strawberry etc. Recently, the application of exogenous gibberellic acid (G_{A3}) promotes plant growth, improve yield and increase tolerance to abiotic stresses such as drought, heat, salinity (Bhaskar *et al.,* 1997). The relations among G_{A3} supply through foliar spray or through the nutrient solution and yield, quality and post-harvest life of these vegetables. The quality of leafy vegetables is strictly related to leaf appearance and nutritional value such as vitamin C, nitrates and antioxidants etc. Gibberellins may play a key role in many metabolic pathways affecting these characteristics, such as chlorophyll production and degradation, translocation of assimilates, nitrogen metabolism and nitrogen redistribution.

Cytokinins are a class of phytohormones and can stimulate water uptake, increase cell division, promote organ development and lead to the regeneration and proliferation of shoots (Letham *et al.,* 1983). The importance of plant growth regulators also in the plant tissue culture is well documented. Cytokinin is tested for stimulation of shoot production.

Cytokinins are generally stimulating auxiliary and adventitious shoot proliferation, regulate differentiation, stimulate root formation, activate RNA synthesis and stimulate protein & enzyme activity. Gibberellins are generally used to promote stem elongation, flowering and breaking dormancy of seeds, buds & bulbs. Hormones such as Cytokinins, Gibberellins & Auxins are chemicals that regulate and stimulate the plant growth. As such, they shape the plant and affect seed growth, time of flowering, sex of flowers and the senescence of leaves and fruits. Also, they affect the tissues that grow upward and downward, the formation of the leaf and the growth of the stem (Helgi-opik and Stephen, 2005). Cytokinins which include 6-Benzylamino Purine and Zeatin are group of the chemicals that influence cell division & shoot formation. Plants need hormones at very specific times, during the plant growth and at specific locations (Helgi-opik & Stephen *et al.,* 2005). Gibberellins usually inhibit adventitious root formation as well as adventitious shoot formation.

Plant growth hormones are signal molecules, produced at the specific location in the plant in the extremely low concentrations (Srivastava *et al.,* 2002). A large number of related chemical compounds synthesized in the laboratory that function as hormones are called plant growth regulators.

The role of cytokinin in the seed germination was also observed by (Khan and Tao *et al.,* 1978). The overall growth of plant was improved by the plant growth regulator treatments, when it was compared to the control, because these treatments significantly, increase all plant growth parameters. The increased vegetative growth of the plants nourished and developed in a better manner, than without treatment plants. Kn & GA_3, which are most important plant growth regulators (PGRs) and has a thoughtful effect on the crop production, through increase in the stem

length, leaf area, flower induction, yield, weight & size of the crops.

There are numerous studies on the effect of growth hormones on plants (Reis *et al*., (2000). Some of these studies have shown physiological and the morphological parameters have found promotion in these traits in response to increased growth hormone treatments. The impact of plant growth regulators on various physiological parameters have been worked out by various workers. Mahmud *et al.,* (1983) evaluated that the effect of various growth regulators on growth, development and yield of various varieties of oil-seed crops well documented. The treatments of different growth substances have given remarkably encouraging results in promoting seed germination in tomato, radish, lettuce, watermelon, brinjal, carrot and a number of other vegetables have been studied by Swaminathan *et al.,* (1987).

Exogenous GA_3 stimulates amylase activity. Aleurone layer of endosperm is sensitive to GA_3 hormone. GA_3 also cause release of enzyme amylase and protease. These enzymes participate in the break down of stored starch to simple sugars. These sugers are then translocated to grow in embryo where they provide energy for growth. Thus, both oxygen and GA_3 enhance seed germination. Cytokinins have also been reported to release dormancy and enhanced germination. The endogenous cytokinins (Kn) would appear to be key factors in the initiation of the radicle growth. The external application of cytokinins and gibberellins has been shown to substitute for the physiological influence of roots on the growth of de-rooted oat (Jordan & Skoog *et al.,* 1971) and in the soybean seedlings was observed by Holm & Key, (1969).
Kinetin used as seed treatment or foliar spray individually or in combination, increased the seed yield by 26%, while foliar spray increased it by 43.6% over control. The significant increase in the content of the total chlorophyll with kinetin application as also reported by (Khalil & Mandurahi *et al.,* 1989) may also be responsible for the increase in photosynthesis (Gzik *et al*., 1987).

The Kinetin mediated increase in seed yield under water stress has also been reported for wheat. Comparatively, more height of Kinetin treated plants also indicates the beneficial effects in general on plant growth. The Kn application was associated with a high Harvest Index (HI), thereby, indicating partitioning of more photosynthates towards seeds. Significantly higher seed yield in Kn treated plants also led to higher water use efficiency (WUE) (Blackman & Davies *et al.,* 1985). Mok (1994) observed that a large number of plant developmental processes have been found to be influenced by the cytokinin effect on cell expansion, inhibition of leaf senescence, chloroplast development, root and shoot branching. Nagel *et al.,* (2001) have evaluated that cytokinin application plays a significant role in the flower production and exerted a positive effect on the yield of soybean, thus increasing the total seed production. Skoog and Miller *et al.,* (1959) evaluated that the ratio of cytokinin in nutrient media profoundly influences the morphogenesis of roots and shoots.

The GA_3 did not affect cell expansion, but strongly promoted transverse cell divisions and consequently increased the internode length. The similar effects of GA_3 and IAA on the internode elongation have been reported by Phillips (1972). In the dwarf pea (Brian & Hemming *et al.,* (1958) and in cucumber (Sandhu & Kasper Baver *et al.,* (1974) were observed that the IAA and GA_3, both hormones are promoted internode elongation.

The gibberellins have been observed to influence the carbohydrate status in the many plant species (Yim *et al.,* 1997). Gibberellin has the characteristics property to improve the yield, plant height and flower induction in the *chrysanthemum* (Mohariya *et. al.,* 2003).

The application of various growth substances viz. GA_3 and Kn etc. the shoot length was found to be increased in a poplar plants. The plant height was increased by GA_3, while branch number per plant was increased by all growth regulators. The interaction of plant growth regulators (PGRs) has significant promotory effect on shoot morphogenesis as reported by Baraldi and Lercari (1988). Zhang *et al.,* (2005) showed that the various PGRs such as GA_3, Kn etc. play a significant role in the regulation of shoot growth and tuber formation in potato the certain evidences that the IAA promote GA_3 biosynthesis in Barley and the role of developing inflorescence is discussed in relation to this GA_3 interaction evaluated by Wolbang *et al.,* (2004).

Due to the treatment of growth regulators, production and quality characters like seed yield and germination percentage of *Okra* seeds were significantly influenced. Shah and Samiullah (2006) studied the effect of plant

growth regulators on growth and yield of black cumin and observed that, these substances were found to be more effective in promoting shoot length, dry weight, leaf number and seed yield. The treatment with growth regulator probably antagonizes the effect of growth inhibitory substances and also enhance the rate of metabolism during germination (Verma and Tondon *et al.,* 1988).

It is well documented that this phytohormone affects stem growth, through both cell elongation and cell division. Gibberellin is a well-known stimulator of cell expansion, cell elongation and elongation of the internodes (Huttly and Phillips *et al.,* 1995).

Plant growth regulators are the chemicals, which influence the plant growth when applied in very minute quantity. There are many reports which indicate application of growth regulators enhances plant growth and crop production (Ashraf *et al.,* (1987). GA_3 increased stem length and number of flowers per plant. Cytokinin enhance the cell expension in soyabean and increased stem thickness, while Kinetin reduces shoot length, but increased the fresh weight by increasing stem diameter (Chaudhry and Khan *et al.,* 2000). Therefore, the present study was aimed at characterizing the effect of gibberellic acid (G_{A3}) and Kinetin on the stem and root growth patterns of the Cicer arietinum.

MATERIAL AND METHODS

Materials and methodology: The meteorological data of the study area are set in the table (2.1 and fig. 2.1). The rainfall was recorded by automatic rainguage; temperature and relative humidity by automatic thermo hygrograph and solar radiation was recorded by the solar meter by author himself, at the research field plots

Table 2.1: Mean maximum and minimum temperature (^{0}C), rainfall, temperature and relative humidity of the study area, during the period October 2021-till to March 2022.

Month	Rainfall (mm)	Relative humidity (%)	Temperature		
			Max	Min.	Ave.
October	32.0	74	28.5	13.3	20.5
November	10.9	82	24.8	7.6	15.7
December	2.8	89	21.9	4.0	12.0
January	46.9	91	19.3	3.6	10.9
February	54.9	83	22.4	5.6	13.3
March	54.4	69	26.2	9.1	17.5

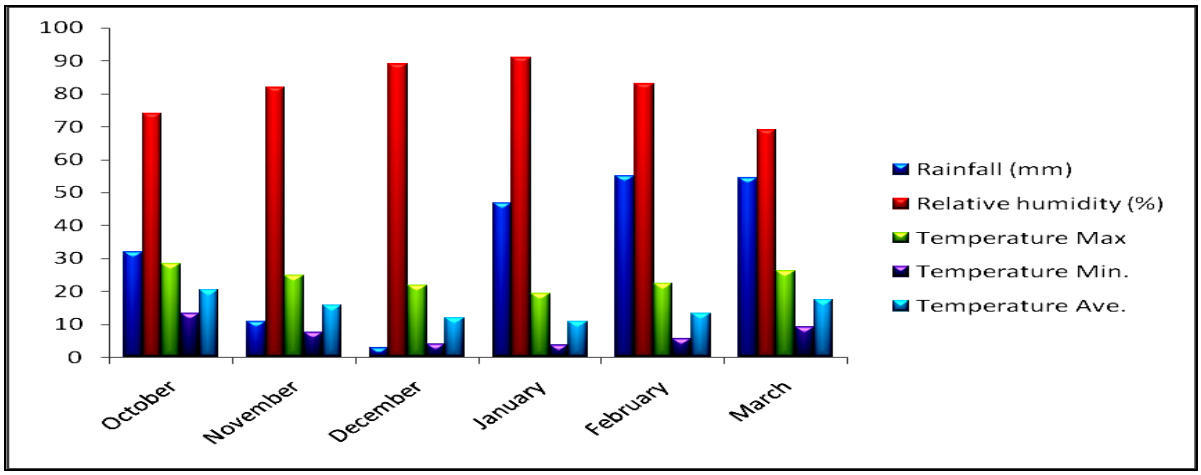


Fig 2.1: Mean maximum and minimum temperature (^{0}C), rainfall, temperature and relative humidity of the study area, during the period October 2021-till to March 2022.

Edaphic condition: Certain physical and chemical characteristics of the soil of the study area were analyzed in (Table 1.1 & Fig.1.1).

Table 1.1: Average physical and chemical properties of the soil samples collected at three different depths of the study plot.

Soil Texture	**(Soil Depth)**		
	0-10 (cm)	**10-20 (cm)**	**20-30 (cm)**
Physical properties			
Sand (%)	55	47	45
Clay (%)	7	9	14
Silt (%)	39	37	34
pH	8.4	7.8	7.5
Water holding capacity (%)	33	44	48

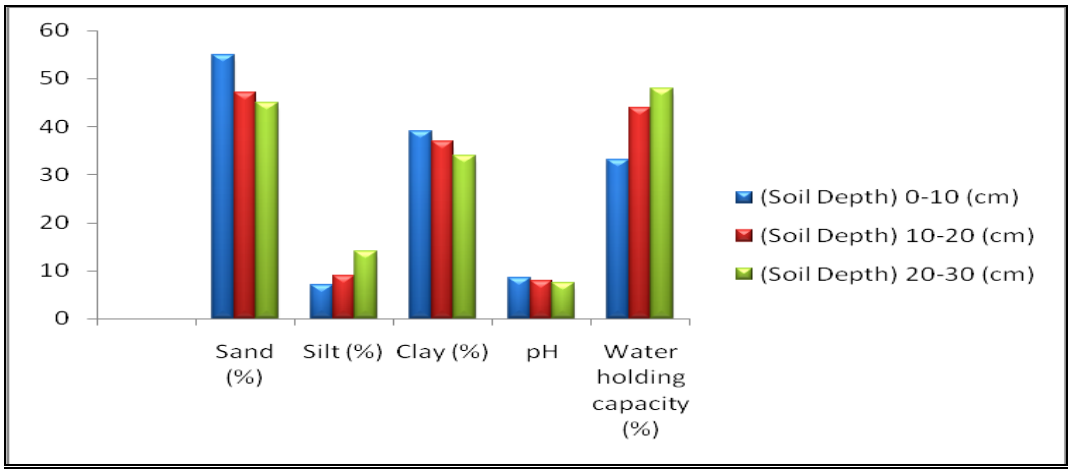


Fig. 1.1: Average physical properties of the soil samples collected at three different depths of the study plot.

Table 1.2: Average chemical properties of the soil samples collected at three different depths of the study plot.

Chemical properties of soil sample	**Soil Depth**		
	0-10 (cm)	**10-20 (cm)**	**20-30 (cm)**
Conductivity	0.08	0.05	0.11
Organic carbon, (%)	0.53	0.55	0.61
Total Nitrogen (N) (%)	0.08	0.04	0.12
Phosphorus (P) (ppm)	2.21	3.90	4.10
Potassium (K) (ppm)	207.0	210.0	215.0
Calcium (Ca) (ppm)	218.0	201.0	229.0
Sodium (Na) (ppm)	2170	208	220.0

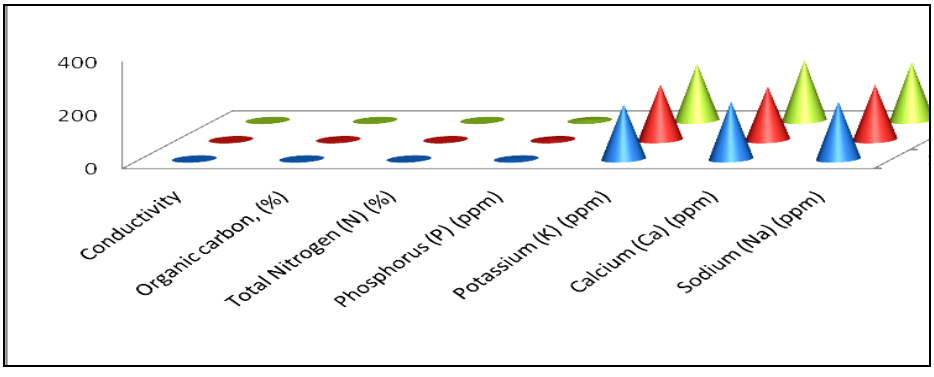


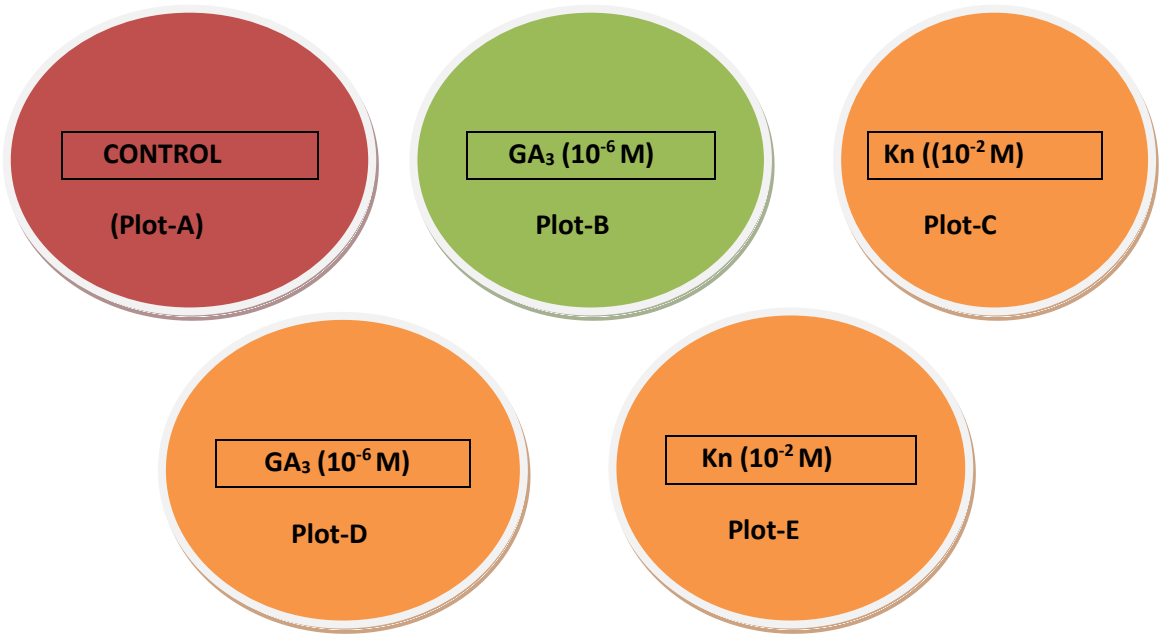
Fig.: 1.2: Average chemical properties of the soil samples collected at three different depths of the study plot.

Generel experimental design in the field plots

Field study: During field study, one species of the legumes were grown in field and the plots were divided into five blocks. Each field block was given treatments as follows:

Treatments of the field plots:

1. In the plot-A, crop of *Cicer arietinum* was taken as control. No treatment was given to the crop of this plot.
2. Plot-B was sprayed with GA_3 (10^{-6} M) concentration in *Cicer arietinum* daily.
3. Plot-C was sprayed with Kn (10^{-2} M) concentration in *Cicer arietinum* daily.
4. Plot-D was sprayed with GA_3 (10^{-6} M) concentration in *Cicer arietinum* daily.
5. Plot-E was sprayed with Kn (10^{-2} M) conc*entration* in *Cicer arietinum* daily.



Experimental design in the field plots: Effects of plant growth hormone on stem and root growth pattens of the *Cicer arietinum.*

Methodology:

The field for the cultivation was prepared before sowing of the seeds of *Cicer arietinum*, as proposed by Dhasmana *et al.,* (1984). The pre-soaked seeds of the *Cicer arietinum* crops were sown in the experimental field plots. The general experimental studies of different treatments were laid after complete germination as observed by Kumar (1981) and Bhatt N (2004) respectively.

Growth pattern:

Seeds of *Cicer arentum* (Chick pea) were sown in the sandy loam soil in rows placed 0.1m apart in 5 plots (A, B, C, D & E) of 1 x 1 m each plot separately. The crop of plot-A treated as control and not sprayed with plant growth hormones. The plot B, C, D & E of crop such as *Cicer arietinum* was treated with different concentrations of plant growth hormones.

The crop of Plot-B (*Cicer arietinum*) was sprayed with GA_3 solution of (10^{-6} M) concentration daily, through hand spray machine. The crop of Plot-C *(Cicer arietinum*) was sprayed with of Kn solution of (10^{-2} M), crop of Plot-D *(Cicer arietinum)* was treated with of GA_3 in (10^{-6} M) and the crop of Plot-E (*Cicer arietinum*) was sprayed with Kn solution of (10^{-2} M) respectively, with respective to the control. The above treatments were carried out daily with stem and root growth patterns of the *Cicer arietinum.*

Growth analysis:

The plant samples for growth analysis were taken regularly at the 15th day interval from each field plot separately, after the seedling emergence (two leaf stage) till maturity. For each field plot study, the five phenotypically identical plants were taken from field carefully to laboratory, where these washed by running water to remove the soil particles, using a

mesh of 0.32 nm pore size and tap water current. The growth measurements were taken on parts of per plant basis for the stem and root of *Cicer arietinum*, for each treatment separately. The mean values of 5 plants of each sample plot (A, B, C, D & E) were calculated and results represented with ±S.D.

RESULTS AND DISCUSSION

The seeds of Chick pea *(Cicer arietinum)* were sown in the sandy loam soil in the different plots in the growing seasons of October-2021 to till March 2022. Plot-A taken was (control), Plot-B treated by GA_3 (10^{-6} M) and Plot-C was treated by Kn (10^{-2} M) concentration in *(Cicer arietinum)* and Plot-D was treated by GA_3 (10^{-6} M) & Plot-E was treated by Kn (10^{-2} M) concentration in *Cicer arietinum* accordingly. The results have been documented in the tables 4.1 & 4.2 and Fig 4.1 and 4.2 for the *Cicer arietinum*.

Stem gsrowth patterns of *Cicer arietinum*:

The data of the stem growth patterns as improved by the various treatments are presented in table 4.3 & fig. 4.3. In the control plot (A), the value of stem length (cm/pl), fresh and dry weight (g/pl) of the stem were recorded at the fifteen (15) day stage of the growth as 6.6 (cm/pl), 0.15, 0.014 (g/plant) respectively and observed to be increased continuously up to maturity and noticed as ca. 24.25 (cm/pl), 2.81 and 1.21 (g/plant) respectively, while the plot (B) was sprayed by GA_3 (10^{-6} M) concentration daily, the enhancement was observed to stem length, fresh and dry weight with respective to the control. The maximum promotion in length, fresh and dry weight was noticed at the 15th day stage of growth and recorded as ca.65%, 64%, 85%; at the 30th day as ca. 95%, 16%, 74%; at the 45th day as ca. 43%, 65%, 78%; at the 60th day ca. 84%, 42%, 123% and at the 75th day ca. 98%, 74%, 64% respectively, as compared to the control.

Table 1.1: Stem growth patterns of field grown *Cicer aritinum* as increased by some plant growth regulators (PGRs) such as Kn and GA_3 respectively.

TREATMENT	PARAMETERS	CROP	AGE		IN	DAYS
		15	30	45	60	75
	Length (cm)	**6.6**±0.5966	**9.18**±0.925	**14.22**±0.522	**18.8**±3.9623	**25.8**±4.974
Control	F.W.(g)	**0.158**±0.0213	**0.39**±0.0219	**0.308**±0.0352	**0.636**±0.04321	**0.738**±0.05322
	D.W.(g)	**0.014**±0.0049	**0.05**±0.0142	**0.072**±0.121	**0.174**±0.01949	**0.285**±0.02045
	Length (cm)	**10.9**±0.54	**17.94**±1.909	**20.34**±1.059	**34.6**±2.329	**40.72**±3.524
GA_3 (10^{-6}) M	F.W.(g)	**0.252**±0.0031	**0.45**±0.014	**0.65**±0.0151	**1.286**±0.0655	**2.387**±0.0765
	D.W.(g)	**0.028**±0.0021	**0.23**±0.0261	**0.2**±0.045	**0.388**±0.0339	**0.498**±0.0447
	Length (cm)	**9.76**±1.032	**14.9**±0.807	**28.3**±2.731	**30.2**±3.564	**38.3**±4.665
Kn (10^{-2}) M	F.W.(g)	**0.224**±0.1461	**0.44**±0.0179	**0.42**±0.0172	**1.55**±0.368	**2.74**±0.470
	D.W.(g)	**0.032**±0.0051	**0.21**±0.0341	**0.081**±0.008	**0.46**±0.2043	**0.69**±0.2247

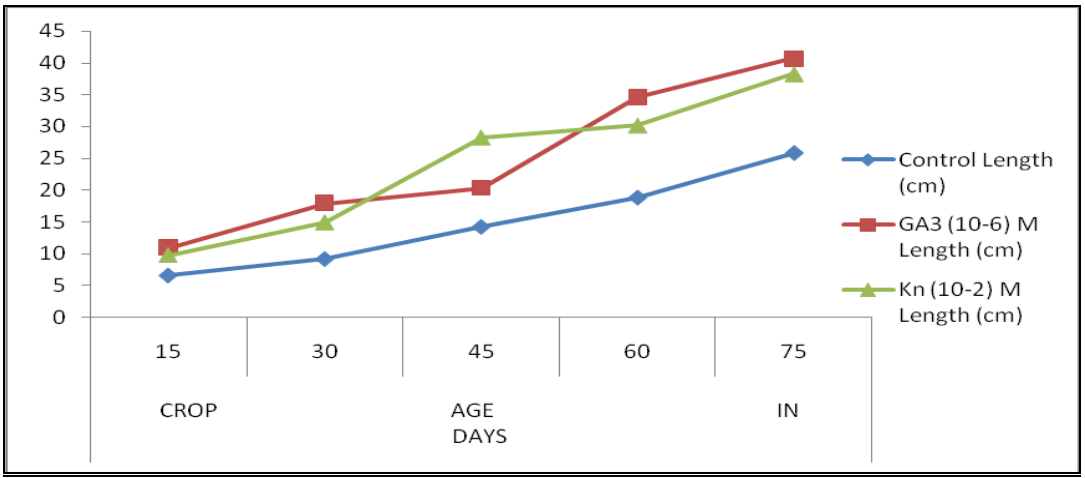


Fig. 1.1: Stem growth patterns of field grown *Cicer aritinum* as increased by some plant growth regulators (PGRs) such as Kn and GA_3 respectively.

Table 1.2: Root growth patterns of field grown *Cicer aritinum* as increased by some plant growth regulators (PGRs) such as Kn and GA_3 respectively.

TREATMENT	PARAMETERS	CROP AGE IN DAYS				
		15	30	45	60	75
	Length (cm)	**6.02**±1.105	**8.82**±1.810	**13.76**±1.125	**16.36**±2.9703	**25.26**±3.870
Control	F.W.(g)	**0.21**±0.0141	**0.66**±0.0141	**1.04**±0.0458	**1.784**±0.0287	**3.684**±0.0267
	D.W.(g)	**0.022**±0.0053	**0.24**±0.0178	**0.098**±0.0023	**0.284**±0.0132	**0.394**±0.0134
	Length (cm)	**7.98**±1.547	**11.65**±1.414	**13.84**±0.833	**15.8**±1.6046	**26.8**±1.7036
GA_3 (10^{-6}) M	F.W.(g)	**0.252**±0.0051	**0.45**±0.0346	**1.33**±0.1643	**2.772**±0.0498	**4.773**±0.0448
	D.W.(g)	**0.032**±0.0051	**0.22**±0.0103	**0.144**±0.015	**0.386**±0.04456	**0.576**±0.0446
	Length (cm)	**7.66**±1.884	**12.7**±1.245	**13.84**±1.246	**14.38**±0.5495	**28.22**±0.6485
Kn (10^{-2}) M	F.W.(g)	**0.264**±0.0102	**0.46**±0.024	**0.91**±0.0087	**2.452**±0.1116	**4.451**±0.1127
	D.W.(g)	**0.034**±0.0029	**0.23**±0.0185	**0.13**±0.0046	**0.39**±0.1253	**0.57**±0.1351

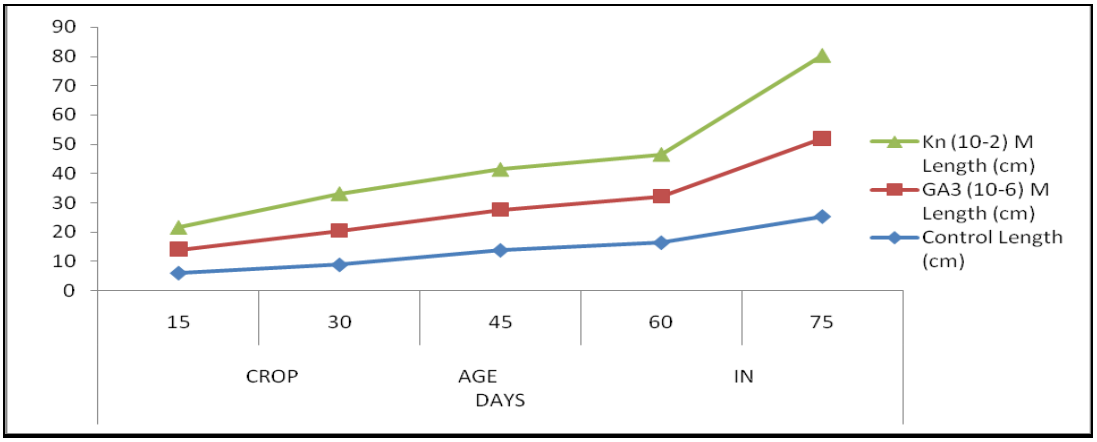


Fig. 1.2: Root growth patterns of field grown *Cicer aritinum* as increased by some plant growth regulators (PGRs) such as Kn and GA_3 respectively.

Plot (c) was sprayed by Kn (10^{-2} M) concentration daily, the maximum promotory effect was observed on the stem length, fresh and dry weight as compared to control. The maximum promotion of stem length, fresh and dry weight was noticed at the 15th day stage of growth and noticed as ca. 27%, 73%, 128%; at the 30th day as ca. 62%, 13%, 40%; at the 45th day as ca. 99%, 40%, 13%; at the 60th as ca. 60%, 146%, 170% and at the 75th day as ca. 82%, 95%, 82% respectively, with respective to the control.

Root growth patterns of *Cicer arietinum:*

The root growth patterns was also carried out from the 15th day stage up to maturity, in terms of length, fresh and dry weight (g/pl) and data were depicted in the table 4.4 and fig. 4.4. In the control plot, the value of length, fresh and dry weight of root was found at the 15th day stages of growth and recorded as ca. 6.02, 0.21, 0.02 respectively and observed to be increased continuously up to maturity. When these plants were sparyed to plant growth regulators such as GA_3 and Kn daily, the promotion were also found in these considered parameters with respective to the control condition. When the plants of plot-(B) were studied along with GA_3 (10^{-6} M) concentration, a maximum promotory response was observed in terms of root length, fresh and dry weight from the 15th day stage till to maturity and increased by ca. 133%, 19% 98%; 25%, 46%, 9%; 2%, 28%, 47%; 84%, 13%, 64% & 54%, 24%, 21% respectively, with respective to the control plot. When the plants of plot-(C) were sprayed along with Kn (10^{-2} M) concentration, the promotory effects was reported from the 15th day stage till to maturity satages of growth and increased by ca. 27%, 73%, 28%; 62%, 13%, 40%; 99%, 40%, 13%; 60%, 146%, 170% and 82%, 95%, 82% respectively, with respective to the control.

DISCUSSIONS

The present investigation has been carried out to study the promotory effects of different plant growth regulators, when applied on the the stem and root growth patterns of the *Cicer arietinum* and compared to the control. The promotory effects of the different plant growth regulators viz. GA_3 (10^{-6} M) & Kn (10^{-2} M) in *Cicer arietinum,* were found most effective in case of stem length, root length (cm) fresh and dry weight (g) of root and stem. When crops under investigation were treated with PGRs, an increase in all the above parameters were observed as compared to control. In C*. arientium* the GA_3 (10^{-6} M) concentration was showed enhancement on the stem length, fresh and dry weight with respective to the control. The maximum promotion in length, fresh and dry weight was noticed at the 15th day, 30th day, 45th day, 60th day and 75th day stage of growth and recorded and compared to the control. The maximum promontory effects on the stem length, fresh and dry weight was noticed with the Kn (10^{-2} M) at the 15th day, 30th day, 45th day, 60th day and 75th day stage of growth and recorded and compared to the control. The crop was studied along with GA_3 (10^{-6} M) concentration, a maximum promotory response was observed in terms of root length, fresh and dry weight from the 15th day stage and increased till to maturity with respective to the control plot. When the plants of plot were sprayed along with Kn (10^{-2} M) concentration, the promotory effects was reported from the 15th day stage and increased till to maturity satages of growth with respective to the control. The above studies found support from the work of Gupta *et al*., (2011), Mishra *et al.,* (1986) and Reis *et al*., (2000). Therefore, these plants were sparyed by plant growth regulators such as GA_3 and Kn daily, the promotion were found in all these considered parameters as compared to the control.

A number of studies have been carried out in India and abroad on the promotory effects of various plant growth regulators on the growth and development of various crops and natural vegetation. Daily treatment of PGRs, observed the overall enhancement in length and weight of all parts of plants. The maximum promotion was observed in plant height, fresh and dry weight respectively, when sprayed to different concentrations of the plant growth regulators. The similar results have also been observed by Mahmud *et al.,* (1983), Normanly *et al.,* (1997), (Arney & Mancinelli *et al.,* (1967) and Jordan *et al.,* (1971).

CONCLUSION

Therefore, GA_3 (10^{-6} M) was showed the maximum growth of stem length (cm) and Kn (10^{-2} M)) was showed the maximum length (cm) of root with respective to the control. Consequently, the plant growth regulators (PGRs) are conscientious in the promotion of stem and root growth of *Cicer arietinum* respectively, over the control.

Conflict of Interest:

None of the authors have any conflicts of interest to disclose. All the authors approved the final version of the manuscript.

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