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Effect of Plant Growth Promoters Application on Peas Germination and Growth

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Abstract

Indian economy is largely influenced by agriculture.The present work focuses on evaluation of Plant Growth Promoters (PGPs) and fungicides based products in plant growth and protection. Lab-scale experimental studies were conducted at Green Vision Life Sciences Pvt. Ltd., Pune, India during January to March 2018 to estimate germination rate (by defining physico-chemical parameters like water pH, seed quality, seed conductivity, hollow heart disease test, blotting test for germination, viability, Root growth (ANOVA analysis) and plant growth by using different application methods like drenching, root dipping and spraying. The degree of rooting and shooting were found to be associated with the applied PGPS type and concentration. Further the project envisages a comparative analysis of agricultural products containing PGPs, where ABI4- 0.1% and ABI4 NEW-0.1% (products with higher concentration of PGPs) showing 100% germination when compared with non-treated plant(control) for plant height, No. of leaves, root growth and grain weight, conductivity test, hollow heart test to calculate EEF (Expected Emergence Field). Results of this study indicates that the PGP_S and fungicides either commercially available (procured from market) or lab prepared widens the commercial prospects of PGP_S in more concentrations for increasing the agricultural productivity of other dicot plants thereby increasing the agricultural sector's input to India's GDP through sustainable agriculture methods (promoting biodiversity, minimizing loss of resources).

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Introduction

Pea (*Pisum sativum*) - a representative of the dicot variety; is an annual plant with a life cycle of one year. It is amongst the four important cultivated legumes next to soybean, groundnut, and beans[1]. It is predominant export crop in the world trade.

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According to FAO statistics, India is one of the largest producers of field pea in the world and stands at the 5th place in the list of major field pea producers next to France; contributing to around 7% of the total world produce. Share of peas in India's total pulses export jumped from 6.44% (2015-2016) to 6.53% (2016-2017) [Commodity Profile for Pulses-March, 2017]

It has been widely accepted that organic materials play important role in sustaining and improving soil structure, soil quality, soil function, soil health, soil fertility, and overall crop performance (growth and yield) in agricultural production. Use of organic materials in crop production offers numerous benefits to the agricultural development[2,3]. Investigating the performance of pea plant in soil treated with different organic materials could provide sustainable way of improving soil quality and high crop yield in agriculture[3]. Studies have been conducted to investigate the weekly performances of pea plant under compost soil condition (vermi-compost +Cocopeat) in 1:1 ratio,this base material used for present study is selected after screening various materials / combinations of soil and cocopeat. Objective of present study was to evaluate the performance of pea plant from germination period to maturity period under compost soil condition managed with agricultural products containing PGPs, on weekly basis where they are selected from commercially available technical grade chemicals and those prepared in the laboratory from naturally occurring raw material to evaluate the difference of activity between them.

The pea plant was selected for this experimental study as it has many visible contrasting characters such as tall/dwarf plants, round/wrinkled seeds, green/yellow pod, purple/white flowers, etc. and plants have a short life span and produce many seeds in one generation.

Plant naturally takes time for growth and development and use of PGPS provides nutrients for the soil microorganisms, thus increasing the activities of microbes in soil, which in turn helps to convert unavailable plant nutrients into available form for faster plant growth promotion.

Natural plant growth promoters (Phyto-hormones) are involved in urging and stimulating root and shoot growth whereas organic plant growth promoters (PGPS) including soil fertility and productivity of crop also helps in faster plant growth promotion and avoids grain diseases. With improved chemistry PGPs have multisite modes of actions without being in contact only on leaf surface and are absorbed by the leaves and other plant parts and move within the treated plant.

It also gets easily washed off from vegetables at the time of intake. Thus in the present study different organic plant growth promoters (PGPS) where used on physico-chemical parameters and growth rate study compared with non-treated plant to analyze its effect on plant growth.

Material and Methods

Land Preparation

The soils were prepared by mixing 50% (vermi compost) and 50% (Cocopeat) and were levelled manually for PGPS application at rate of 3kg/sq.

PGPs used are; GAT is Gibberellic acid, BAP is benzyl adenine; ABI4 is Indole-3-butylic acid. These technical grade chemicals are procured from market. GAIM1 BAP-NEW & ABI4 NEW are prepared in the laboratory from naturally occurring raw material where, 50% applied at the time of sowing and remaining 50% was top dressed at the rate of 25% for 25 days after sowing. After 35 days the organic fungicides were applied containing (DMSO), which helps in development and delivers improved seedling disease resistance.

Sowing and Plant Protection Practices

Sowing was done at 5cm equidistant intervals in each pot on 4th February 2018. PGPs were applied separately in respective concentrations, where GAT-BAP, 1.8% and GAIM1-BAP New, 1.8% were applied in 0.28ml/L,0.5ml/L and 1.0 ml/L Concentrations respectively in each specified pot and ABI4, 0.1% and ABI4 NEW, 0.1% were applied in 5ml/L, 10ml/L and 25ml/L concentrations.

Treatment Characters

Seed Quality

This test is carried out to ensure the genetic and physical purity, uniform growth and maturity, capacity to withstand adverse conditions and higher yield. The seeds (Pea) were manually tested for outer appearance to separate out the damaged seeds, according to reference[4].

Conductivity Test

In this process, 10 seeds (Pea) were soaked overnight in 500 ml flask containing 250 ml D/W respectively, and then subjected to conductivity test by dipping the electrode. Simultaneously, the reading of D/W (without soaked seeds) was also recorded, according to reference[5].

Hollow Heart Disease Test

The test is used to detect whether the seed has the potential for germination and high yield.The inner surface of one or both cotyledons (enclosed in the seed coat) showed a brown lesion of varying extent, sometimes accompanied by partial or entire necrosis of the plumule, it has been confirmed that the primary effect of manganese deficiency. The Seeds of pea were subjected to test for hollow heart disease according to reference[6,7].

Germination Test

The test is used to detect the viability of the seeds. Ten seeds of pea were placed on a moist blotting paper at 20^0C for 2 days and observed for germination preventing loss of moisture, and allowing diffusion of oxygen, which the seeds need when germinating and respiring[8]. The germination factor (G %) was determined, according to reference[8].

Moisture Content of Seeds

Ten seeds each of pea were weighed before drying. Later, the seeds were placed in Petri dish and dried in oven at 60^0C. Now the weights of the dried seeds were detected, using the formula according to reference[9].

Expected Emergence Field (EEF)

The percent seed emergence is influenced by many factors i.e. conductivity of seeds, germination of seeds and diseases of the Pea seeds using the following equation. The survival of germinated seeds to harvest can be calculated by measuring seed emergence formula to determine the EEF of the seeds[9].

Crop Management

Pisum sativum (peas) were sown in well manured pots with the PGPs. The PGPs were sprayed respectively in each specified pot after 30-35 days of sowing in above mentioned specific concentrations and the organic fungicide was applied in 2ml/10L concentration as drenching. Observations on growth and yield parameters and were recorded at maturity stage using standard procedures, all other agronomic and crop management aspects were followed as per the recommendations of Green vision life science industry.

Statistical Analysis

The experimental data of all parameters were observed and the subjected to statistical analysis as per method suggested by[10] to ANOVA (analysis of variance) at $P < 0.10$ level (F-table) as the null hypothesis was rejected under this P value, where F at 0.10 is 3.95.

Result and Discussion

Data in respect to seed germination and other tests are presented in Table1. Seed germination fastened with the increased concentration of growth promoters. Maximum and fast seed germination (100%) was recorded on ABI4, 0.1% and ABI4 NEW- 0.1% samples and others after 2 days of sowing. There was increased seed germination as compared to GAT-BAP, 1.8% and GAIM1-BAP New, 1.8% were applied in 0.28ml/L, 0.5ml/L and 1.0 ml/L which were comparatively in less concentration to ABI4 and ABI4, New-0.1% as shown in table1.

The significant increase in growth characters of pea might be due to combination of nutrients in soil base material and growth promoter foliar spray, which play a major role in growth development and metabolism of pea. The combined effect of these favors better translocation of assimilates to sink resulting in improvement in growth and yield parameters. Foliar application of PGRs might have enhanced the CO_2 fixation and induced activity of carbohydrates synthesizing enzymes which is analyzed by increase in number of pods per plant and number of seeds

per pod leading to balanced metabolism maintained continuously inside the plant for subsequent phases of growth[11].

The statistical analysis was done according to Fisher philosophy to get rough impression about significance of the finding and it was observed that at P < 0.10 level the F-value was less than the estimated F-value at 10% i.e. 3.95 (F-value table) of the sample treated plant compared to control plant. The overall growth rate was higher in treated plants with the ABI4, 0.1% and ABI4 NEW,0.1% samples than the control hence the alternate hypothesis is accepted.

Plant height and root length increased with the higher concentrations of ABI4, 0.1% and ABI4 NEW, 0.1%.The maximum mean increase in height is 32.8 cm in these concentrations whereas; the rate of increase in height was seen gradual growth in lower concentrations i.e. of ABI4, 0.1% and ABI4 NEW,0.1% samples.

The rate of growth was seen slow till 15 days and it was noteworthy during 30, 45, 60 days (Table 2) and thereafter, the growth gradually decreased. The increase in height may be due to its effect on elongation of internodes.

It is evident from table 2 that all the treatment and was effective to enhance the number of leaves per plant over control and samples ABI4, 0.1% (commercially prepared) and ABI4 NEW,0.1% (prepared in lab) were found significantly superior over all other treatments during 30,45 and 60 days. The numbers of branches were also influenced in same pattern as observed in case of leaves.

Significantly increase in the number of nodules during 30, 45,60 days in samples GAT-BAP 1.8% and ABI4 NEW,0.1% was seen compared to control plant. It is seen that nodules play important role in atmospheric N2 fixation by leguminous crops. Exogenous application of plant growth promoters were found to promote the nodules formation thus helping crops to tend higher yield by supplying nitrogen during seed development stage.

Table 1: The Effect of Plant growth promoters on Germination and other parameters

Treatments Sample code	Conc. (mg/L)	Germination% (avg. 4th day)	Conductivity% ($\mu Scm^{-1}g^{-1}$)	Hollow heart %	Moisture %	EEF
GAT-BAP, 1.8%	0.28mL/L	100%	25.8	5%	70%	27.32
	0.5mL/L	100%	25.8	5%	70%	27.32
	1mL/L	100%	25.8	5%	70%	27.32
GAIM1-BAP New,	0.28mL/L	100%	25.8	5%	70%	27.32
1.8%	0.5mL/L	100%	25.8	5%	70%	27.32
	1mL/L	100%	25.8	5%	70%	27.32
ABI4, 0.1%	5mL/L	100%	25.8	5%	70%	27.32
	10mL/L	100%	25.8	5%	70%	27.32
	25mL/L	100%	25.8	5%	70%	27.32
ABI4 NEW,0.1%	5mL/L	100%	25.8	5%	70%	27.32
	10mL/L	100%	25.8	5%	70%	27.32
	25mL/L	100%	25.8	5%	70%	27.32
CONTROL	-	75%	25.8	5%	70%	27.07
	-	75%	25.8	5%	70%	27.07
	-	75%	25.8	5%	70%	27.07

Table 2: The Effect of Plant growth promoters on morphological-physiological parameters of Pea

Growth Regulators (mIL^{-1})	Plant Height (cm)			No. of branches			No. of leaves			Root length (cm)			No. of Nodules			No. of seeds/ plant
	30	45	60	30	45	60	30	45	60 DAYS	30	45	60	30	45	60	90
GAT-BAP, 1.8%																
0.28mL/L	25	32	39	2	6	7	15	28	35	18	26	31	7	19	25	48
0.5mL/L	20	29	37	2	5	6	14	26	33	17	24	30	6	20	24	46
1mL/L	27	34	40	3	6	7	16	28	37	20	26	36	8	22	28	50
ABI4, 0.1%																
5mL/L	28	35	42	3	6	8	14	32	40	19	26	33	7	18	22	48
10mL/L	27	38	45	2	6	7	15	33	42	18	26	34	8	19	25	50
25mL/L	25	34	40	4	6	10	17	34	44	23	31	38	8	20	26	56
GAIM1-BAP New, 1.8%																
0.28mL/L	29	36	43	3	6	8	18	34	42	20	32	38	6	18	20	53
0.5mL/L	26	30	35	3	6	7	14	24	33	18	27	31	6	19	23	48
1mL/L	24	33	39	2	6	7	15	27	34	17	28	32	7	19	26	55
ABI4 NEW,0.1%																
5mL/L	25	31	38	3	6	7	14	26	33	20	29	32	6	19	24	45
10mL/L	27	36	41	3	5	8	15	26	33	21	26	33	7	21	26	53
25mL/L	26	32	40	4	8	10	17	28	35	28	36	41	8	22	27	58
CONTROL	16	23	30	3	6	7	14	24	30	15	23	30	6	15	20	47
ANOVA (P<0.10) where F at 0.10 is 3.95	2.00	2.00	1.99	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

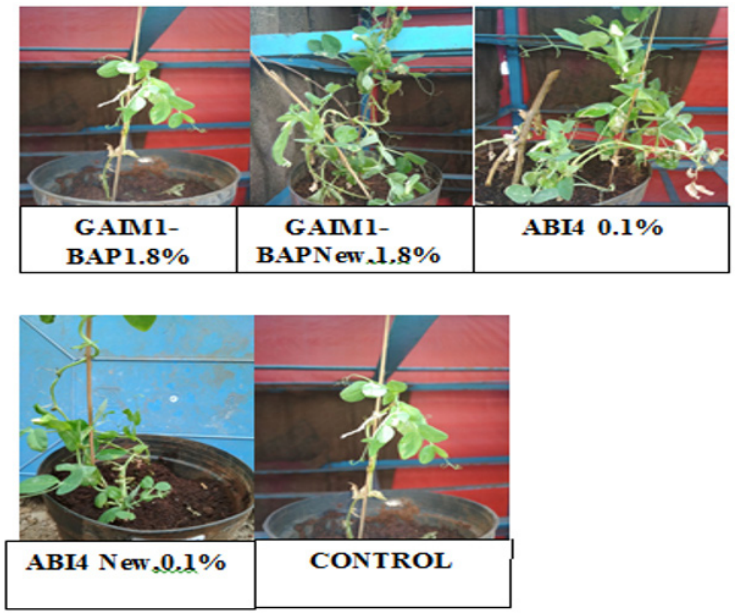

Fig. 1: The Effect of Plant growth promoters on morphological-physiological parameters of Pea plant

Conclusion

Conclusions drawn from this study are that the higher concentrations of the samples show better growth on plant morphological-physiological parameters on application of recommended doses, enriches compost soil, stimulates cell division, increases post-harvest life of the green vegetables as seen in ABI4 New, 0.1%, although GAIM1-BAP New, 1.8% and ABI4 NEW,0.1% were prepared in lab with naturally occurring components, the growth was seen better in ABI4 NEW,0.1% than GAIM1-BAP New, 1.8% it is because the concentration of sample prepared varied and showed more growth in higher concentration. Similarly in commercially available technical grade chemicals which are procured from market i.e. ABI4, 0.1% and GAT-BAP, 1.8% the ABI4, 0.1% with more concentration showed better results.

Growth and productivity of plants depend on types of plants growth regulators used with suitable method and concentration as proved by the experiment having commercially and natural PGPs. The environmental factors also plays important role in the growth and optimization of plants. In the present research, it was found that the application of plant growth promoters at higher concentration (commercial/ lab prepared) through foliar spray method gave the optimum growth for *Pisum sativum*. Inthe overall costing of the project, PGPs (prepared in lab and commercially procured products) set was compared with costs of control plants. It was observed that the experimental plant setup of plant growth promoter treatments required maximum cost of organic sources of nutrients than the control plant setup. Hence the yield of plant's growth (leaves, roots, nodules, fruits) was seen more in PGPs applied plants than the control plant (Table 2).

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