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INFLUENCE OF DIFFERENT RELATIVE ORIENTATION OF STATIC AND AKTERNATIVE MAGNETIC FIELDS AND CRESS ROOTS ON THEIR GRAVITROPIC REACTION

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The following variants of roots location relatively to static and alternative components of magnetic field were studied. At first variant the static magnetic field was directed parallel to the gravitation vector, the alternative magnetic field was directed perpendicular to static one; roots were directed perpendicular to both two fields' components and gravitation vector. At the variant the negative gravitropysm for cress roots was observed. At second variant the static magnetic field was directed parallel to the gravitation vector, the alternative magnetic field was directed perpendicular to static one; roots were directed parallel to alternative magnetic field. At third variant the alternative magnetic field was directed parallel to the gravitation vector, the static magnetic field was directed perpendicular to the gravitation vector, roots were directed perpendicular to both two fields components and gravitation vector; At forth variant the alternative magnetic field was directed parallel to the gravitation vector, the static magnetic field was directed perpendicular to the gravitation vector, roots were directed parallel to static magnetic field. In all cases studied the alternative magnetic field frequency was equal to Ca ions cyclotron frequency. In 2, 3 and 4 variants gravitropism was positive. But the gravitropic reaction speeds were different. In second and forth variants the gravitropic reaction speed in error limits coincided with the gravitropic reaction speed under Earth's conditions. At third variant the gravitropic reaction speed was slowed essentially.
Keywords: static magnetic field, alternative magnetic field, gravitropic reaction, roots direction, cyclotron frequency.

INTRODUCTION

The investigation of combined magnetic field (CMF, static and parallel to it alternative magnetic field) influence on the plants roots gravitropic reaction was studied in details before [1]. The roots in the experiments were located by the following way:

1. CMF was parallel to the gravitation vector; the roots were located perpendicular to gravitation vector and CMF vector;
2. CMF was perpendicular to the gravitation vector and roots were located perpendicular to CMF and gravitation vectors;
3. CMF was perpendicular to the gravitation vector and roots were located parallel to CMF.

It was found that roots gravitropic reaction was negative at first case and it was slowed essentially in the second one. At third case it was usual.

The hypothesis of CMF and SMF (static magnetic field) action was proposed in [1]. To confirm or throw away the hypothesis the experiments with different relative orientation of static and alternative magnetic fields and gravitation force and roots were fulfilled.

In the work the following variants of roots location relatively to static and alternative components of magnetic field were studied.

- At first variant the static magnetic field was directed parallel to the gravitation vector, the alternative magnetic field was directed perpendicular to static one, roots were directed perpendicular to both two fields components and gravitation vector;
- At second variant the static magnetic field was directed parallel to the gravitation vector, the alternative magnetic field was directed perpendicular to static one, roots were directed parallel to alternative magnetic field;
- At third variant the alternative magnetic field was directed parallel to the gravitation vector, the static magnetic field was directed perpendicular to the gravitation vector, roots were directed perpendicular to both two fields components and gravitation vector;
- At fourth variant the alternative magnetic field was directed parallel to the gravitation vector, the static magnetic field was directed perpendicular to the gravitation vector, roots were directed parallel to static magnetic field;
- In all cases studied the alternative magnetic field frequency was equal to Ca ions cyclotron frequency.

MATERIALS AND METHODS

The materials and methods of the investigation were described before [2, 3].

The only distinction is the possibility to obtain perpendicular magnetic fields (static and alternative ones)/. For this purpose we added a new solenoid 10 to our setting. (See fig.1).

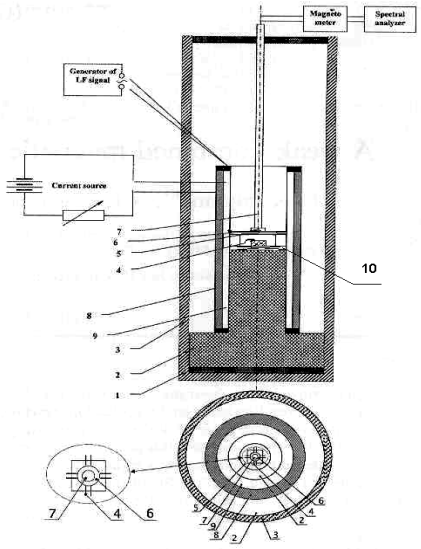


Fig.1. The damping rubber (1) supported the holder of dielectric material (2). The μ-metal shield (3) surrounded the samples (4) that were mounted inside a moist chamber of non-magnetic plastic material (5) and solenoids (8, 9). The magnetic field was measured and controlled by sensor elements (fluxgate magnetometer or SQUID), (6) inside a holder

(7). The solenoids (8, 9, 10) have a cylindrical shape and comprise the system that generates the static magnetic field (9). The enlarged central part of the top view shows the orientation of 4 pairs of roots (4), arranged around the magnetic field sensor (7). The coils of solenoids (8, 9) are the spaces between the circles in the bottom part. The space between the innermost circles is the holder of dielectric material (2).

RESULTS AND DISCUSSION

First variant.

Fig. 2. The cress roots after 0.5 and 1 hour treatment in the field B_{DC}=40 μT, B_{AC}=74 μT, f=32 Hz

Second variant.

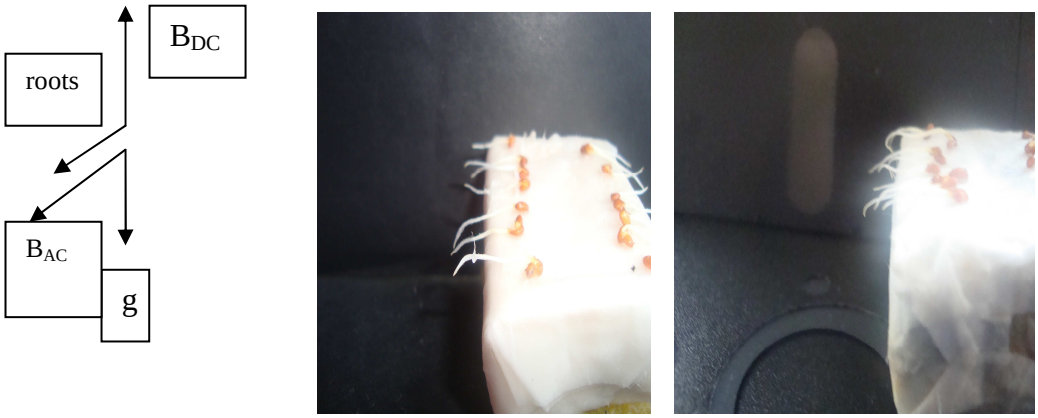
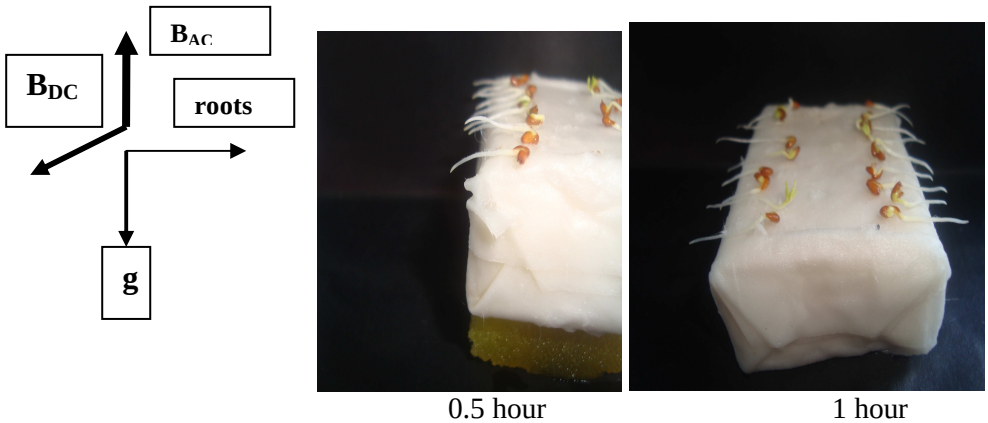


Fig.3. The cress roots after 0.5 and 1 hour treatment in the field B_{DC} =40 μT, B_{AC} =74 μT , f=32 Hz

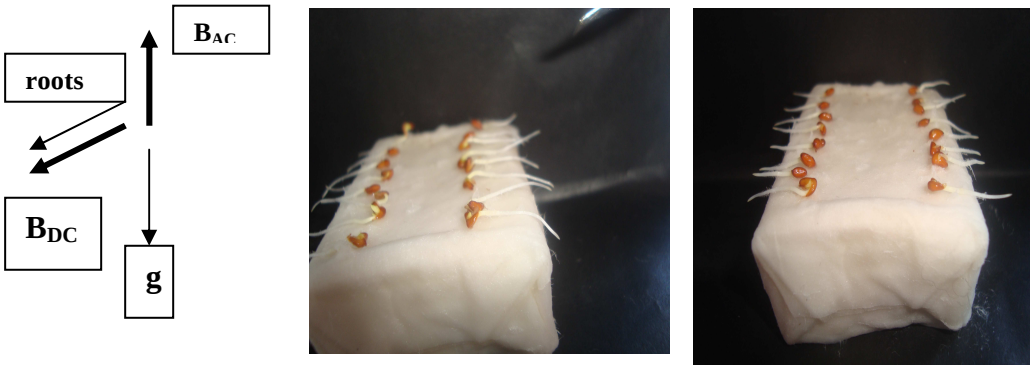
Third variant



0.5 hour 1 hour

Fig.4. The cress roots after 0.5 and 1 hour treatment in the field B_{DC} =40 μT, B_{AC} = =74 μT , f=32 Hz.

Forth variant.



0/5 hour 1 hour

Fig.5 The cress roots after 0.5 and 1 hour treatment in the field B_{DC} =40 μT, B_{AC} = =74 μT , f=32 Hz.

It was shown that the roots direction relatively B_{DC} and B_{AC} are essential for negative gravitropic reaction and decreasing of gravitropic reaction observation. The effect we obtained may be explained by our theory based on Liboff's hypothesis (the electric field was taken in consideration) and ours previous work. The breathing of the membrane is important only in the cases when the ions direction of moving is not parallel either for B_{DC} or B_{AC} .

We have to notice that while the gravitropic reaction is absent the roots become thicker. The effect may be connected with water detained in roots.

CONCLUSIONS

1. The direction of roots relatively both static and alternative magnetic field is very important.
2. The effect may be explained by membrane breathing caused by alternative magnetic field.

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Богатина Н. И. Влияние различной ориентации постоянного и переменного магнитных полей относительно корней кресс-салата на их гравитропическую реакцию / Н.И.Богатина, Н.В.Шейкина // Ученые записки Таврического национального университета им. В.И. Вернадского. Серия «Биология, химия». – 2014. – Т. 27 (66), № 1. – С.24-28.

Были исследованы следующие варианты расположения корней относительно постоянного и переменного магнитных полей. В первом варианте постоянное магнитное поле направлено параллельно вектору гравитации, а переменное магнитное поле перпендикулярно ему, корни расположены перпендикулярно обоим полям и вектору гравитации. Для этого варианта наблюдали
отрицательный гравитропизм. Во втором варианте постоянное магнитное поле было направлено параллельно вектору гравитации, переменное магнитное поле – перпендикулярно постоянному, а корни – параллельно переменному полю. В третьем варианте переменное магнитное поле было направлено параллельно вектору гравитации, постоянное - перпендикулярно ему, а корни - перпендикулярны обоим полям и вектору гравитации. В четвертом варианте переменное магнитное поле было направлено параллельно вектору гравитации, постоянное – перпендикулярно ему, а корни – параллельно постоянному полю. Во всех исследованных вариантах частота переменного магнитного поля равнялась циклотронной частоте ионов Са. Во 2, 3 и 4 вариантах гравитропизм был положительный, однако скорость гравитропической реакции была различной. Во втором и четвертом вариантах скорость гравитропической реакции в пределах ошибки совпадает со скоростью гравитропической реакции в земных условиях. В третьем варианте скорость гравитропической реакции существенно замедляется.
Ключевые слова: постоянное магнитное поле, переменное магнитное поле, гровитропическая реакция, направление корней, циклотронная частота.

Богатіна Н.І. Вплив різної оріентації постійного та змінного магнітних полів відносно коренів кресс-салату на їх гравітропічну реакцію / Н.І. Богатіна, Н.В. Шейкіна // Вчені записки Таврійського національного університету ім. В.І. Вернадського. Серія „Біологія, хімія”. – 2014. – Т. 27(66), № 1. – С. 24-28.

Вивчали наступні варіанти розташовування коренів та постійної і змінної складових магнітного поля В першому варіанті постійне магнітне поле паралельно вектору гравітації, змінне магнітне поле перпендикулярне постійному, корени перпендикулярні обом полям і вектору гравітації. В цьому варіанті спостерігали від’ємний гравітропізм. В другому варіанті постійне магнітне поле паралельно вектору гравітації, змінне магнітне поле перпендикулярне постійному, корени паралельні змінному магнітному полю. В третьему варіанті змінне магнітне поле паралельно вектору гравітації, постійне магнітне поле перпендикулярне вектору гравітації, корени перпендикулярні обом полям і вектору гравітації. В четвертому варіанті змінне магнітне поле паралельно вектору гравітації, постійне магнітне поле перпендикулярне вектору гравітації, а корени паралельні постійному магнітному полю. В усіх варіантах частота змінного магнітного поля дорівнює циклотронної частоті іонів кальцію. У 2, 3 та 4 варіантах гравітропізм був додатний, але швидкість гравітропічної реакції була різною. В другому та четвертому варіантах швидкість гравітропічної реакції в межах помилки збігається зі швидкістю гравітропічної реакції в земних умовах. У третьему варіанті швидкість гравітропічної реакції значно зміньшується.
Ключові слова: постійне магнітне поле, змінне магнітне поле, гравітропічна реакція, напрямок коренів, циклотронна частота.

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