SUMMARY

In the present study the growth of black cumin *Nigella. sativa* L plant were studied using certain elements (i.e. Boron, sulphur and potassium) and some the growth regulators (i.e. Naphthalene acetic acid, Benzyl adenine and paclobutrazal) as separated treatments as well as some of their combination. Therefore, experiments were included, laboratory experiments for studying germination aspects under different applied treatments. Also, pot experiments for studying vegetative and reproductive growths as well as hormonal and anatomical studies. Besides, field experiments for yield determination specially its economic part (i.e. seeds and oil yields) as well as some of their chemical bioconstituents.

Experiments were carried out in the experimental form of Agric. |Bot. Department Faculty of Agric. Moshtohor for pot experiments yet, uere in the vegetable production station, Dept. of Horticultre sci . during 2003 and 2004 successive seasons.

The following treatments were applied in different assigned testaments:

The applied treatments: (Seeds soaking) :

A- Separately treatments:

1- in elements:

- Boron (B) at 50 ppm (in form of Boric acid).
- Boron (B) at 250 ppm (in form of Boric acid).

- Sulphur (S) at 50 ppm (in Microphet form 80% (S) water soluble).
- Sulphur (S) at 250 ppm (in Microphet form 80% (S) water soluble).
- Potassium (K) at 100 ppm (in form of chelated potassium citrate 48% K).
- Potassium (K) at 500 ppm (in form of chelated potassium citrate 48% K).

2- In the assigned growth regulators:

- Benzyladenine (BA) at 5 ppm.
- Benyladenine (BA) at 25 ppm.
- Naphthalene acetic acid (NAA) at 10 ppm.
- Naphthalene acetic acid (NAA) at 50 ppm.
- Paclobutrazol (PP_{333}) at 1 ppm.

B- Combination treatment :

1- Mixture of Boron (B)+ Sulphur (S) at 50 ppm for each.

2- Benzyladenine (BA) at 5 ppm+ (B + S at 50 ppm for each).

3- Naphthalene acetic acid (NAA) at 10 ppm + (B + S at 50 ppm for each).

4- Paclobutrazol (pp_{333}) at ppm + (B + S at 50 ppm for each).

5- BA at 5 ppm + NAA at 10 pm. + (B + S at 50 ppm for each).

6- Soaking in water as control.

I – laboratory experiments (Germination process):

1- The lowest concentration of each treatment gave a 100% of germination, mean while the highest concentration of each treatment gave less germination percentage when compared with the lowest concentration. Despite of that, the highest concentration of each treatment still higher more than the control.

2- The treatment of paclobutrazol at one part per million combined with born and sulphur at 50 ppm for each; also decreased germination percentage less than control treatment but still more than the paclobutrozol alone.

3- The combined treatments of BA at 5 ppm + (B+S each at 50 ppm), NAA at 10 ppm + (B+S each at 50 ppm) and BA at 5ppm + NAA at 10 ppm + (B+S each at 50 ppm) each of them gave a 100% of germination.

II- Pot experiments

II.1. Seedling emergence:

a- The most of applied treatments hastened seedlings emergence of *Nigella setiva*.

b- The only exception of seedling emergence was that retardation existed with poclubutrazol at 1 ppm. Mean while, the combination of PP_{333} with (B +S each at 50 ppm) minimized that retardation to reach nearly one third of paclubutrazol when applied separately.

c- Different applied treatments shortened the number of days required till first seedling appearance when related to the

control. The only exception was that PP_{333} at one ppm that gave a retardation comparing with control yet, sulphur at 50 and 250 ppm, K at 100 and 500 ppm, BA at 5 and 25 ppm, NAA at 10, 50 ppm, B + S at 50 ppm for each as well as their combination with BA and NAA at 10 ppm + (B +S each at 50 ppm) were the more pronounced treatments for hastening of first seedling appearance.

d- The all applied treatments increased percentage of speed germination. The only exception was that slight reduction (5%) with PP_{333} at 1 ppm.

II.2.1. Root growth

II.2.1. Root length:

a- All the applied treatments showed an inhibition of root growth at 66 days of plant age (i.e first sample) that reached to the level of significance in most cases two seasons.

b- All the second sample (176 days after sowing), treatments of BA at the two applied concentrations, NAA at 50 ppm; (B+S at 50 ppm for each); BA at 5 ppm + (B+S each at 50 ppm); NAA at 10 ppm + (B+S each at 50 ppm) increased the root length of treated plants during the two seasons.

II.2.2. Root diameter

a- In the first sample during the two seasons: root diameter significantly was increased or decreased or did not show any effect in comparison with the control.

b- At the second sample benzyladenine alone or in combination with boron and sulphur showed significant increase (the

highest increase) of this diameter. Also, during the two seasons root diameter significantly increased with the most of applied treatments. Since, each of pp_{333} at 1 ppm alone or when combined with (B+S each at 50 ppm) as well as BA at 5 ppm combined with NAA at 10 ppm + (B+ S each at 50 ppm) significantly increased this diameter.

II.2. 3. Root size:

1- In most cases different applied treatments significantly increased the root size of treated plants in comparison with the control, since the highest significant increase was that of BA at 5 ppm + (B + S each at 50 ppm) in 2003 season and with pp_{333} at 1ppm + (B + S each at 50 ppm) in 2004 season.

II.3. Shoot measurements:

II.3.1. Plant height

a- The treatments of BA and NAA each combined with B and S as well as NAA alone at 50 ppm exhibited the greatest plant height at the second sample during 2003 season. Meanwhile the maximum plant height at the second sample existed with BA at 5 ppm and NAA at 10 ppm each combined with B and S each at 50 ppm.

II.3.2. Stem diameter

It's more obvious that BA as exogenously applied or its endogenously stimulation by the exogenous application of pp_{333} gave highest increase of stem diameter.

II.3.3. Number of leaves:

a- During the first sample this number did not show clear effect, mean while, at the second sample, significant increases during the two seasons existed expecially in case of combined treatments.

b- Also, BA at 10 ppm combined with B+S (each at 50 ppm) were superior in this respect.

II.3.4. Number of branches:

a- Different applied treatments at the harvest time increased this number to reach the high level of significance.

b- Also, the summation of branches height / plant was behaved as the same as their number.

II. 4.1 Leaves characteristics:

a- For number of leaves of leaves, the all applied treatments increased this number to reach the level of significance especially in the second season.

b- For the total leaf area it was significantly increased during the two seasons to reach its maximum with BA at 5 ppm + (B + S each at 50 ppm).

II.4.2 Absolute growth rate (AGR):

The treatment of NAA at 25 ppm significantly increased this trait meanwhile other treatments insignificantly increased it or even it was significantly decreased.

II.4.3 Net assimilation rate (NAR):

Different applied treatments gave variant results during the two seasons. Yet. pp_{333} gave the highest increase of this rate.

II.4.4. Photosynthetic pigments:

a- Chlorophylls a + b was increased in most cases of the applied treatments.

b- Meanwhile it was decreased with S at 250 ppm, K at 500 ppm, NAA at 10 ppm, pp_{333} at 1 ppm, B + S (each at 50 ppm) and NAA at 10 ppm + (B + S each at 50 ppm) during the two seasons.

II.5. Histological study:

a- Different applied treatments highly increased root diameter to reach its maximum with BA treatments and K at 100ppm.

b- Increase of root diameter was mainly due to that increase in each of cortex and vascular tissues.

c- Also, different treatments increased stem diameter to reach its maximum with BA at 5ppm + NAA at 10 ppm + (B + S each at 50 ppm) followed by PP_{333} at 1ppm.

d- Increase of stem diameter was mainly due to the increase of stem wall thickness not to the diameter of hollow pith.

II.6. Phytohormones determination:

i- The treatments of BA at 25 ppm, pp_{333} at 1ppm and NAA at 50 ppm increased the endogenous content of auxin in roots with more than two, three and nine times comparing with control roots. But this content was decreased with BA at 5 ppm + (B +S each at 50 ppm).

ii- In shoots: endogenous auxin highly was increased with pp_{333} at 1 ppm and NAA at 50 ppm, yet it was decreased with BA either separately or in combination.

iii- The endogenous gibberellic acid (GA_3) the only BA at 25 ppm gave a detectable amounts in roots, yet, the rest of treatments either in roots or in shoots did not give any detectable amount of this hormone.

iv- Meanwhile, in ease of endogenous cytokinins it was decreased with different assigned treatments in shoots, yet, it was decreased in roots with exogenous applications of BA.

11.7. Flowering:

a. Number of days required for first flower anthesis is being shortened with one, two or three days when compared with control. The only exception was that increasing of these days by only one day in case of pp_{333} at 1ppm and the combination of (B+ S at 50 ppm for each), as well as with two days in case of BA at 5 ppm + (B+S at 50 ppm for each).

b. Reduction in days number reached about seven days in K at 500 ppm, BA at 5ppm and 25 ppm, meanwhile it was seventeen days in control.

II. 8. Fruiting:

II. 8. 1. Fruit setting:

- NAA at 10 ppm and BA at 5 ppm combined with each of boron and sulphur 50 ppm for each were the most effective treatments for shortening that time required for first fruit setting than the control.

II.8.2. Fruits number

- BA at 5 ppm, NAA at 10 ppm and pp_{333} at 1 ppm each combined with B + S (each at 50 ppm) gave highest significant increased of fruit number and their dry weight. Also, B at 50 ppm and pp_{333} at 1 ppm (each alone) gave high significant.

II.8.3. Biological, economical yields and the harvest index

- The treatment of BA at 5 ppm + (B + S each at 50 ppm) exhibited the highest biological and economical yields (i.e. weight of dry seeds).

III- Field experiments:

1- Number of capsules / plant:

The only treatment of NAA at 50 ppm in the two seasons decreased this number, meanwhile, 250 ppm B, 50 and 250ppms and 100 & 500 ppm K either had no effect or in significantly increased it, yet, the rest of treatments showed its high significant increase.

2- Weight of intact capsule:

Clearly it could be noticed that different treatments increased this parameter to reach its maximum with BA at 5 ppm in 2003 season and at 25 ppm in 2004 season.

3- Weight of seeds/ capsule:

As in case of intact capsule weight; the weight of seeds per capsule was also significant increased with different treatments.

Fruit characteristics:

1- Different treatments in the two seasons significantly increased the weight of intact capsule to reach its maximum with BA at 25 ppm (0.600 & 0.680 gm/capsule in the two seasons, respectively).

2- For the seeds number per capsule it behaved as the same as the weight of intact capsule.

3- Seeds weight per capsule behaved as the same as each of weight of intact capsule and seeds number as well- thereby, the weight of empty capsule was less than the control in most cases.

4- Also, the weight of 100 seeds in different treatments increased this weight to reach either the 5% or even 1% levels of significance.

Capsule measurements:

1- Capsule diameter was increased to reach the high level of significance especially with BA at 5 ppm, pp_{333} at 1 ppm, B + S at 50 ppm for each and with pp_{333} + (B + S at 50 ppm for each).

2- Also, for capsule length different treatments showed variant capsule lengths.

3- As for the capsule size it was significantly increased with BA at 5 and 25 ppm; 25 ppm BA + (B + S each at 50 ppm); 1 ppm pp_{333} + (B + S each at 50 ppm) and 5 ppm BA + 10 ppm NAA + (B + S each at 50 ppm).

4- Some applied treatments increased the locul number such as 5 ppm BA + 50 ppm B + S for each.

Essential (volatile) and fixed oils:

1- Different treatments increased each of essential and fixed oils when compared with the control.

2- Also, 5ppm BA gave the highest increase of both oils (1.43 and 34.9% for volatile and fixed, respectively). Also, nearly the same content was obtained with each of BA at 25 ppm, pp_{333} at 1ppm, (B + S) 50 ppm for each.

Chemical analysis:

1- As for nitrogen it was increased in shoots with different treatments, so, the crude protein also increase in shoots.

2- Also, phosphorus and potassium were in most cases increased in shoots.

3- With regard to NPK content in black cumin defatted seeds different treatments increased the percentage of each of these elements.

4- As for carbohydrates content it was reversely behaved with the oil content.

CONCLUSION

All experiments revealed that soaking Nigella seeds with different applied treatments increased seed yield and seed components (oils) due to improved root, shoot and reproductive growths of *Nigella sativa* L. Also, benzyladinine at the two concentrations, paclubutrazol as separately or in combination with mixture of boron & sulphur each at 50 ppm and the mixture of benzyladinine at the lowest concentration + the lowest concentration of Naphthalin acetic acid + the mixture of boron + sulphur (each at 50 ppm) were the best applied treatments that reached the high yield.