Research Article

# Effect of Light Duration on Growth of Two Competitive Weeds *Parthenium hysterophorus* and *Cannabis sativa*

**Rahamdad Khan[1], Saad Muhammad[2], Muhammad Haroon[3], Saad Jan[1] and Syed Majid Rasheed[1*]**

*[1]Department of Agriculture, Bacha Khan University, Charsadda, Khyber Pakhtunkhwa, Pakistan; [2]Department of Agronomy, The University of Agriculture, Peshawar, Khyber Pakhtunkhwa, Pakistan; [3]Department of Agriculture, University of Swabi, Khyber Pakhtunkhwa, Pakistan.*

**Abstract** | Weeds are exposed to light that induces different responses that increase or reduce growth and biomass. Light duration has an important role in plant growth development and allows plants to work properly. Therefore, the aim of this study was to determine the effect of light duration on the growth performance of *Parthenium hysterophorus* and *Cannabis sativa*. The results showed that under reduced light duration (2 hours), plant growth performance (i.e., biomass, plant height, leaf area, and number of branches) was all reduced. In addition, with increasing light duration (9 hours), both species grew faster and recorded their maximum biomass plant height, leaf area, and number of branches. Both weed species grown under reduced light duration could not reach maturity and complete their life cycles. *P. hysterophorus* has the potential to grow quickly and replace *C. sativa* under 9 hours of light duration, which is suitable for enhancing the medicinal value of *C. sativa*.

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***Correspondence** | Syed Majid Rasheed, Department of Agriculture, Bacha Khan University, Charsadda, Khyber Pakhtunkhwa, Pakistan; **Email:** smrasheed@bkuc.edu.pk
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## Introduction

Light is an important source of energy for plant photosynthesis and growth. A wide range of signals and information for morphogenesis and many other physiological processes are triggered by light (Bajwa *et al*., 2017). Different characteristics of light, such as spectral composition (wavelengths), intensity, duration, and direction, can influence plant growth and development. Photosynthesis is also sensitive to all aspects of lighting conditions (Saleem *et al*., 2020). Without enough light, a plant cannot perform photosynthesis very quickly, even if there is plenty of water, carbon dioxide, and a suitable temperature. Increasing the light intensity increases the rate of photosynthesis until some other factor, a limiting factor, becomes in short supply (Naeem *et al*., 2012).

*P. hysterophorus* is a common invasive plant that is allelopathic in nature and is causing a change in

the natural ecosystem (Kaur *et al*., 2021). In some areas, outbreaks have been of almost epidemic proportions, affecting crop production, cattle, and human health (Kanaujiya *et al*., 2018). Parthenium is found in Pakistan in association with *Cannabis sativa*. Parthenium weed is competing with *Cannabis sativa,* which is a less aggressive and problematic weed. Parthenium weed has already replaced Cannabis sativa in some areas (Khan *et al*., 2011). Growth reduction and extinction of local flora by any invasive plant are attributed to high competition for natural resources, i.e., light, water, space, and nutrients. Any restriction on natural resources may greatly affect plant performance (Hussain *et al*., 2021). Parthenium is an invasive plant that is changing the natural ecosystem just as *Cannabis sativa* is an important raw material for the textile industry and drugs and is therefore more important than Parthenium because, besides agricultural losses, it is the causative agent of bronchitis, acute dermatitis, and eczema in humans (Early *et al*., 2016).

The objectives of this study were to judge the nature of *Parthenium hysterophorus* and *Cannabis sativa* towards different light durations and to compare the vegetational changes of *Parthenium hysterophorus* and *Cannabis sativa* toward light.

## Materials and Methods

*Experimental description*

This experiment was conducted in the laboratory of Bacha Khan University, Charsadda, Pakistan. *Parthenium hysterophorus* and *Cannabis sativa* of the same size were obtained from a local field in Charsadda, Khyber Pakhtunkhwa, and transplanted in a free-draining pots, 60 in number, with a similar volume of soil. All of the pots were watered regularly until the plants were well established. The experiment was laid out in the laboratory in a Completely Randomized Design (CRD) with two factors and three replications. The combination of treatments was Factor A (*Parthenium hysterophorus* and *Cannabis sativa*), and Factor B was light duration (2, 5, 7, 9 hours and control). The plants were exposed to the said duration of light whereas control was kept in open field without any shade. During the experiment, the data were recorded on leaf area per plant, number of branches, plant height, shoot biomass (g) and root weight (g).

*Statistical analysis*

Complete Block Design (CBD) was used to determine all of the data collected. Analysis of variance was applied to replicated data using STATISTIX 8.1. When the ANOVA showed a statistical effect, means were separated by the least significant difference (LSD) at $P < 0.05$.

## Results and Discussion

*Leaf area plant$^{-1}$ (mm$^2$)*

The data regarding the leaf area of *P. hysterophorus* and *C. sativa* under different light durations are shown in Table 1. Compared *with C. sativa*, the leaf area of *P. hysterophorus* (121.60 cm$^2$) was increased. Different light durations affect the leaf areas of both species. Compared with control, species treated with 9 hours of light duration increased leaf area (144), followed by 7 hours of light duration, and a minimum leaf area (17 cm$^2$) was recorded for 2 hours of light duration. Under the interaction of species and light duration, *P. hysterophorus* with 9 hours of light duration recorded a maximum leaf area of (218 cm$^2$), and *C. sativa* with 2 hours of light duration recorded a minimum leaf area (0.00), the reason behind no leaf area per plant was that apart from single pot, no leaf survives under 2 hours light exposure duration. Bajwa *et al*. (2018) predicted that the reduced leaf area of the wheat plant was due to reduced light penetration, these findings are in line with our results. Similarly, Saleem *et al*. (2020) and Kim *et al*. (2004) also observed that the leaf size was affected by light quality.

**Table 1:** *Effect of light duration on leaf area per plant (cm$^2$) of P. hysterophorus and C. sativa.*

| Light duration | Weeds species | | Mean |
|---|---|---|---|
| | ***Parthenium hysterophorus*** | ***Cannabis sativa*** | |
| 2 hours | 34.00 de | 0.00 e | 17.00 d |
| 5 hours | 72.00 d | 46.00 de | 59.00 c |
| 7 hours | 156.00 b | 58.00 d | 107.00ab |
| 9 hours | 218.00 a | 70.00 d | 144.00 a |
| Control | 128.00 bc | 79.00 cd | 103.50 b |
| Mean | 121.60 a | 50.60b | |

*LSD for plant: 24.822; LSD for treatment: 39.246; LSD for plant and treatment: 55.503*

*Number of branches plant$^{-1}$*

The light duration applied in this study significantly affected the number of branches of both plants (Table 2). Light application for 2 hours greatly reduced the

number of branches (0.875), followed by 5 and 7 hours (5.625), compared to control treatment. There is a significant difference in the number of branches between *P. hysterophorus* and *C. sativa* (4.75 and 8.00 branches, respectively). The interaction means data showed an increased in the number of branches in *C. sativa* under control treatment (13.50) compared with 2 and 5 hours of light duration. Zero branches per plant were recorded in *C. sativa* under 2 hours light exposure duration. Magagnini *et al.* (2018) also proposed that light can be used to manipulate plant morphology, increasing or decreasing in the number of branches depending on the duration.

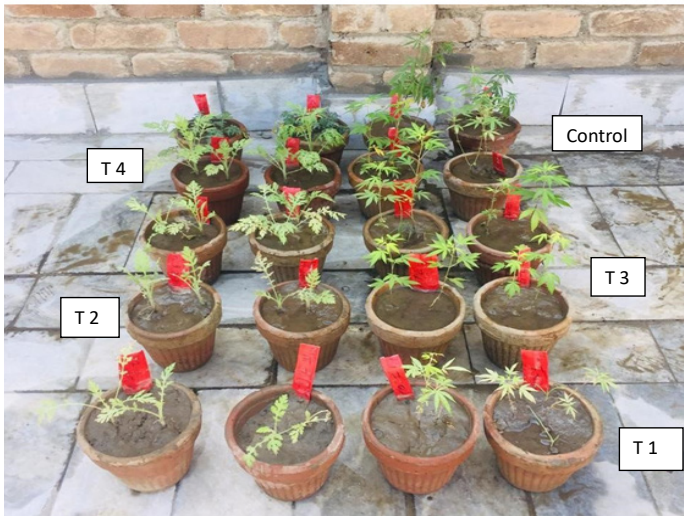


**Figure 1:** *Effect of light duration on plant growth of P. hysterophorus and C. sativa (Representative pots of the experiment).*

**Table 2:** *Effect of light duration on the number of branches per plant of P. hysterophorus and C. sativa.*

| Light duration | Weed species | | Means |
|---|---|---|---|
| | *P. hysterophorus* | *C. sativa* | |
| 2 hours | 1.75 cd | 0.00 d | 0.875 c |
| 5 hours | 3.75 bcd | 7.50 b | 5.625 b |
| 7 hours | 4.75 bc | 6.50 b | 5.625 b |
| 9 hours | 6.25 b | 12.50 a | 9.375 a |
| Control | 7.25 b | 13.50 a | 10.375 a |
| Means | 4.75 b | 8.00 a | |

*LSD for plant: 1.8320; LSD for treatment: 2.8966; LSD for plant and treatment: 4.0964*

*Plant height (cm)*

Significant variation in the final plant height of *P. hysterophorus* and *C. sativa* was found under the influence of light duration (Table 3). The results showed that *C. sativa* recorded the maximum plant height (6.50 cm), while the minimum was recorded for *P. hysterophorus*. Light duration of 9 hours increased plant height (7.30 cm) when compared to light duration treatments of 2, 5, and 7 hours. Under interaction, the maximum height of 8.65 cm was observed for *C. sativa* with a 9-hour light duration. C. sativa had a minimum height of 2.00 cm and a light duration of 2 hours. Yasin *et al.* (2017) also deducted that daily light integral of 0.69 to 3.71 mol $m^{-2}$ $d^{-1}$ substantially reduced the plant height in certain weed plants. Contrary to our finding Tang at al. (2022) stated that seedlings grown under low light intensities had significantly increased plant height.

**Figure 2:** *Effect of light duration on P. hysterophorus and C. sativa after 42 days of sowing.*

**Table 3:** *Effect of light duration on plant height of P. hysterophorus and C. sativa.*

| Light duration | Weeds species8i9o | | Mean |
|---|---|---|---|
| | *P. hysterophorus* | *C. sativa* | |
| 2 hours | 4.00 efg | 2.00 g | 3.00 c |
| 5 hours | 4.57 def | 6.35 bcd | 5.46 b |
| 7 hours | 5.50cde | 8.20 ab | 6.85 ab |
| 9 hours | 5.50 cde | 8.65 a | 7.30 a |
| Control | 3.20 fg | 7.50 abc | 5.35 b |
| Mean | 4.64 b | 6.54 a | |

*LSD for plant: 0.9542; LSD for treatment: 1.5087; LSD for plant and treatment: 2.1336*

*Shoot biomass (g)*

Table 4 shows the effects of light duration on the biomass of *P. hysterophorus* and *C. sativa* shoots. In this experiment, the shoot biomass of both species was assessed under different light durations. Compared

with *P. hysterophorus*, *C. sativa* recorded the highest shoot biomass (1.67 g) . The exposure of both species to different light durations significantly increased the shoot biomass and recorded maximum shoot biomass (2.00 and 1.75 g) in 5- and 9-hour light durations, while minimum shoot biomass (0.87 g) was observed in 2-hour light durations. Under interaction, *P. hysterophorus* and *C. sativa* with control and 9 hours of light duration recorded maximum shoot biomass (2.00 g) as well as minimum shoot biomass (0.85 g) for *P. hysterophorus* with 2 hours of light duration. Rothe and Gottfried (1981) also made evident the correlation of the specific enzyme activity in the stem being significantly depressed in the absence of light, resulting in a decrease in shoot biomass. Similarly, Guilherme *et al*. (2022) also suggested that variable fresh weight was strongly negatively correlated with light intensity.

**Table 4:** *Effect of light on shoot biomass per plant of P. hysterophorus and C sativa.*

| Light duration | Weeds species | | Mean |
|---|---|---|---|
| | ***P. hysterophorus*** | ***C. sativa*** | |
| 2 hours | 0.85c | 0.90 c | 0.87 c |
| 5 hours | 1.50 bc | 2.50 a | 2.00 a |
| 7 hours | 1.15 bc | 1.45 bc | 1.30 bc |
| 9 hours | 2.00 a | 1.50 bc | 1.75 ab |
| Control | 2.00 a | 2.00 ab | 2.00 a |
| Mean | 1.50$^{NS}$ | 1.67 $^{NS}$ | |

*LSD for plant: 0.3936; LSD for treatment: 0.6224; LSD for plant and treatment: 0.8802*

*Root biomass (g)*

Light duration greatly affects the root biomass of both weed species (Table 5). Compared with *C. sativa*, *P. hysterophorus* enhanced root biomass under light duration, with maximum root biomass (0.93 g). Compared with the control treatment, a light duration of 9 hours increased root biomass (0.97 g) followed by 5 hours (0.95 g) as minimum were recorded in 2 hours light duration (0.70 g). Under interaction of weed species and light duration, *P. hysterophorus* and *C. sativa* with control and 9 hours light duration recorded maximum root biomass (1.00 g) as minimum root biomass (0.70 g) were recorded for *P. hysterophorus* and *C. sativa* with 2 hours light duration. Baldwin *et al*. (2009) stated that continuous shading reduced the dry mass of the root in some cultivars of barmudagrass compared to full sun. The findings of Gong *et al*. (2015) revealed that shade increases the height but decreases the biomass, chlorophyll contents, and photosynthesis of soybean plants.

**Table 5:** *Effect of light duration on root biomass of P. hysterophorus and C. sativa.*

| Light duration | Weed species | | Mean |
|---|---|---|---|
| | ***P. hysterophorus*** | ***C. sativa*** | |
| 2 hours | 0.70 c | 0.70 c | 0.70 c |
| 5 hours | 1.00 a | 0.90 ab | 0.95 ab |
| 7 hours | 0.95 ab | 0.85 b | 0.90 b |
| 9 hours | 1.00 a | 0.95 ab | 0.97 ab |
| Control | 1.00 a | 1.00 a | 1.00 a |
| Mean | 0.93 a | 0.88 a | |

*LSD for plant: 0.0626; LSD for treatment: 0.0990; LSD for plant and treatment: 0.1401*

## Conclusion and Recommendation

This experiment aimed to study the response of *P. hysterophorus* and *C. sativa* growth to light duration. The results demonstrate that 9 hours of light duration may have a beneficial effect on the growth, and biomass of *P. hysterophorus* and *C. sativa* as minimum light duration greatly affects the performance of *P. hysterophorus* and *C. sativa*. Light duration plays an important role not only in plant height, and biomass but also show the aggression of *P. hysterophorus* and *C. sativa* toward light duration. Light duration of 9 hours is suitable to enhance the medicinal value of *C. sativa* and *P. hysterophorus* has the potential to grow fast and replace the *C. sativa* under 9 hours light duration.

## Acknowledgement

NA.

## Novelty Statement

Weeds are exposed to light that induces different responses that result in an increase or reduction in growth and biomass. Light duration has an important role in plant growth development and allowing plants to work properly.

## Author's Contribution

**Muhammad Saad:** Investigation, draft preparation.
**Rahamdad Khan:** Supervision.

**Muhammad Haroon:** Data curation, conceptualization.
**Saad Jan and Tamana Bakht:** Writing and editing.
**Syed Majid Rasheed:** Data curation, editing and polishing.

*Conflict of interest*
The author have declared no conflict of interest.

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