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Promotory effects of some phytohormone on the stem growth patterns of the *Pisum sativum* (pea) over the control

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Abstract

The seeds of *Pisum sativum* were sown in the sandy loam soil in the different plots for the treatment in the field studies. *Pisum sativum* was treated by GA_3 (10^{-6} M) & Kn (10^{-3} M) concentrations with respect to the contol. The plants of *Pisum sativum*, for the growth analysis were taken regularly and randomly at the 15 days interval from the seedling emergence stage till to maturity. The length of *Pisum sativum* stem (Pea) was observed with two concentrations of plant hormones to evaluate the appropriate concentrations of these growth regulators, which showed the maximum stem length of the *Pisum sativum* with respect to the control.

Keywords: *Pisum sativum* | Stem, GA_3 | Kn hormone |

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Introduction

The earth is surrounded by a cover of gases as atmosphere; this atmosphere allows most of the electromagnetic radiation to pass through, which reaches the surface of earth. This light or rays from the sun is absorbed by the earth surface & converts it into heat energy. This heat energy is re-emitted by the surface of the earth during night. Due to excessive presence of some gases in the atmosphere, this escape of heat from earth surface is prevented, resulting in heating of earth called global warming. The gases which are responsible for causing global warming are called green-house gasses. The harmful effects of green-house gasses in the atmosphere are causing global warming, climate change, ozone depletion, sea level rise, adverse effects on agricultural crop as well as on the whole biological system.

The effects of global warming on the environment and for human life are numerous and varied. It is generally difficult to attribute specific natural phenomena to long-term causes, even though some effects of recent climate changes as rising sea levels, glacier retreat, arctic shrinkage & altered patterns of agricultural crops are cited as direct

consequences. Among secondary and regional effects extreme weather events, expansion of tropical diseases, changes in the timing of seasonal patterns in ecosystems and drastic economic impact are predicted.

Changes of methods of the rice farming processes and the capture of methane from landfill sites contributed to this rise, it is felt. This is very useful information provided as it will help people to get aware of environmental problems & issues being faced worldwide. Though there are certain people that are helping to preserve environment. But only few people can't do anything (Partha Das Sharma'S *et al.*, 2008).

Inrease in penetration of ultraviolet radiation to terrestrial surface as a consequence of depletion of the stratospheric ozone layer has received much globle concern 10% depletion in stratospheric ozone corresponds to a 20% increase in the flounce of biological damaging ultraviolet radiation (Baker and Allen *et al.*, 1994).The enhanced ultraviolet radiation can deleteriously affects overall growth and biomass accumulation of the plant species (Tevini, 2000). The plants contain a large number of ultraviolet exposure sensitive targets such as nucleic acids (DNA & RNA), lipids, proteins and quinens (Jordon, 1996), which must be protected to ensure the normal growth & development of plants.

It has been well established that the plant growth regulators (PGRs), influence the growth and development of plants. These chemical substances are able to coordinate growth among different plant parts or different physiological & biochemical processes, these chemical substances are known as phytohormone. Cytokinins are generally stimulating auxiliary & adventitious shoot proliferation, regulate differentiation, stimulate root formation, activate RNA synthesis & stimulate protein & enzyme activity. Gibberellins are generally used to promote stem elongation, flowering and breaking dormancy of seeds, buds & bulbs. There are over 90 forms of gibberellins, but GA_3 is the most commonly used form (*Phyto*-Technology Laboratories (2011). Hormones such as Cytokinins, Gibberellins & Auxins are chemicals that regulate and stimulate the plant growth. The plant growth hormones are 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 (BAP) 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. Hormones are naturally produced within plants, though very similar chemicals are produced by fungi and bacteria that can affect plant growth (Srivastava *et al.*, 2002). A large number of related chemical compounds synthesized in the laboratory that function as hormones are called plant growth regulators (PGRs).The concentration of hormones required for plant responses at the very low concentrations (Srivastava *et al.*, 2002). Plant hormones affect gene expression and transcription levels, cellular division and growth. The hormones

have positive and inhibitory functions, and they often work in tandem with each other (Rost and Eliot *et al.*, 1979).

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. IAA, 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. 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. Kinetin (Kn) also affected two important plant processes viz. photosynthesis and nitrogen metabolism. Net photosynthetic rate and nitrate reductase activity are significantly increased in the plant treated with kinetin. 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 concentrations of starch soluble protein and free amino acids were maximum, when Kinetin (Kn) was applied both as seed treatment and foliar spray. This could be due to kinetin mediated increase in photosynthetic & nitrate assimilation activity, besides decrease in protease activity and immobilization of nutrients and metabolites from Kn treated tissues as observed by Kumari & Bharti *et al.*, (1992). Few attempts have been also made to investigate the role of endogenous cytokinins (Kn) on the lateral bud-growth and apical dominance. The most of the hypotheses concerning the possible involvement of these hormones in apical dominance were formulated after conducting experiments with synthetic compounds. This is probably the main reason for the views that are presently held regarding the role of cytokinins in the control of the apical dominance and growth of lateral bud. Auxins and gibberellins (White *et* al., 1975; Jones and Phillips, 1966) produced by the apical bud as well as by the leaves and both hormones have been suggested to be growth factors, which might regulate growth (Thimann *et al.*, 1997).

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). In a series of experiments, 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 crop improvement also through the conventional method to provide food security for the ever growing population has several limitations. Modern plant biotechnology has held promise over the years to improve outputs from plants. The uses of PGRs as a way of improving plant yield through micro-propagation and somatic embryogenesis. Improved and disease resistant crops could easily be made available to farmers, if the use of synthetic growth hormones for plantlet regeneration is vigorously pursued. The hormones like auxins, cytokinines & gibberellins could be made available at reduced cost to users for rapid multiplication of cultivated crops (Gana, A. S, (2010). 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 (Kaul and Farooq *et al.,* 1994) and (Chaudhry and Khan *et al.,* 2000).

There are numerous studies on the effect of growth hormones on plants (Jawanda *et al.,* (1979); Mishra *et al.,* (1986) and 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).

GA_3 is produces by the apical bud (Jones & Phillips (1996). Thus, it is conceivable that internode elongation is modulated by the apex by way of the effects of GA_3 on cell division on one hand and by their synergistic effects on cell elongation on the other. The effects of GA_3 in dwarf pea, enhanced internode elongation, when applied separately (Arney & Mancinelli *et al.,* 1967). The role of gibberillic acid in the seed germination is also well established. 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.

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 dwarf bean plants confirm the central importance of GA_3 in inducing the mitotic activity necessary for elongation, but they also indicate a role for the auxin in the regulation of internode elongation.

The gibberellins have been observed to influence the carbohydrate status in many plant species (Canomedrano *et al.,* (1997) and Yim *et al.,* (1997). In elongated tissues, common response to exogenous gibberellins is an increase in acid invertase activity (Wu *et al.* 1993). Gibberellin has the characteristic property to improve the yield, plant height and

flower induction in the *chrysanthemum* (Mohariya *et. al.,* 2003). Pharis and King *et al.*, (1985) observed that the gibberellins (GA_3) play a major role in the development of fruit set. 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 *et al.*, (1988).

During field study, it has been demonstrated by Yadav *et al.,* (2005) that the growth promoters significantly improved growth & yield of rice. A lot of work has been done on the effects of growth substances on the different parameters of plant growth and development by Bahuguna *et al.,* (1988). 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. Giberellins are tetracyclic diterpenoid growth factors that are essential regulators of stem elongation and other developmental processes (Hooley *et al.*, 1994). It is well documented that this phytohormone affects stem growth, through both cell elongation and cell division (Knede and Zeevart; 1997). Gibberellin is a well known stimulator of cell expansion, cell elongation and elongation of the internodes (Huttly and Phillips *et al.,* 1995). GA_3 induced wall extensibility (Huttly and Phillips *et al.*, 1995) and expantion, elongation of internodes (Morie *et al.,* 1989) and expantion of leaf area which in turn manifestes itself in the form of more dry matter. At the time of cell division, the cells need more nutrients, which are made available by the efficient manipulation, absorption and utilization of the available nutrients triggered by the GA_3 spray. GA_3 increased stem length and number of flower per plant.

The promotory effect of growth regulators in a particular concentration is a well known feature. The many of these factors are necessary for the success of plant life. Therefore, the present investigation is being carried out to study the promotory effects of the some phytohormone concentrations viz. Kn 10^{-2} (M) and GA_3 10^{-7} (M) was observed on the stem growth pattern of the *Pisum sativum* (Rai).

Materials and Methods:

Laboratory and field experiments were conducted in the Uttaranchal College of Science and Technolgy, Dehradun (Utttarakhand). Certified seeds of the *Pisum sativum* were procured from Seed centre of Forest Research Institute (FRI) Dehradun (Utttarakhand) for the study.

General experimental design in the laboratory

(A) Control: Seeds of *Pisum sativum* were soaked for 24 hrs. in distilled water and placed on moistened filter paper in Petridishes.

(B) Growth Regulators: Test solution of Kn and GA_3 were prepared in three concentrations viz.10^{-7} to 10^{-2} M) (molarities) in *Pisum sativum.* Seeds of *Pisum sativum* were soaked for 24 hrs. in different concentrations of growth regulators, soaked seeds were placed in paired Petridishes lined with moistened filter paper.

Field study: During field study, crop of *Pisum sativum* was grown in field and the plots were divided by black paper sheets into five blocks. On the basis of the maximum germination, survival and minimum mortality percentage of the plant hormone concentrations viz. Kn (10^{-3})

& GA_3 10^{-7} (M) respectively were sprayed during field study. Each field block was given treatments as follows:

Treatments of field plots

1. One field plot was taken as control. No treatments were given to crop of this plot.
2. Other field plot was sprayed with GA_3 (10^{-7} M) concentration daily with respect to the control.
3. Next other field plot was sprayed with Kn (10^{-2} M) concentration daily with respect to the control.

Observation

In the control plot, the values of stem length (cm/pl), fresh and dry weight (g/pl) of the stem were recorded at the fifteen day stage of the growth as 7.42 (cm/pl), 0.28.6 and 0.03 (g/plant) respectively and observed to be increased continuously up to maturity and noticed as ca. 60.5 (cm/pl), 4.79 and 2.23 (g/plant) respectively. When the other plot was sprayed by GA_3 (10^{-7} M) concentration daily, the promotory effect was observed on the stem length, fresh and dry weight with respect to the control condition. The maximum promotion of length, fresh and dry weight was noticed at the 15 day stage of growth and recorded as ca.91%, 51%, 34%; at the 30th day as ca. 27%, 85%, 46%; at the 45th day as ca. 65%, 41%, 28%; at the 60th as ca. 72%, 27%, 24% & at the maturity as ca. 72%, 27%, 24% respectively with respect to the control.

When the next other plot was sprayed by Kn (10^{-3} M) concentration daily, the maximum enhancement was observed to stem length, fresh and dry weight with respect to the control. The maximum promotion of length, fresh and dry weight was noticed at the 15th day stage of growth and recorded as ca. 78%, 34%, 24%; at the 30th day as ca. 68%, 30%, and 22%; at the 45th day as ca. 82%, 42%, 38%; at the 60th day as ca. 74%, 23%, 16% and at the maturity as ca. 86%, 48%, 34% respectively with respective to the control. (Table 1 and fig.1)

TREATMENTS	PARAMETERS	CROP AGE IN DAYS				
		15	30	45	60	75
	Length (cm)	7.42±0.7302	9.66±1.269	30.2±4.965	50.5±1.331	59.4 ±1.441
Control	F.W.(g)	0.286±0.0063	0.27±0.0141	1.21±0.0487	2.79±0.206	4.69±0.306
	D.W.(g)	0.03±0.0032	0.02±0.0026	0.21±0.0102	0.686±0.0631	0.866±0.0731
	Length (cm)	14.16±0.8683	41.3±4.166	74.1±18.456	68.4±12.03	82.6±14.03
GA_3 (10^{-7}) M	F.W.(g)	0.604±0.0326	0.77±0.0209	1.71±0.0352	3.102±0.0144	5.102±0.0242
	D.W.(g)	0.22±0.0126	0.28±0.021	0.48±0.0121	0.866±0.0429	0.967±0.0629
	Length (cm)	13.2±1.224	38.9±4.465	55.1±9.101	87.8±24.87	95.7±28.77
Kn (10^{-3}) M	F.W.(g)	0.674±0.0458	0.83±0.026	1.72±0.206	3.676±0.0731	5.651±0.0832
	D.W.(g)	0.246±0.0102	0.42±0.0143	0.50±0.0357	1.058±0.0337	3.067±0.0437

Table 1: Stem growth patterns of field grown *Pisum sativum* as increased by some plant growth regulators (PGRs) such as Kn and GA_3 respectively.

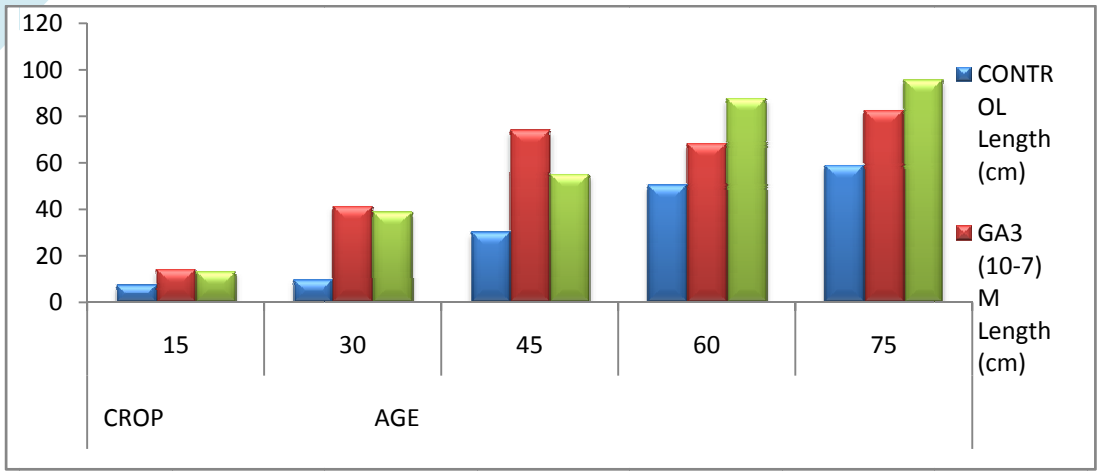

Fig. 1: Stem length of field grown *Pisum sativum* as increased by some plant growth regulators (PGRs) such as Kn and GA_3 respectively.

Pisum sativum treated with Kn (10^{-3}) M concentration, showed Enhancement of stem growth

Pisum sativum treated by GA_3 (10^{-7}) M concentration, showedenhancement of stem growth

Discussion

Present study was carried out in the laboratory & field to observe the promtory effects of the plant growth regulators on the Pisum sativum (Pea) with respect to the control.Hence for the further studies GA_3 (10^{-7} M) and Kn (10^{-3} M) concentrations were applied in the *Pisum sativum* respectively, for the treatment during field studies.The effects of plant growth regulators on the stem growth of *Pisum sativum* was showed maximum enhancement with respect to the control.

When the crop was sprayed by GA_3 (10^{-7} M) concentration daily, the promotory effect was observed on the stem length, fresh and dry weight with respect to the control. The maximum promotion of length, fresh and dry weight was noticed at the 15th day stage of growth and recorded as ca.91%, 51%, 34%; at the 30th day as ca. 27%, 85%, 46%; at the 45th day as ca. 65%, 41%, 28%; at the 60th as ca. 72%, 27%, 24% and at the maturity as ca. 72%, 27%, 24% respectively with respect to the control.

The maximum promotion was also noted with the Kn (10^{-3} M) on the length, fresh and dry weight of the stem was noticed at the 15th day stage of growth and recorded as ca. 78%, 34%, 24%; at the 30th day as ca. 68%, 30%, and 22%; at the 45th day as ca. 82%, 42%, 38%; at the 60th day as ca. 74%, 23%, 16% and at the maturity as ca. 86%, 48%, 34% respectively with respect 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 with plant growth regulators such as GA_3 and Kn daily, the promotion were found in all these considered parameters as compared to the control.

Conclusion

As noted the promotory affects of the plant growth regulators (PGRs) was observed on the *Pisum sativum* as compared to the control. Kn (10^{-3}) & GA_3 ($1O^{-7}$) hormone concentrations were found to promote the stem growth of the *Pisum sativum* (Pea). This showed that the plant growth regulators caused significant change in the stem growth patterns of the *Pisum sativum* (pea).

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