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EFFECTS OF PLASMA TREATMENT ON GERMINATION AND BIOCHEMICAL CONTENT OF CHICORY (*SONCHUS OLERACEUS* L.)

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Abstract

An experiment was conducted to explore the changes of germination rate, protein and vitamin C content in the seeds and the chlorophyll content of the seedlings under different irradiation time and intensity. Experiments showed that plasma treatment of chicory seeds promoted the germination and biological content of bitter seeds in 100-300W, 5-15s, and the germination rate was relatively higher under 200W conditions, the content of vitamin C and protein in seeds was relatively higher under 300W conditions.

Introduction

With the widespread application of physical technology in agricultural production, physical agriculture has developed rapidly in the world. Gamma rays and ion implantation in physical agriculture are often used for mutation breeding (Kong *et al.* 2018), among them, plasma treatment of crop seed technology is widely used due to its low cost, simple operation and no pollution (Puač *et al.* 2017). It plays an important role in promoting seed germination and plant growth in modern agriculture. It was found that it can stimulate seed germination (Zhou *et al.* 2011), increase crop yield (Li *et al.* 2015), activate the activities of enzymes such as α-amylase and protease in seeds, accelerate the catabolism rate of stored substances in seeds, and increase soluble sugar and soluble protein content, etc. The results have been confirmed in the research of various crop seeds like radish (Puligundla *et al.* 2017), various legumes (Zhang *et al.* 2017), and mustard (Dubinov *et al.* 2017). Seed germination occupies an important position in the complete reproductive history of plants, and has an important impact on the later growth and development of plants and morphogenesis and yield formation. At present, it is of great significance to explore how to increase the seed germination rate to improve crop yield (Tian *et al.* 2014).

Plasma is a gas that ionizes at a sufficient voltage and changes to a state of ions and electrons with equal positive and negative charges. The interaction of charged ions and light in the seed cell wall causes the ionization of the material in the seed, thereby activating the activities of different enzymes like amylase and protease in the seed.

Chicory is classified as Asteraceae. According to research reports, Chicory is rich in nutrients, tastes bitter cold, but it has good health effects such as cooling serum fever, anti-inflammatory and detoxification, protecting bile and liver, anti-tumor and regulating human immunity (Xia *et al.* 2012), and has a positive impact on people's health. The plasma treatment of chicory seeds would affect the physiological indexes of chicory, but there were few studies on chicory, and a little research on the technology of present plasma treatment of chicory seeds. Hence, keeping the above facts under consideration the study was undertaken to increase the germination rate and yield of chicory.

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Materials and Methods

Chicory（*Sonchus oleraceus* L.）seeds were collected from Beijing Green Oriental Institute of Agricultural Technology. Mortar, funnel, funnel holder, filter paper, disposable Petri dish, glass rod, 25ml brown volumetric flask, 50ml beaker, Plasma cleaner (Shenzhen Dongxin Hi-Tech Automation Equipment Co. Ltd.), One-tenth scale (FA2204 balance, Shanghai Hengping Instrument and Meter Factory), UV-Vis photometer (Shimadzu UV-2450) were used for conducting the experiment.

The chicory seeds were soaked at 20-25℃ for one day to release the dormancy. A plasma cleaner (Shenzhen Dong xin Hi-Tech Automation Equipment Co. Ltd.) was used to treat the chicory seeds with a treatment intensity of 100, 200, and 300W, and a treatment time of 5, 10, and 15s. For the control group is the treatment time (Table 1). The 0.07g of the treated seeds was taken and the vitamin C and protein contents of the seeds were measured by an ultraviolet spectrophotometer (Shimadzu UV-2450). After treatment, the seeds were tested for germination rate. Seventeen treated and control seeds were placed in a Petri dish containing 9 mm of earthen medium, and. each group had three replicates. During cultivation, the cultivation environment was 15-20℃, light conditions were 12 : 12 hrs and humidity was 65%. The germination rate was counted after sowing 7 days, and 2 weeks after germination, chlorophyll A and B content were measured using an ultraviolet spectrophotometer.

Germination rate (G) = number of seeds that normally germinate at the end of germination / number of tested seeds × 100%.

The absorbance of seed nucleic acid, protein, vitamin C, and chlorophyll of seedlings was measured with a UV spectrophotometer, then use GraphPad Prism5 data processing software was used to process the absorbance, further the concentration was calculate, and GraphPad Prism5 data processing software was used.

Results and Discussion

Different time and intensity of plasma radiation seed treatment had different effects on the germination rate of chicory seeds (Fig. 1). The content of germination rate at 100, 200, and 300W (1.1-3.3) were higher than those of the control group, and the germination rate was relatively higher under 200W treatment. Within 100-300W, 5-15s, plasma treatment of chicory seeds increased the germination rate of chicory seeds (Abuzairi *et al.* 2017).

Table 1. Experimental processing group.

Treatment group	Intensity/(W)	Time/(s)
0	0	0
1.1	100	5
1.2	100	10
1.3	100	15
2.1	200	5
2.2	200	10
2.3	200	15
3.1	300	5
3.2	300	10
3.3	300	15

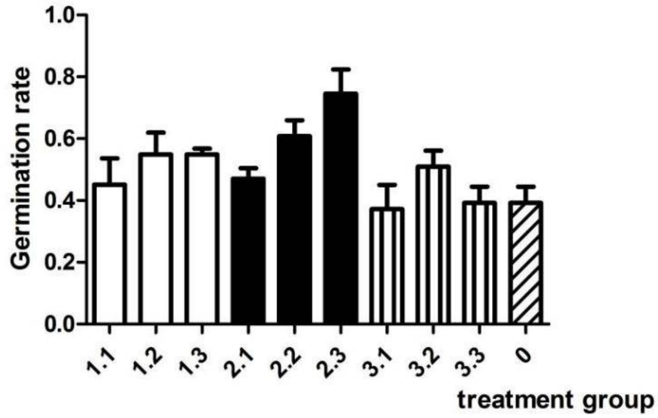

Fig. 1. Effect of plasma treatment on germination rate of chicory seeds.

Different time and intensity of plasma radiation seed treatment had different effects on protein content (Fig. 2). With the increase of plasma radiation intensity, under the same time conditions, the protein content was decreased first and then increased (Ling *et al*. 2015). The seed protein content at 100, 200, and 300W (1.1-3.3) was higher than that of the control group (0). The maximum protein content in the seeds of the 300W and 5s (3.1) treatment group reached about 0.07 mg/ml, which was 3.5 times higher that of the control group. Within 100-300w, 5-15s (1.1-3.3), plasma treatment of chicory seeds promoted the production and accumulation of protein in the seeds.

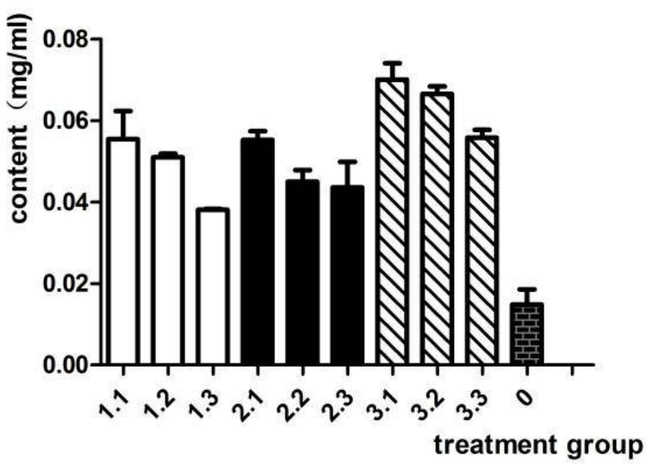

Fig. 2. Effect of plasma treatment on protein content of chicory seeds.

The time and intensity of plasma radiation seed treatment had different effects on vitamin C content (Fig. 3). With the increase of plasma radiation intensity, the content of vitamin C increased at the same time(Ahmad *et al.* 2012), and the relative content was higher at 300W radiation intensity. At the same radiation intensity, as the plasma radiation time increased (5, 10 and 15s), the vitamin C content was increased first and then decreased. The content of vitamin C in the experimental group was higher than that of the control group. The maximum vitamin content in the seeds of the 300W, 10s treatment group (3.2) was about 6.1×10 ^ -5mg / l. 1.6 times higher than that of the control group. The indicates that the plasma treatment of chicory seeds in 100-300W, 5-15s promoted the production and accumulation of vitamin C in the seeds.

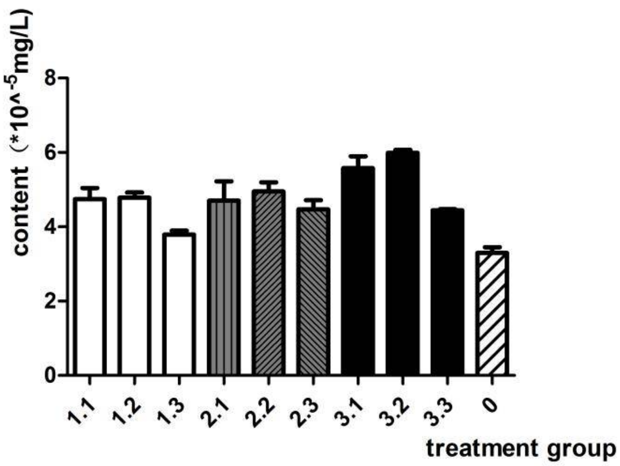

Fig. 3. Effect of plasma treatment on vitamin C content in chicory seeds.

Different time and different intensity of plasma radiation seed treatment had different effects on chlorophyll A content (Fig. 4). Content of chlorophyll A in the seedlings under the radiation intensity of 100, 200, and 300W was higher than that of the control group. The chlorophyll content in the seedlings reached a maximum of about 1.1 mg / g under 200W and 10s treatment conditions (2.2), which was 2.8 times higher than that of the control group. This showed that within 100-300W, 5-15s, plasma treatment of chicory seeds promoted the production and accumulation of chlorophyll A in seedings.

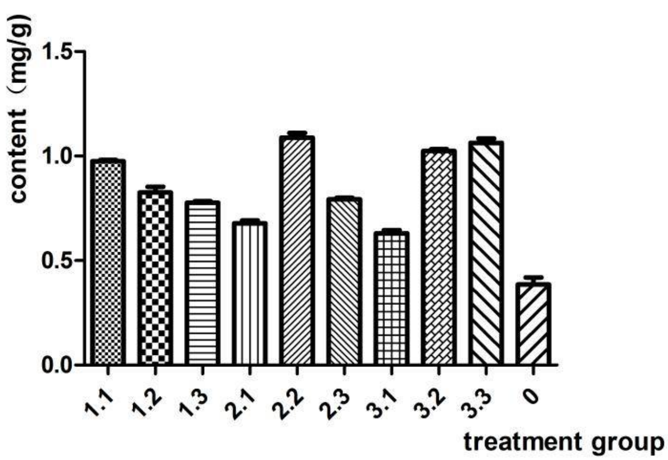

Fig. 4. Effect of plasma treatment on chlorophyll A content in chicory seedlings.

Different time and different intensity of plasma radiation seed treatment had different effects on the content of chlorophyll B, which was higher than the control group at 200W, 10s (2.2) and 300W, 15s (3.3), and the other are lower than the control group, and the maximum value of chlorophyll B content in seedlings under 200W and 10s treatment (2.2) was about 0.24mg/g (Fig. 5).

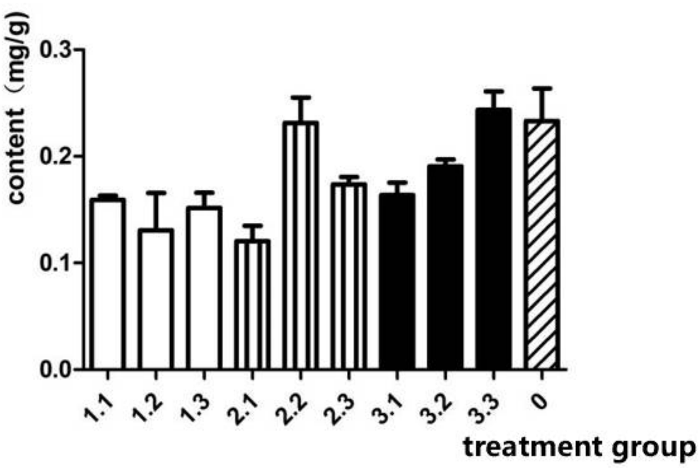

Fig. 5. Effect of plasma treatment on chlorophyll B content in chicory seedlings.

Different time and intensity of plasma radiation seed treatment have different effects on total chlorophyll content (Fig. 6). The total chlorophyll content of seedlings reached a maximum under 200W and 10s treatment conditions (2.2), which was about 0.7 mg / ml. and 1.4 times higher than the control group.

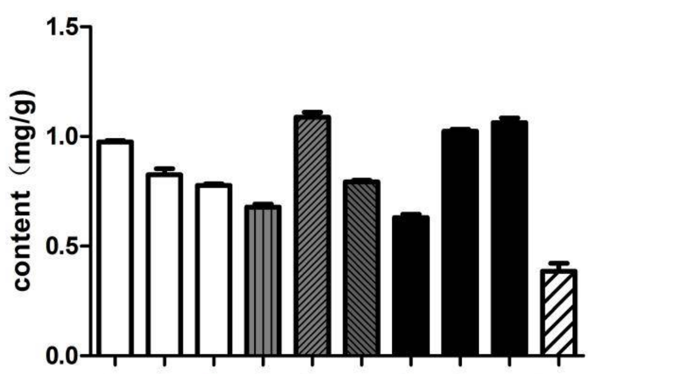

Fig. 6. Effect of plasma treatment on total chlorophyll content in chicory seedlings.

In the present experiment, under the treatment conditions, plasma treatment of chicory seeds stimulated the germination rate of chicory seeds, and also increased the content of vitamin C, protein and chlorophyll of seedlings (Adhikari *et al.* 2020). Plasma treatment of chicory seeds had an increasing effect on chicory seeds under 200-300w intensity in a short time. Therefore, plasma treatment of chicory seeds had a positive effect on the growth of chicory under certain conditions.

From the present study it may be concluded that plasma treatment of chicory seeds in 200W, 10s can effectively increase the seeds activities, and helped in the growth of seedlings. The condition was conducive to plasma breeding of chicory. Furthermore, the content of vitamin C and protein in seeds was relatively higher under 300W conditions， when the radiation time increases, The content of protein and vitamin of chicory seeds decreased, resulting in the inhibition of chicory seedling growth by irradiation.

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