PHYSIOLOGY AND BIO – CHEMISTRY OF GERMINATION OF DIFFERENT TYPES OF SEEDS – IV – EFFECT OF CERTAIN CHEMICALS ON GROWTH AND DEVELOPMENT OF CUCUMBER, MUNGO, PADDY, RADDISH AND TOMATO PLANTS

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ABSTRACT: The effect of 100 ppm solution of each of kinetin, adenine, uracil and thymine on the vegetative and reproductive growth of Cucumis sativus, phaseolus mungo, Oryza sativus, Raphanus sativus and Lycopersicum esculentum plants were studied. The rate of vegetative growth was found to be more in the Cucumis sativus, Raphanus sativus and Lycopersicum esculentum plants treated with all the chemicals mentioned above over that of the controls. Phaseolus mungo and Oryza sativa plants shows almost the same growth rate with that of the control plants. So far the reproductive phase is concerned, measured as the size of fruit and number of fruit and seed, Cucumis sativus plants produced about same number of fruits in all the treatments but fruit size varied greatly along with the number of seeds in kinetin and adenine treated plants.

INTRODUCTION

Growth and development of a plant are influenced by a number of environmental factors: Light, water and nutrient availability, gas composition of the atmosphere and temperature etc. From seed germination to seed maturity a chain of different events occur – germination, seedling emergence, anthesis, pollination, fertilization and seed development. Under a particular set of environmental conditions a certain time is necessary for the completion of these stages of development.

The pattern of development during vegetative growth is influenced by a variety of internal and external factors, like genetical nutritional, environmental and hormonal. The inter-play among these various factors and their effect on growth and differentiation are complex.

During plant development, growth and differentiation result in an orderly appearance and formation of tissues and organ systems – roots, leaves, stems, flowers so that each plant acquires a distinctive appearance. Growth substances, metabolities, inorganic ions etc. are involved in some instances and temperature or light etc. apparently functions as other factors.

Auxins, gibberellins seen to play a normal role in causing the elongation of stem, perhaps of roots, leaves and flowers of most
higher plants (Boissya 1969). Indole-3-acetic acid is an auxin that occurs naturally in plants. Auxin and giberellins generally increase the length of cells (Witer and Bukovac 1956, Braian 1957) rather than an increased number of cells, where-as kinetin brings about cytokinesis (Guttmann 1956). There are considerable differences among response to the various kinds of giberellins. One giberellins may be active in causing a particular response where – as another may be much less effective.

Gibberellic acid, IAA and kinetin etc. are capable of influencing a variety of growth process in plants (Boissya 1976, 1978). The growth effect of IAA and GA₃ vary from plant to plant and from organ to organ in the same plant (Boissya and Sarma 1974, 1977).

In the previous reports the authors studied the effect of light and different chemicals on the germination of certain types of seeds (Majumdar and Boissya 1979 a, b, 1980).

Although certain external manifestations in plants in response to some of the chemicals are known today, yet in view of their differences in the behaviour in different plant species, it was proposed to study the effect of kinetin, adenine, uracil and thymine on the vegetative and reproductive growth of Cucumber, Mungo, Paddy, Radish and Tomato plants.

**MATERIALS AND METHODS**

Seeds of Cucumber (Cucumis sativus var long), Mungo (Phaseolus mungo var chatali), Paddy (Oryza sativa var konijoha,) Radish (Raphanus sativus var longscarlet) and Tomato (Lycopersicum – esculentum var marglobe) were collected from the seed Corporation of Assam, Gauhati.

Different chemicals viz. kinetin, adenine, uracil an thymine were collected from commercial sources. 100 ppm of each of the solutions was used in the experiments. Samples of seeds were soaked in distilled water (control) and in 100 ppm solution of each of the different chemicals for 6 hours. After 6 hours of soaking the treated seeds were thoroughly washed with distilled water and were put in clay pots containing previously prepared soil mixture (clay soil, fine sand and cow-dung in 1 : 1 : 1 proportion). 3 replicate samples were used for each treatments. The following growth parameters were studied – leaf number, branch number, number of flowers, fruits and seeds etc. along with other morphological characters.

The average growth rate of the different plants is presented in figures 1 to 5. The number of leaves, flowers, fruits and seeds are analyzed statistically over that of the control to study whether the obtained results are statistically significant. Statistical analyses are presented in tables 1 to 5.
**TABLE – I**

Table showing statistical analysis on the effect of kinetin, adenine, uracil and thymine on the production of leaves, male and female flowers, fruits and seeds in *cucumis sativus* plant.

| Treatments | Leaves | Male Flowers | Female Flowers | Fruits | Seeds |
|------------|--------|--------------|----------------|--------|-------|
| Kinetin    | 4      | 3.65         | 6.15           | 2.09   | 17.37 |
|            | **     | **           | **             | **     | **    |
| Adenine    | 4.82   | 12.08        | 6.15           | 2.09   | 1.67  |
|            | **     | **           | **             | **     | **    |
| Uracil     | 3      | 6.5          | Zero           | Zero   | Zero  |
|            | **     | **           |                |        |       |
| Thymine    | 3.8    | 6.73         | 3.19           | Zero   | 2.26  |
|            | **     | **           | **             | **     |       |

** Highly significant,  
* Significant at 5% level only.

**TABLE – II**

Table showing statistical analysis on the effect of kinetin, adenine, uracil and thymine on the production of leaves, flowers fruits and seeds in *phaseolus mungo* plant.

| Treatments | Leaves | Flowers | Fruits | Seeds |
|------------|--------|---------|--------|-------|
| Kinetin    | .71    | .41     | 1      | 3.18  |
|            |        |         |        | **    |
| Adenine    | .47    | .61     | 1.2    | 2.21  |
|            |        |         |        | *     |
| Uracil     | .47    | .41     | 1.6    | 1.99  |
|            |        |         |        | *     |
| Thymine    | .23    | 1.03    | 1.8    | 1.85  |

** Highly significant,  
* Significant at 5% level only.
**TABLE – III**

Table showing statistical analysis on the effect of kinetin, adenine, uracil and thymine on the production of spikelets and caryopsis in *Oryza sativa* plant.

| Treatments | Spikelets | Caryopsis |
|------------|-----------|-----------|
| Kinetin    | 3.41      | 4.18      |
|            | **        | **        |
| Adenine    | 2.43      | 3.41      |
|            | *         | **        |
| Uracil     | 1.31      | 2.07      |
|            |           | *         |
| Thymine    | 1.63      | 2.49      |
|            |           | *         |

* ** Highly significant, * Significant at 5% level only.

**TABLE – IV**

Table showing statistical analysis on the effect of kinetin, adenine, uracil and thymine on the production of leaves, flowers fruits and seeds in *Raphanus sativus* plant.

| Treatments | Leaves | Flowers | Fruits | Seeds |
|------------|--------|---------|--------|-------|
| Kinetin    | 1.9    | 1.62    | 2.04   | 18.07 |
|            |        |         | *      | **    |
| Adenine    | 2.55   | 4.45    | 3.07   | 17.01 |
|            | *      | **      | **     | **    |
| Uracil     | 2.12   | 2.64    | 2.19   | 18.87 |
|            | *      | **      | *      | **    |
| Thymine    | 1.9    | 4.01    | 2.81   | 17.55 |
|            | **     | **      | **     | **    |

* ** Highly significant, * Significant at 5% level only.
TABLE – V

Table showing statistical analysis on the effect of kinetin, adenine, uracil and thymine on the production of leaves, flowers fruits and seeds in *Lycopersicum esculentum* plant.

| Treatments | Leaves | Flowers | Fruits | Seeds |
|------------|--------|---------|--------|-------|
| Kinetin    | .87    | .81     | 24.46  | 1.18  |
| Adenine    | .65    | .41     | 24.46  | 1.47  |
| Uracil     | .44    | .81     | 23.53  | 1.09  |
| Thymine    | .65    | 1.68    | 24.46  | 1.22  |

** Highly significant, * Significant at 5% level only.

**Results and Discussion**

From the results, it is seen that the growth rate of Cucumber plant seem to be highest in adenine treated seeds and lowest in case of kinetin treated seed. Uracil and thymine treated seeds show almost similar but intermediate growth rates (Figure – 1). As regard to the production of leaves, flowers, fruits and seeds, the treated plants are highly significant almost in all cases (Table – 1), but in adenine treated plant the production of seeds is not significant over that of the control and it is significant only at 5% level in thymine alone. The production of female flowers and fruits in uracil treated plant are similar with that of the control ones. In the case of fruit production the control and thymine treated plants show almost similar results.

From the growth rate of Mungo plant presented in figure – 2, it is seen that control plant shows the highest growth rate and kinetin treated plant the lowest. Adenine, Uracil and thymine treated plants are intermediate between the control and kinetin treated plants.

In the case of Mungo plants the production of seeds in kinetin treated plant are highly significant statistically and it is only significant at 5% level in case of adenine and uracil treated plants. The statistical analysis on the production of leaves, flowers and fruits over the control shows that in all the cases it is below the level of significance (Table – 2).

So far as the height of the paddy plant is concerned, it is seen that there is no significant difference between the treated and the control plants. However, the growth rate is maximum in the control and minimum in the thymine treated plants. The
plant given other treatment show almost similar growth ie height with that of the control (Figure – 3).

Statistical analysis presented in Table – 3, shows that spikelets and caryopsis formation in paddy plant are highly significant in kinetin treated plant, Adenine treated plant show high significance so far as production of caryopsis is concerned, whereas, in regard to spikelet production it is significant at 5% level only. The uracil and thymine treated plants show significance at 5% level only so far as caryopsis production is concerned and do not show any significance in case of spikelet formation.

The results presented in regard to the development of the inflorescence axis, adenine treated Radish plant shows the maximum growth rate which is followed by thymine, uracil and kinetin treated ones respectively. The control plants show the minimum growth rate (Figure – 4).

In case of radish the production of seeds is highly significant in all the treated plants where as fruit production is highly significant only in case of adenine and thymine treated ones. It is significant at 5% level in plants treated with kinetin and uracil. The flower production is highly significant in all the treated plants except in case of kinetin where it is not significant. Formation of leaves is not at all significant in case of kinetin and thymine treated plants but it is significant at 5% level only in adenine and uracil treated plants (Table – 4).

Tomato plants show the maximum height when treated with kinetin. The other plants treated with thymine, adenine and uracil do not seem to have any effective increase in height (Figure 5).

In regard to the production of leaves, flowers and seeds the statistical analysis of the treated plants shows that in all cases the developments are not statistically significant but in regard to the production of fruits, it is high significant in all the treated plants (Table – 5).

From a scrutiny of the results it is seen that except for Tomato and Radish (inflorescence axis) kinetin inhibited growth of Cucumber, Mungo and Paddy plant. Kinetin was shown to cause elongation of coleoptiles tissue in darkness (Shrank 1957, Wheeler 1959) but inhibited elongation of pea stem tissue in darkness (Wheeler 1959) and in light (Brain and Hemming 1957).

From the foregoing reports and the results obtained in the experiments it is clear that kinetin act differently in regard to growth in height in various conditions and in relation to different plants. As in the present experiments only the seeds are given 6 hours soaking treatment, the variation expected are more than when expected in organs where it is applied locally. The other chemicals viz adenine, uracil and thymine have also similar variation in growth in regard to different plant species. These variation in height in the different plants may be attributed to similar explanations as has been put forth in the case of kinetin.

It is interesting to note that almost all the used chemicals enhanced the number of leaves, male and female flower, fruits and seeds in Cucumber, Paddy and Radish plants, whereas the chemicals are effective only in enhancing number of fruits in Tomato plants. Kinetin, adenine and uracil are effective in respect of increasing number of seeds in Mungo plant. Excepting for this effect the chemicals are not effective on mungo plant.
The importance of RNA on protein synthesis has been demonstrated by Heys (1959, 1960) and Chantrenne (1961). Boissya (1969, 1976, 1978) has demonstrated that kinetin helps in the retention of protein and RNA, and production of new protein and RNA. The results of the present experiments viz enhancement of leaf, flower, fruit and seed production particularly in cucumber, paddy and radish plants may possibly be attributed to retention and new synthesis of RNA and protein in these plants. Further, it is more possible as adenine, uracil and thymine are nucleic acid derivatives. But as the soaking treatment has done only in the seeds and that too for 6 hours only and the effect is long lasting (90 – 120) days. It is therefore very probable that these chemicals trigger some master reaction, may be in the molecular level, in the soaking seeds which in turn control future life processes of these plants. But as the effect are not identical in the case of mungo and tomato a generalization is, however, not possible. These differences in the effect of the used chemicals may, however, be attributed to the inherent differences in the physiology and biochemistry of the used seeds and subsequent plants raised there from. Therefore, more research at the physiological and biochemical level are needed to establish a generalized view in this respect.

The work is being continued to substantiate the finding with more physiological and biochemical information’s.
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