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Response of monocot and dicot cash crop plants in Libya to butenolide

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ABSTRACT

Fire's phenomenon has the ability to produce flames which send out heat and light as well as smoke. Different plant groups like monocots and dicots and their life stages such as germination, seedling establishment, flowering and seed dispersal can be influenced by fire or one of its derivatives. Butenolide is one of fire smoke components and it described as an important environmental factor which enhance seed germination and improve seedling vigor. Treatingtomato and barley seeds as dicot and monocot cash crop plants in Libya, using concentrations of 0, 25, 50, 100, 250, 500 and 1000 ppm of synthesized butenolide, showed that response of both plants were influenced. Seed germination and seedling development is concentration depending. The effect was varying among the concentrations but in general, low concentrations reflect positive effect and, on the other hand, high concentrations caused inhibition due to phytotoxicity of butenolide to the receptor plant cells.

Key words: Fire Smoke; Synthesized Butenolide; Monocot; Dicot; Cash crop; Libya.

INTRODUCTION

Fire's phenomenon and its ability to produce flames is something amazing. It send out heat and light as well as smoke. Due to its vital role, fire is described as a major factor in the formation of forests[14].There is an important positive effect of fire on the conservation and restoration of plant communities[8],[18]; It can affect plants and their development stages through different ways, but one of the many effects of fire is exposing seeds in the soil to the environmental factors like smoke [26],which produce by the fire its self. Smoke described as a grey, black or white mixture of gas and carbon and it can stay in the air for weeks [20].From the chemical side, more than 100 compounds were identified in smoke[16].some of those are known to have physiological effects on plants, including NO_2[12], CO_2, SO_2 , and O_3[19].The role that smoke plays in the release of dormancy, germination and seedling growth has been examined since 1990, and only in 2004 germination-active compound, a butenolide, was identified from plant-derived smoke [27]. and burned cellulose[18]. Butenolide (3-methyl- 2H-furo[2,3-c]pyran-2-one) is a compound in smoke that induces germination [7].

Because fire products prefer high seedling establishment they might increase the diversity of species [18, 29].Generally, both monocots and dicots behave the same way in their life stages, even though they have different characteristics. Seed germination, the first process in plant life, takes different way in monocots compare to that in monocots.

Here, we tested different concentrations of butenolide on seed germination and seedling establishment of cash crop plants in Libya in Laboratory. Tomato *Lycopersicone sculentum* Mill.(dicot)and barley *Hordeum vulgare* L.(monocot) are two of most cash crop plants in Libya, therefore, they were suggested to use as models in this study.

MATERIALS AND METHODS

Plant material: Tomato *Lycopersicone sculentum* Mill.(dicot)and barley *Hordeum vulgare* L. (monocot)were used as plant receptors in this study. Seeds of these two plants were certified and purchased from the local market in Benghazi, Libya. and authenticated by the Herbarium of Botany Department, University of Benghazi.

Chemicals: Concentrations of 0, 25, 50, 100, 250, 500 and 1000 ppm of butenolide (Aldrich, Germany)were prepared and kept in the refrigerator in dark flasks until they used. (3%) alkyl dimethylbenzyl ammonium sodium hypochlorite (Clorox) was used to prevent microbial growth on seeds after planting**.**

Germination experiment: Seeds were sterilized for 3 minutes, washed with distilled water, and incubated overnight in flasks contained butenolide concentrations in a dark place. While, distilled water was used as control with concentration of (0.0). Subsequently; fifteen seeds of each species were placed in Sterilized Petri dishes (diameter 9.0 cm) lined with double layers of Whatmann filter papers. The filter papers were watered by adding 5 ml of distilled water whenever seeds needed; all replicates were incubated (BINDER, Tuttlingen, Germany)in darkness under 20 ± $1C^0$. Germinated seeds were counted daily for the calculations of daily and final germination percentages.

Seedling growth test: Germinated seeds were allowed to develop into seedlings for more one week. Distilled water was added to the Petri dishes whenever they needed. Different parameters such as plant shoot and root length, fresh and dry weight were measured. Dry weight was determine dusing micro balance (Mettler Toledo) after incubating plant parts in oven ((Heraeus, U.K) at 100 C^0 for 48 hours.

Statistical analysis: The data were statistically analyzed by one-way test (ANOVA) for testing the differences in means of several groups using a computer program of SPSS version 11, and Dunnet test was used to compare difference between individual's means and control.

RESULTS

Response of barley: The effect of different concentrations of butenolide on daily germination percentages of *Hordeum vulgare* L. (Barley) was clear. Results showed that, high concentrations (up to 250 ppm) of the butenolide decreased germination of seeds and caused inhibition at 1000 ppm. On the other hand, the results of seedling development showed that the best mean of seedling length was obtained at 50 ppm. but; above 500 ppm the results revealed decreasing in length(Figure 1).The results of fresh and dry weight(Figure 2) revealed no differences in shot length and fresh weight of seedlings using all concentrations with exception of 1000 ppm which reflected decreasing in these two parameters(Figure 1).

Response of tomato:
The seeds of *Lycopersicone sculentum* Mill. (Tomato) were germinated under all concentrations of butenolide. However, there is a delay in growth at control condition (0 ppm), where treated seeds started their germination from the fourth day of planting under (25, 50, 100 and 250 ppm) but; in control condition (0 ppm), this process started after seven days. The influence of butenolide on fresh and dry parameters are shown in figure 3 and 4. These parameters were increased at all concentrations. Tomato seedling fresh weight and length(Figure 3 and 4) appeared that the best mean was at 100 ppm, and there is significant effect between all concentrations when $p < 0.01$. The best mean of effect on dry weight was also given at concentration of 100 ppm. Analyze the data using Dunnett test showed a highly significant between control and 100 ppm of concentration in length and fresh weight.

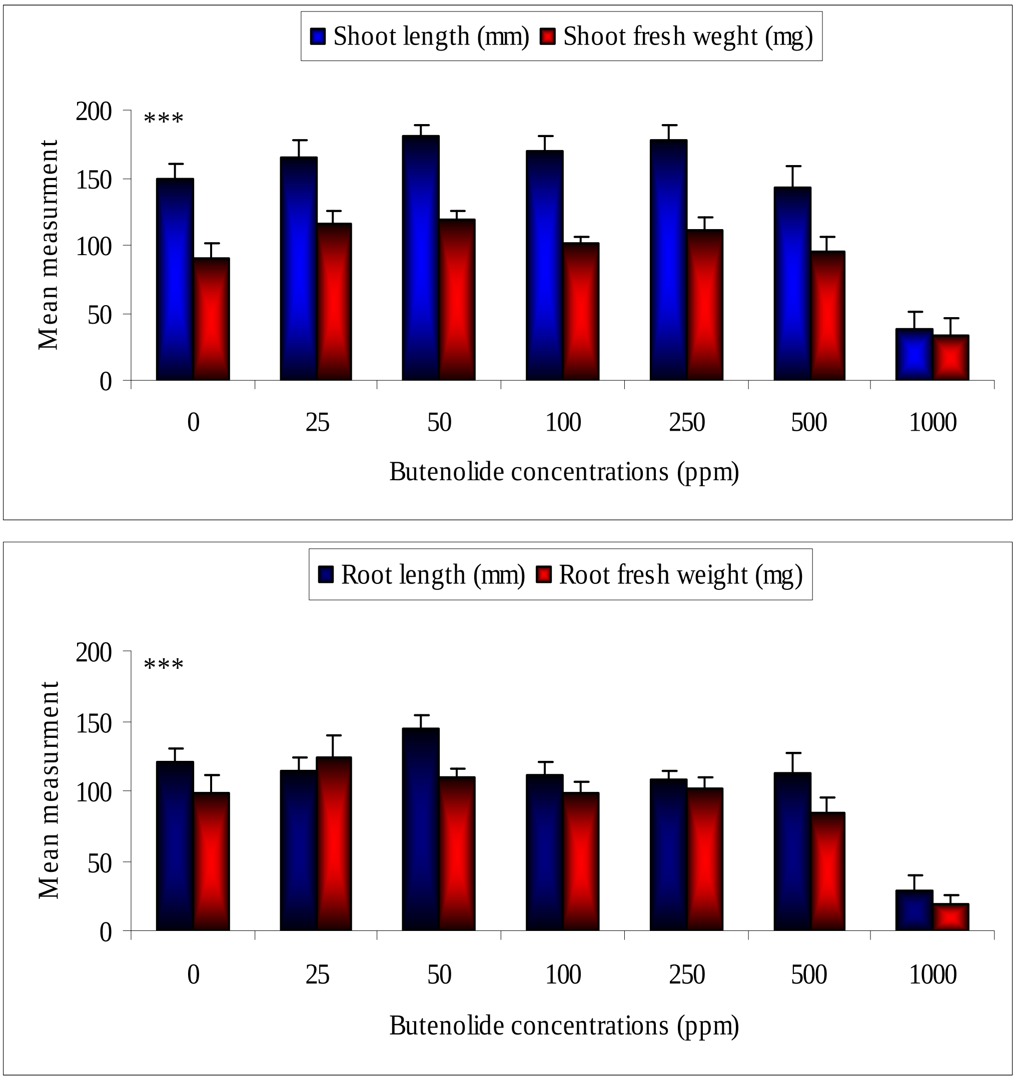
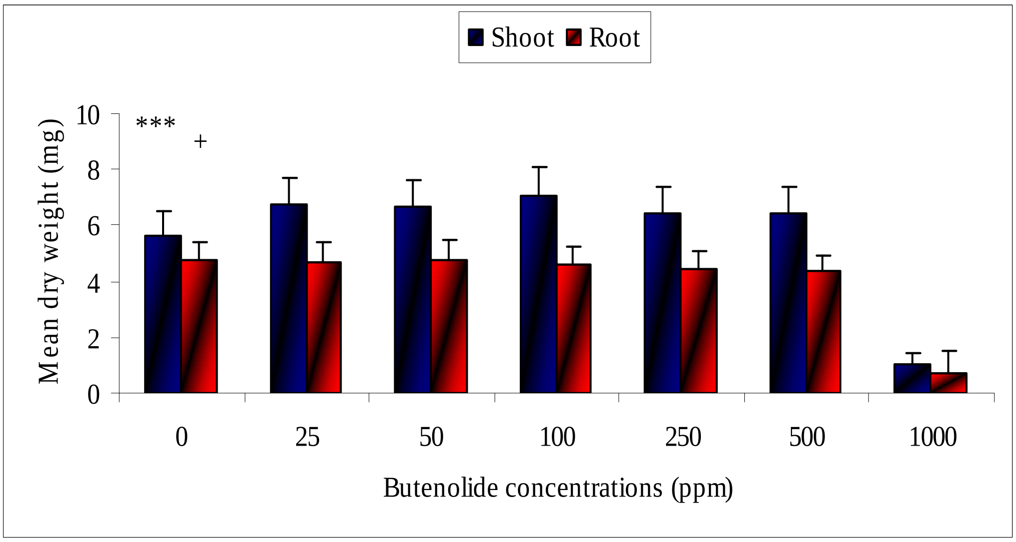


Figure 1. Response of *Hordeum vulgare* L. (Barley) to different concentrations of butenolide. The effect on shoot and root length and fresh weight. (* = High Significant at *P*< 0.001). Bars are standard error of means**



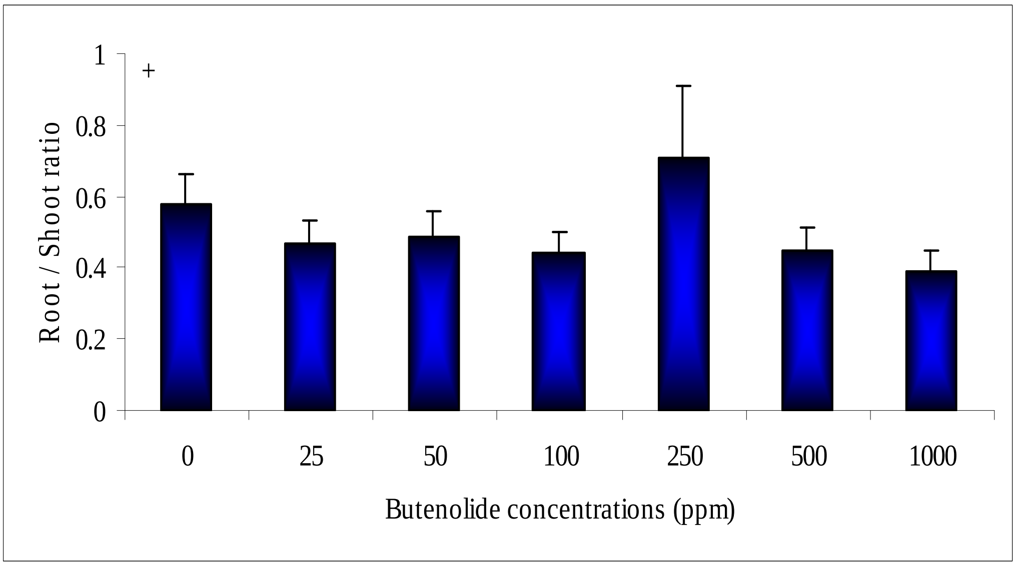
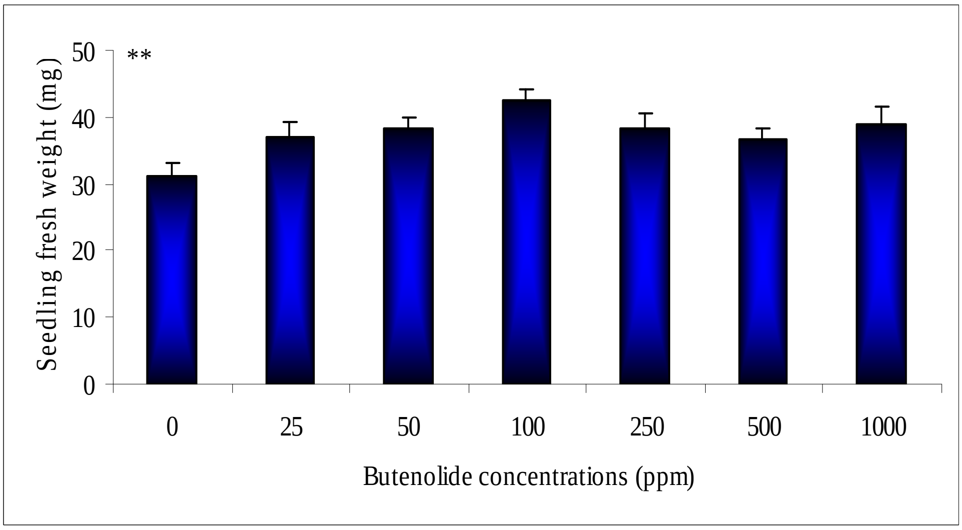


Figure 2. Response of *Hordeum vulgare* L.(Barley)to different concentrations of butenolide. dry weight of shoot and root and root/shot ratio. + = Not significant, * = High Significant at *P*< 0.001, Bars are standard error of means**



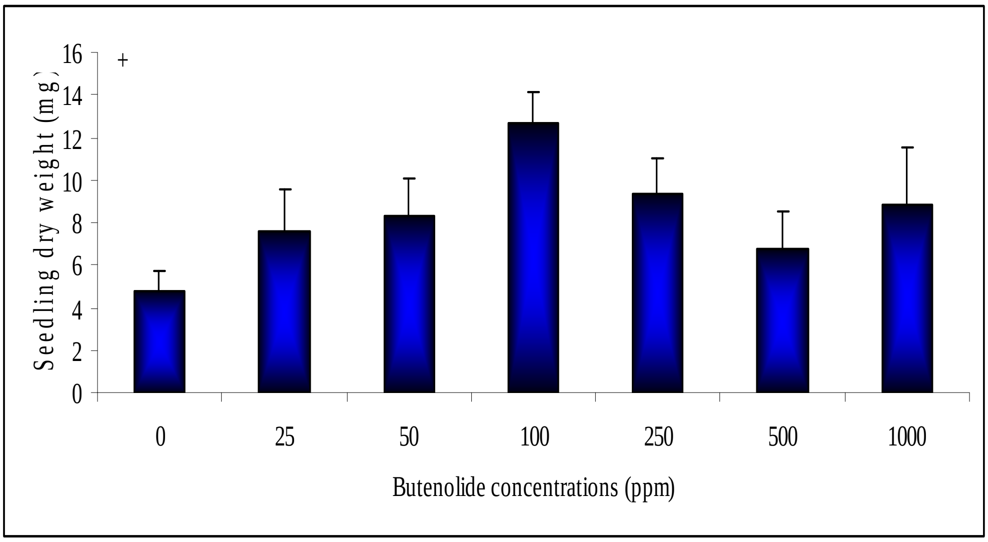


Figure 3. Dry and fresh weight of *Lycopersicone sculentum* Mill. (Tomato) seedlings and response of these parameters to different concentrations of butenolide. (+ = Not significant, ** = Significant at p < 0.001). Bars are standard error of means

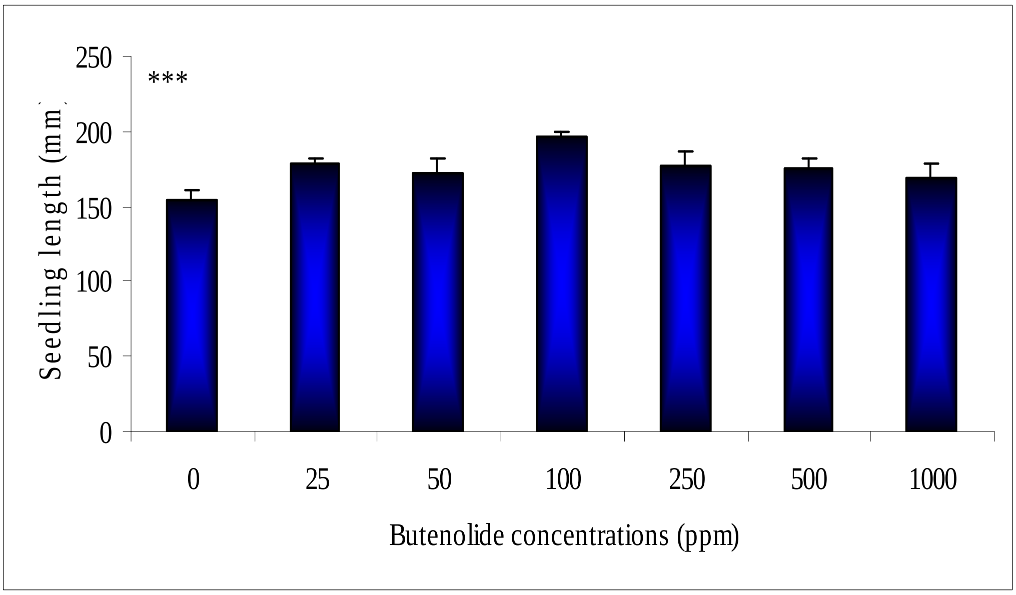


Figure 4. The effect of butenolide on total seedling lengh of *Lycopersicone sculentum* Mill. (Tomato) at different concentrations(* = High significant $p < 0.001$).Bars are standard error of means**

DISCUSSION

Clearly, both monocot and dicot seeds, which used in this research, revealed same results even though the sequence for these plants is somewhat different. The results appeared an increasing of seed germination and seedling growth parameters(figures 1,2 and 3), when receptor plants treated with different concentrations of butenolide. This effect increased by increasing the butenolide dosage, while 1000 ppm caused complete inhibition of growth and development of both plants. Fire smoke was identified as a vital germination cue in post-fire conditions [3]. De Lange and Boucher [7] were the first proved that plant derived smoke stimulates seed germination. Smoke treatments also improve post-germinative growth into large extent (seedling vigor). Smoke is assessed for its characteristic of improving seed germination and growth of plants [9]. In addition, smoke also stimulates somatic embryogenesis [21], flowering [11] and rooting [24].It is not clear enough how the seed perceives the butenolide but there is evidence that it triggers germination by facilitating uptake of water [11]. However, in butenolide treated seeds, the ratio of cells with replicated DNA increased [10]. Chromosomal aberrations can be accepted as indicators of genetic damage induced by butenolide at high concentrations[2],thus, concentration of 1000 ppm caused inhibition of growth of both plant receptors. This result was agreed with our previous study when *Lepidium sativum* L. was treated with butenolide[1].

In Libya, different plant species are using as cash crops and both receptor models in this Laboratory study are cultivated in different seasons. Therefore, these results might be generalized and applied on field studies in Libya as further work using other different cash crops.

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