Title page

Long daylength promotes the flowering transformation of bermudagrass

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Abstract

Photoperiod is a very critical environmental factor affecting plant growth and development. Controlled environmental conditions and extended photoperiod have been shown to promote flowering in the long-day plant *Arabidopsis thaliana* and to shorten breeding time in some crops. However, ~~the study~~no previous research on the regulation of bermudagrass flowering by photoperiod is ~~not clear~~scarce. Therefore, this study investigated the effect of photoperiod on the growth and flowering of bermudagrass by prolonging the photoperiod in a controlled greenhouse. Supplemental lighting in the controlled greenhouse with sodium lamps equipped with metal halides. Three different photoperiods were set up in the experiment: 22/2 h (22hours light/2 hours dark), 18/6 h (18hours light/6 hours dark), 14/10 h (14hours light/10 hours dark). Results showed that extending the photoperiod not only promoted the growth of bermudagrass but also its nutrient uptake. Most importantly, under 22/2 h photoperiodic condition~~s~~, flowering time was successfully reduced to 44 days for common bermudagrass (*Cynodon dactylon* [L.] pers) genotype, A12359 and 36 days for African bermudagrass (*Cynodontransvaalensis*Burtt-Davy) genotype, ABD11. This study ~~investigated~~ demonstrated a successful method of bermudagrass flowering earlier that usual time by manipulating daylength ~~and~~ which might provide useful insight for bermudagrass breeding.

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Key Words: Bermudagrass, Photoperiod, Flowering, Rapid Breeding

Introduction

Light is not only a source of energy, but it is also one of the most important environmental factors for plants growth and development (Fukuda et al, 2008). Light intensity, light quality (spectral qualities of light), and photoperiod (length of exposure to light) are three major factors that have ~~a~~ significant influences on plants (Nadav & Nirit, 2021). Photosynthesis is directly ~~impacted~~affected by light intensity, with increased photon flux density at selective wavelengths enabling higher rates of carbon fixation. Light quality influences the synthesis and storage of photosynthetic pigments in leaves, as well as the metabolism of nutrients, and nitrogen (Shafiq et al, 2021). It also regulates plant development, photo-morphogenesis, and material metabolism (primary and secondary metabolism) (Monostori et al, 2018). Photoperiod is the amount of time that plants are exposed to a predefined light and dark state each day, which influences plant physiological and biochemical reactions to enhance fast growth~~,~~ and development (Adams & Langton~~F.A.~~, 2005; Zha & Liu, 2018). Plants must shift from vegetative to reproductive development in order to secure their own reproduction in a variety of uncertain surroundings. It is mostly depend on the interaction of internal regulation and external factors. The photoperiod pathway, vernalization pathway, autonomous pathway, and gibberellin pathway are all involved in the regulation of plant blooming. Among them, photoperiod is a very critical environmental factor affecting plant growth and development (Yamaguchi & Abe, 2012; Wellmer & Riechmann, 2010; Srikanth & Schmid, 2011; Wolabu et al, 2016). Photoperiod not only plays an important role in inducing flowering of crops, but also has significant effects on other aspects of crop external growth (Munir etal, 2001; Martín et al, 2018).

Growing populations and changing ecosystems, on the other hand, create serious worries about global food security. Plant breeding has played a critical role in maintaining food security and has had a significant influence on food production throughout the world since the early 1900s (Tester & Langridge, 2010; Shiferaw et al, 2013). Plant breeding can be used to create plants with specific characteristics (Godwin et al, 2019). Plant breeders and academics from all around the globe presented a variety of ways to increase crop breeding efficiency. With the advent of genetic engineering and molecular technology, genetic transformation has been applied to generate crops

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with desirable characteristics (Ahmar et al, 2020; Arauset al, 2018; Fenget al, 2014; Majid et al, 2017). Plant breeding has been proven to be accelerated by emerging technologies established in this decade, such as genomicselection and high-throughput phenotyping. Breeding new, advanced varieties for most crops will take years, and present development rates for some vital crops are insufficient to fulfill future demand(Muth et al,2010;Ray et al,2013).The efficacy of agricultural genetic improvement is substantially determined by cycle time, and various ways have been explored to decrease the duration of plant reproductive cycles(Voss-Felset al,2019). Watson and his colleagues proposed the concept of "speed breeding," which involves using regulated environmental conditions and extended photoperiod to reduce generation times for long-cycle crops of spring wheat (*Triticum aestivum*) and oilseed rape (*Brassica napus*) to 6 and 4 generations per year, respectively, rather than 2-3 generations under normal glasshouse conditions (Ghosh et al, 2018; Watson et al, 2018). This non-transgenic strategy cuts generation time in half, speeds up breeding and other cutting-edge plant breeding procedures, and can meet the genetic gain targets required for our future crops(Liet al,2018;Wangaet al,2021).

Bermudagrass has good color, high density, drought endurance, salt tolerance, wear resistance, and quick reproduction, making it one of the most valued grasses among other warm-season turfgrasses (Pang et al, 2011). It's not just one of China's most popular turfgrasses, but it's also a great plant for soil consolidation and slope protection (Harlan,1970;Shi et al,2014; Zheng et al, 2017; Taliaferro,1995; Beard, 1972). There are significant and widespread wild bermudagrass germplasm resources all over the world today, with China being one of the wealthiest countries in terms of bermudagrass breeding (Zhang, 2018; Hajjar & Hodgkin, 2007). Plant breeding relies heavily on genetic resources and wild species, finding resistant and high-performing variations is the key goal of crop enhancement (Kearns et al, 2009). However, breeding of bermudagrass was

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sluggish to begin in China, the introduction of new kinds in the 1950s and 1960s that breeding activity began.Systematic breeding, cross breeding, mutagenesis breeding, and biotechnology breeding are the most used bermudagrass breeding strategies nowadays. Almost all new bermudagrass species have been generated by crossbreeding, both intraspecific and interspecific, in recent years. Crossbreeding (*C. dactylon* × *C. transvaalensis*) was used to create popular varieties as Tifway, Latitude 36, Northbridge, Tahoma 31, and TifTuf (Wuet al, 2013, 2014, 2019). Furthermore,because developing genetically stable bermudagrass variants takes a long time, quick breeding is required to enhance the breeding of outstanding kinds. In the present study supplemental light was used to increase the photoperiod as 22/2 h (22 hours light/2 hours dark) at greenhouse to see the effect on flowering~~this~~ in bermudagrass ~~study we proposed aprogram: Supplemental lighting in the controlled greenhouse with sodium lamps equipped with metal halides increased the photoperiod to 22/2 (22 hours light/2 hours dark).The results showed~~and found that prolonging the photoperiod could promote flowering of bermudagrass. This study will provide useful insight for time-efficient breeding of bermudagrass~~ breeding. .~~

Materials and methods

Plant materials and growth conditions

The plant materials used in this investigation were common bermudagrass (*Cynodon dactylon*) and African bermudagrass (*Cynodon transvaalensis*), designated as A12359 and ABD11, respectively. The experimental materials ~~was~~ were separated into two identical portions for monitoring growth and blooming. Each treatment has ~~3~~ three biological replicates. The soil at the experimental location was commercial peat soil, and whole bermudagrass stolons were extracted and planted in cylindrical flowerpots with a culture mechanism (Peilei, Zhenjiang, China). The same number of

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bermudagrass stolons were planted in each cylindrical flowerpot. To remove seeding disparities between individuals, stolons from the mother plant were evenly propagated. Half-strength Hoagland nutrient solution (1/2 HS) was irrigated once a week.

Experimental design and treatment

The experiment was carried out in the greenhouse of coastal grass germplasm resources and breeding center of Ludong University on September 2020.The area is 127 meters above sea level, with geographical coordinates of N37.53° (latitude) and E121.36° (longitude). The entire experiment lasted three months, from September to December 2020. All experimental materials were grown on plant shelves in the controlled greenhouse and were supplemented by sodium metal halide lights (RVP350; PHILIP Shanghai China) positioned at a height of 1.8 m from the shelves. ~~In the experiment,t~~Three photoperiods, namely ~~were used:~~ 22/2 (22 hours light/2 hours dark), 18/6 (18 hours light/6 hours dark), and 14/10 (14 hours light/10 hours dark) were used. Bermudagrass was separated into three categories accordingly under each photoperiod condition. Each treatment has 3 biological replicates. Above each group of photoperiodic materials, a sodium metal halide light was installed. The supplementary light was set to automatically turn off for two hours from 9pm to 11pm to achieve a 22/2 photoperiod. Under the same conditions, 18/6 and 14/10 were covered by paper boxes at regular intervals (complete coverage) and guaranteed complete darkness. The 18/6 photoperiod was covered at 5 pm and uncovered at 9 pm; 14/10 photoperiod was covered at 9 pm and uncovered at 7 am the next day (Fig. 1). Other growth conditions were 60% humidity, natural temperature in controlled greenhouse. To illuminate the effect of photoperiod on bermudagrass growth and flowering, materials under different photoperiodic conditions were cultured at the same temperature and light intensity. A temperature and light recorder (WS1PROG; ubibot, Dalian, China) was used to record the temperature and light intensity, as shown in Figure 2.

Comment [MC8]: Which experimental design followed?

Recording inflorescence number and growth indicator

Every two weeks, growth indices such as plant height, branch number, and biomass (fresh weight, dry weight) were assessed under various photoperiod circumstances. The growing material was clipped every two weeks. At the specified times, each pot was harvested manually using a hand shear at a consistent height of 10 cm above the soil surface. Every two weeks, the plant height in each pot was measured from the soil surface to the plant's topmost tip (using the Standard scale), and the branches were counted. After mowing, the fresh weight was weighed using an electronic balance. The samples were then dried for 30 minutes at 105°C in a forced-draft oven (DHG-9140A; Shanghai, China) before being oven-dried for 72 hours at 75°C until they reached a consistent weight. After drying the samples, the dry weight (DW) was calculated. The above-ground (shoots) and subsurface sections (roots) of bermudagrass were separated at the end of the experimental treatment. After carefully washing the tissues with deionized water, the fresh weight (FW) of the shoots and roots was calculated, and the dry weight (DW) was calculated after drying the samples. We counted the number of headings and flowering every two days after the first inflorescence developed until the number of headings and flowering were steady.

Determination of nitrogen and phosphorus content

To assess the nutritional value, shoots were pulverized and weighed around to 0.1g, placed in a desiccating tube, mixed with 5 ml of 95%concentrated sulfuric acid (H_2SO_4) and digested in a graphite digestion apparatus (SH220N; Jinan Hanon, Shandong, China).Then,using a chemical automated analyzer, the nitrogen (N) and phosphorus (P) content was determined(SmartChem 200; AMS Alliance,Guidonia, Rome, Italy).

Data analysis

For data processing, Microsoft Excel was utilized. Whereas, for data visualization, Sigmaplot12.3

was used.~~ for data visualization, and~~ Originlab was used for greenhouse temperature and light mapping. SPSS 22.0 software was used to conduct statistical analysis (Microsoft Corp). The noteworthy differences between various photoperiods were analyzed using one-way analysis of variance (ANOVA). The differences were tested using the SNK text at a statistically significant level of $P < 0.05$.

RESULTS

Effect of different photoperiods on the growth of bermudagrass:

The plant height was measured, fresh weight and dry weight were weighed after each cut, and the fresh and dry weights of the shoots and roots were measured at the ~~conclusion~~ end of the ~~test~~ experiment to reveal the influence of photoperiod on the growth of bermudagrass. The result was presented ~~This is seen~~ in Figure3, where the ~~plant height~~ charts ~~depicts~~ depicted the change in plant height during grass mowing. Different photoperiods had a substantial effect on plant height~~, with the plant height~~ under longer photoperiods 22/2 and 18/6 h being higher than that under shorter photoperiod 14/10 h **(Fig. 3a, 3b)**. It was worth noticing that there were variances between the two materials in addition to the photoperiodic discrepancies. The plant height of common bermudagrass, A12359 tended to rise in ~~the~~ early stages (2-4 weeks) before ~~mainly~~got stabilized~~ing~~ in the later stages **(Fig. 3a)**. The plant height of African bermudagrass, ~~(~~ABD11~~)~~ did, however, show a consistent upward tendency **(Fig. 3b)**. The pattern of plant height change suggested that African bermudagrass was more tolerant of mowing than ordinary bermudagrass, and that frequent mowing aided its growth.

The biomass (fresh weight) was measured in every two weeks, as illustrated in Figure 3c, 3d. ~~To~~ At the beginning~~begin~~, there were considerable changes in fresh weight while grown under different photoperiods~~ circumstances~~. ~~Then when long~~ and plants grown under longer photoperiods *viz.*

22/2 and 18/6 h were ~~used, the~~found with higher fresh weight ~~was greater than when~~compared to plants under short photoperiod 14/10 h. ~~was used~~ **(Fig. 3c, 3d)**. A12359's fresh weight in the 22/2 and 18/6 h conditions differed significantly from that in the 14/10 h condition **(Fig. 3c)**. However, for AB11, there was no significant difference in fresh weight between 18/6 and 14/10 h treatments ~~for material AB11~~, while 22/2 was considerably different from the other two groups **(Fig. 3d)**. Second, there were variations between the two materials in addition to photoperiod differences.

Comment [MC9]: Not clear the meaning of the sentence.

The maximal biomass for ABD11 was attained in week eight **(Fig. 3d)**. In comparison to ABD11, the A12359 ~~peaked~~ reached at maximum growth later, at week twelve **(Fig. 3c)**. The rising biomass while the plant height remained constant in common bermudagrass A12359 suggested that the plants were growing stronger.

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The study discovered that variations in dry and fresh weights essentially followed the same pattern. The dry weight exhibited considerable changes under different photoperiodic circumstances. Dry weight was greater ~~W~~when plants were grown at longer photoperiods (22/2 and 18/6 h) compared to ~~were used, the dry weight was greater than when~~ shorter photoperiod (14/10 h) ~~was used~~ **(Fig. 3e, 3f)**.

Comment [MC11]: Of what?

The fresh weight and dry weight of the bermudagrass shoots and roots were evaluated in order to determine the influence of photoperiod on their biomass. As predicted, ~~L~~longer photoperiods resulted in higher biomass of both shoots and roots than shorter photoperiods, ~~as predicted~~ **(Fig. 3g-3j)**. The fresh weight of common bermudagrass (A12359) shoots and roots exhibited substantial variations between the three photoperiod groups **(Fig. 3g)**, while the dry weight ~~of~~ at longer photoperiod 22/2 h showed significant differences from the other two groups **(Fig. 3h)**. Furthermore, ~~we found that~~ the fresh weight of shoots of African bermudagrass (ABD11~~),~~) at longer photoperiod (22/2 h) was significantly different from the other two groups, but the fresh

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weight of roots was not significantly different ~~between~~ among the three photoperiodic groups **(Fig. 3i)**. Nevertheless, ~~and the~~ dry weight of its roots, ~~–~~ at longer photoperiod (22/2 h) was significantly different from the other two photoperiodic groups **(Fig. 3j)**.

These findings revealed that photoperiod had an influence on bermudagrass development and that increasing the photoperiod may increase bermudagrass growth.

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Effect of different photoperiods on nutrient absorption of bermudagrass:

The patterns in N and P content revealed that whether it was A12359 or ABD11, plants at ~~the~~ longer photoperiod, ~~'s~~ N and ~~-~~P content was ~~bigger~~ higher than the shorter photoperiod~~'~~s **(Fig. 4a-4d)**. Yet, under the photoperiod 22/2 h~~condition~~, ~~we discovered that the~~ two bermudagrass genotypes~~material~~s achieved their maximum N and P at different periods. ~~When comparing A12359 to ABD11,~~ ABD11 reached its peak sooner, at week ~~eight~~ 8th **(Fig. 4a, 4c)**, whereas, A12359 reached its peak at week ~~twelve~~ 12th **(Fig. 4b, 4d)**. ~~;~~ In addition, the maximum value of absorbed nutrients was consistent with the maximum biomass **(Fig. 3c-3f)**.

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Effects of different photoperiods on flowering of bermudagrass:

The long photoperiod was regularly longer than the short photoperiod, as seen by the branch numbers of A12359 and ABD11 **(Fig. 5a, 5b)**. However, there was a variation in the branching number trend between the two materials. ~~,~~ ~~with~~ In African bermudagrass (ABD11) branching number ~~increasing~~ increased as daylight duration rose, and the link between daylight length and branching number ~~showing~~ showed a linear change **(Fig. 5b)**. The common bermudagrass (A12359) did not have a propensity to increase its branching number at 14/10 h **(Fig. 5a)**, unlike the African bermudagrass (ABD11), indicating that A12359 could only branch when it reached a particular daylight level, and the daylight length ~~at~~ 14/10 h was insufficient for its branching **(Fig. 5a)**. However, the similar pattern of branching number expansion was seen in both 18/6 and 22/~~2~~ 2

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h periods~~circumstances~~ **(Fig.5a)**, suggesting that 18/6 could be adequate for branching for ?. Furthermore, by week 12th, the common bermudagrass (A12359) reached its maximum number of branches **(Fig. 5a)**.

The blooming number of bermudagrass displayed an inverse curve trend in response to ~~diverse~~ different photoperiodic treatments. ~~Under the lengthy photoperiod 22/2, both~~ Both common bermudagrass (A12359) and African bermudagrass (ABD11) blossomed ~~first~~ at the lengthy photoperiod, 22/2 h, **(Fig.5c, 5d)**. ~~We also tracked their blooming time, which~~It took 44 days under longer photoperiod (22/2 h), 63 days under photoperiod 18/6 h, and 85 days under short photoperiod 14/10 h from planting to flowering, *i.e.* the longer photoperiod shortened common bermudagrass flowering time by 41 days. ABD11, on the other hand, took 36 days from planting to blooming under ~~long~~ photoperiod 22/2 h, 36 days under 18/6 h, and 95 days under short photoperiod, 14/10 h. We discovered that African bermudagrass bloomed 8 days earlier than ordinary bermudagrass under extended photoperiod (22/2 h). These results suggested that extending photoperiod might promote flowering in common bermudagrass and African bermudagrass.

Discussion

The findings of this study demonstrated the effect of photoperiod on the development and blooming of bermudagrass. ~~We~~ It has been discovered that increasing ~~the~~ photoperiod might encourage the growth of bermudagrass biomass. The fresh and dry weights of bermudagrass, for example, rose considerably in photoperiods 22/2 and 18/6 h as compared to the shorter photoperiod (14/10 h) **(Fig 3c-3f)**. This observation was consistent with previous studies of Hay (1990) in case of~~:Daylength extension resulted in significantly enhanced~~ dry-matter production of grass species like ~~by~~ high-latitude types of *Phleum pratense* (both vegetative and reproductive),

Comment [MC16]: Which genotype?

Poa pratensis (vegetative), and *Bromus inermis* (vegetative). ~~(Hay,1990).~~

Flowering transition is a critical feature in plant growth that signifies the end of the vegetative phase and the start of the reproductive state (Quiroz et al, 2021). In our investigation, ~~we~~ it has ~~discovere~~found that ~~prolonging~~ proloned ~~the~~ photoperiod in the controlled greenhouse might encourage the bermudagrass to bloom earlier, with the bermudagrass blooming first under the circumstance of a longer photoperiod 22/2 **(Fig 5c,5d)**. This finding was congruent with that of *A~~a~~rabidopsis thaliana*, a characteristic long-day plant that blooms sooner on long days and slows blooming on short days (Samach, 2000; Suárez-López et al, 2001; Fornara, Montaigu & Coupland, 2010; Ye et al, 2021). The use of longer photoperiod to boost plant development has long been investigated; Sysoeva et al. (2010) undertook a thorough survey of the literature on this issue published in the previous 90 years (Sysoeva et al,2010), including spring wheat (Sc. Name), barley (Sc. Name), peas (Sc. Name), radish (*Raphanus sativus*), alfalfa (*Medicago sativa*), flax (*Linum usitatissimum*), and arabidopsis (*Arabidopsis thaliana*) are among them. Lentils (*Lens Culinaris*), pea (*P. sativum*), canola, chickpea (*C. arietinum*), faba bean (*Vicia faba*), lupin (*Lupinus angustifolius*), sugarcane (*Saccharum spp. hybrid*), and clover (*Trifolium subterraneum*) are some of the more recent instances of employing photoperiod to speed up crop blooming(Mobini & Warkentin, 2016; Croser et al, 2016; Pazos-Navarro et al, 2017; Saeid et al, 2016; Zheng et al, 2013; Deng et al, 2015; Manechini et al, 2021). In addition, for plant introduction and breeding, extending the light in the controlled greenhouse and artificially changing the photoperiod are crucial. The technology of speed breeding, which allows for rapid generational growth, has been tweaked to generate up to six generations of wheat each year. As a result, it's a useful tool for cutting the breeding cycle (Alahmad et al, 2018).

~~Our~~ The research level on bermudagrass is not commensurate with the rich genetic resources

(Devitt et al., ~~; Bowman&Schulte,~~ 1993), the collection of germplasm resources is not comprehensive enough, the breeding research techniques are single, and the technical content is low. At the moment, the majority of bermudagrass utilized in China is still imported types, which have the disadvantages of being a single species, being easily degraded, and having weak tolerance to adversity (Wu et al, ~~,~~ 2007; Casler, Duncan & Ronny et al., ~~,~~ 1976; Harlan & Wet, 1969). Furthermore, because most warm-season turfgrass varieties are asexual, long-term population improvement is required during the seed propagation process to identify superior parental lines, which is typically accomplished through population selection, population breeding, and rotational selection, among other methods. The most essential phase in this process is determining the next variety in a new hybrid population, and it takes years of thorough screening and testing to uncover superior genotypes that persist and are considerably superior to the present variety (Hanna et al, 2013). Several molecular techniques have been developed to expose the diversity of crop natural germplasm resources. DNA amplification fingerprinting (DAF), random amplified polymorphic DNA (RAPD), amplified fragment length polymorphism (AFLP), inter-simple sequence repeat (ISSR), and sequence-related amplified polymorphism (SRAP) markers are among the molecular markers used to assess the genetic diversity of bermudagrass (Etemadi et al., 2005; Gulsen et al., 2009; Zhang et al.,1999; Farsani et al., 2012). Furthermore, lawns for landscaping must be checked for pest resistance to maintain the lawn's long-term functional quality. Genetic resistance is the major way of pest management, with new kinds that may be enhanced for disease resistance utilizing traditional and molecular breeding methods (Gusmo et al., 2016). Rapid generation evolution to purity following crossing in a breeding setting will boost genetic gain of essential features and enable for more rapid development of better varieties through the breeding program (Stacy et al,2006). As a result, we proposed a rapid

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generation system for bermudagrass in the greenhouse with additional supplemental light, extending the photoperiod to 22/2 h, to accelerate plant development and thus shorten the breeding time, and it was successful in reducing the flowering time of common bermudagrass to 44 days and that of African bermudagrass to 36 days. It has been demonstrated that African bermudagrass has a high genetic diversity and may be utilized to improve intraspecific and interspecific breeding (Kenworthy et al.,2006). To speed progress, it is critical to identify the flowering thresholds of African bermudagrass and common bermudagrass.

This study reduced breeding time by increasing the amount of sunshine, which investigated a successful method and gave a new notion for bermudagrass breeding. Furthermore, fast breeding may be integrated with molecular biology, such as genomics, high-throughput sequencing, and genome editing, to increase the speed and precision of developing excellent varieties.

Conclusion

This study was carried out ~~to lengthen the photoperiod~~ in the controlled greenhouse in order to explore the influence of enhanced daylight length on the development and flowering of bermudagrass. Longer daylight length 22/2 h (22 hours light/2 hours dark) clearly enhanced the development and flowering and eventually reduced the~~, cutting~~ flowering period to 44 days for common bermudagrass and 36 days for African bermudagrass.

Acknowledgments

We thank Prof. Jinmin Fu for the valuable advice on the design of the experiments.

Additional information and declarations

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Competing Interests

The authors declare there are no competing interests.

Author Contributions

G.W. and J.F. designed and coordinated the study. M.J wrote the manuscript and performed the data analysis.All authors approved the manuscript.

Data Availability

The following information was supplied regarding data availability: The raw data are available in the Supplemental Files.

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- References are not presented in prescribed style.
- Vol/issue/page number is missing in many cases.
- Pls follow the reference style prescribed by journal.

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Comment [MC24]: ?

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Figure titles and legends

Figure 1 The settings of different photoperiods in the greenhouse

The control of photoperiod was achieved in controlled greenhouses by supplementary lights. The supplementary light was automatically turned off for two hours from 9pm to 11pm every day to achieve a 22/2 h photoperiod;. Under the same light settings as 22/2 h, 18/6 h photoperiod was achieved by covering withed by paper boxes at 5pm and uncovered at 9pm; Under the same light

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Comment [MC26]: Rewrite the title.

Figure 2 Temperature and light intensity in the greenhouse

(a) Greenhouse temperature and (b) illumination intensity were recorded during the experiment.The data for one of the weeks was taken and made into the small graph in the upper right corner.

Figure3 Differences in the growth of common bermudagrass(A12359)and Africanbermudagrass (ABD11) under different photoperiods

The line graph depicts the plant height of materials A12359 (a) and ABD11 (b), fresh weight of A12359 (c) and ABD11 (d), dry weight of A12359 (e) andABD11 (f), fresh weight of shoots and roots after harvest of A12359 (g) and ABD11(h), dry weight of shoots and roots after harvest of A12359(i) and ABD11(j),Each material is designed to be replicated three times.According to the SNK test at P< 0.05, different lowercase letters indicate significant differences.

Comment [MC27]: Of what?

Figure 4Differences of nutrient absorption in bermudagrass under different photoperiods

The graph depicts the N and P contents of A12359 and ABD11. Fresh samples from each mowing were dried and utilized to determine the nitrogen (N) and phosphorus (P) levels (P). (a) Changes of P content in A12359 under different photoperiods. (b) Changes of P content in ABD11 under different photoperiods. (c)Changes of N content in A12359 under different photoperiods. (d)Changes of N content in ABD11 under different photoperiods. Each material is programmed to have three duplicates. According to the SNK test, different lowercase letters indicate significant differences at P< 0.05.

Figure 5 Differences in the branching and flowering of common bermudagrass (A12359) and African bermudagrass (ABD11) under different photoperiods

The graph depicts the blooming and branching of A12359 and ABD11. Every two weeks, the number of branches was tallied, and every two days, the number of blossoms was counted. (a) Branch number variation ofA12359 under different photoperiods. (b) Branch number variation of ABD11 under different photoperiods. (c) Changes of flowering number of A12359 under different photoperiods. (d) Changes of flowering number of ABD11 under different photoperiods. Each material is designed to be replicated three times. According to the SNK test at $P< 0.05$, different lowercase letters indicate significant differences.