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Photoperiodic effects on the growth and yield of *Coixlacryma-jobi* L. cultivar

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Abstract: *Coixlacryma-jobi* L. is a very useful medicine and widely used for various human diseases such as abdominal tumors, cancer, and respiratory tract infections. However, its growth and yield response to different photoperiods has not been studied yet. In this study, three periods (three-leaf, five-leaf, and eight-leaf) and two shading treatment periods (8 and 11 hours daylight) were designed to investigate the effects of photoperiod on the growth and yield of *Coix* cultivars in Sichuan China. Four cultivars were selected and obtained from Beijing, Shandong, Nanjing, and Ya'an, respectively. Several agronomic characteristics of *Coix*, such as tillers, effective tillers, leaf number, plant height, and yield traits, were recorded. The results indicated that Beijing cultivar was more sensitive to light than other cultivars on the short-day growth rate. Southern cultivars show earlier daylight sensitivity than northern cultivars, while daylight length of the northern cultivars was longer than that of southern cultivars. For plant height, photoperiod had more impact on *Coix* at the earlier period than the late period. The three-leaf period was more sensitive to daylight than the five- and eight-leaf period, and the longer shading treatment of the three-leaf period promoted *Coix* to produce more tillers. Our study reveals that shading treatment shortens the growth of *Coix* and can accelerate the transition from nutritive to reproductive growth. It was found that photoperiod had a significant influence on the growth of *Coix* but exhibited no influence on its yield.

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Keywords: Photoperiod, *Coixlacryma-jobi* L., induction of short-day, growth, yield

1. Introduction

In 1920, Garner and Allard first introduced the concept of photoperiod [1, 2]. Since then, many scientists have confirmed the important effects of photoperiod on the development of plants and flowering induction on crops such as rice, wheat, and soybean [3-5]. By artificially controlling photoperiod, early or delayed flowering can be achieved for the process of plant crossbreeding in addition to facilitating the production of ornamental plants. During the introduction of plant crops, it is essential to study their photoperiodic and local requirements.

Coixlacryma-jobi L., commonly known as Job's tears, is considered a nutritious health food (commonly found in cereals) in Asian countries (China, India, Pakistan, Sri Lanka, and Malaysia). Its roots and grain are also used for traditional Chinese medicine, as Job's tears contain chemicals that could potentially inhibit cancer cell growth. Furthermore, they exhibit antioxidant effects and are able to decrease the bacteria and parasitic growth; many people take Job's tears for hay fever, high cholesterol, cancer, warts, arthritis, obesity, respiratory tract infections, etc. [6-10]. Although we have previously reported the effects of *Coix* sowing dates on its yield [11], there is no report about its photoperiod [6, 8, 12, 13]. In this study, four *Coix* cultivars from Shandong, Nanjing, Ya'an, and Beijing were selected to represent the northern, southern, and local cultivars in China. The goal of this study is to investigate and determine the effects of photoperiod on the growth and yield of *Coix* cultivar in Sichuan China.

2. Materials and Methods

2.1 The source of materials

Four *Coixlacryma-jobi* L. cultivars of Shandong, Nanjing, Ya'an, and Beijing were obtained from Shandong Agricultural University, Nanjing Agricultural University, Sichuan Agricultural University, and Chinese Academy of Agricultural Sciences, respectively.

2.2 The design of the experiment

The experiment was carried out at Sichuan Agricultural University in China. The screening grains were sowed on the medium plates (mixture of fine sand and sawdust, the ratio was 2:1, sterilized). Then the plates were placed into incubators to germinate (30℃ /8 h and 25℃/16 h). After three days (Apr. 6, 2004), the well-chosen shootings were transferred to the experiment field at Sichuan Agricultural University. All shootings were planted in pots as our previous study [11], and 4 pots for each treatment (4 repeats), two shootings in each pot. Two shading treatment, 8 hours daylight (shading from 5 PM to 9 AM), and 11 hours daylight (shading from 7 PM to 8 AM), were tested (Table 1). Shading facilities were bamboo structure framework (2.0 m high), and shading material is opaque, slightly breathable, and dark plastic. All other agronomic practices were kept normal and uniform for all the treatments. The records included tassel day, plant height, effective tillers, panicles, 1000-grain weight, grain yield, etc.

2.3 Statistical Analysis

Statistical analysis on the data was performed with Excel, ANOVA, SSR, etc.; differences among treatment methods were compared using a least significant difference test at a 5% or 1% probability level [14].

3. Results

3.1. The effects of shading treatment on the development of Coixlacryma-jobi L.

While the days took from transplanting to tassel of Beijing cultivar was significantly shorter than the days of transplanting to tassel of the other three cultivars, the differences among the other three cultivars was not significant. We predicted that introduction of northern cultivar to the south would accelerate the growth and development and induce early flowering as characteristic of short-day plants. Compared with the Nanjing and Ya'an cultivars, Shandong cultivar – a northern cultivar – showed no significant differences from transplanting to tassel. After the shading treatment, however, the fertility period of Shandong cultivar was greatly reduced and the promotion rate of short-day (8 hours daylight in three-leaf period) was 12.5% (Table 1). This was higher than those of Nanjing and Ya'an cultivars, and suggests that the flowering time of Shandong cultivar was earlier in the south than in the north. Because it was later than Beijing cultivar, the data indicates that Beijing cultivar is more sensitive to photoperiod than other cultivars. This study is consistent with data from Hongmei Ou [15], whose study demonstrated that the growth period of soybean in high latitude regions was shortened when it was planted in low latitude regions.

From treatment time in Table 2, the number of days from transplanting to tassel was significantly lower than control on matter it was 8 or 11 hours of daylight. Especially, the result (63.10) of 8 hours of daylight treatment was extremely significant smaller than that (65.52) of 11 hours daylight. For the short-day promotion rate, 8 hours daylight treatment was the highest in each treatment period. Additionally, seen from each factor in Table 2, there are no interactions between cultivars and treatment period.

3.2. Effects of shading on the fertility process of C. lacryma-jobi L.

3.2.1 Effects of shading treatment on plant height of C. lacryma-jobi L.

For different cultivars, the analysis of variance indicated that the plant height of Ya'an cultivar is significantly higher than other cultivars, and Shandong cultivar is second, while no significant difference is shown between Nanjing and Beijing cultivars (Table

2). Generally, four cultivars were not high due to two reasons. On the one hand, it is determined by the genetic characteristics of plant cultivars, and on the other hand, it is associated with the pots because they are so small that it could be very difficult to hold water and absorb enough fertilizer to meet the growing requirements of *Coix*.

For the different treatment periods (Table 2), that is, the three-, five-, and eight-leaf period, the plant height was significantly different from the control. The plant height of the three-leaf period was significantly shorter than those of the other two periods, and the plant height of the five-leaf period was significantly shorter than that of the eight-leaf period. This indicated that the photoperiod treatment had a higher impact on the earlier stage than the late stage, and the photosensitive of the earlier stage was stronger than the late stage. For the different treatment time, the plant height of 8 and 11 hours of daylight was extremely significantly shorter than their control, and the plant height of 8-hour-daylight was also very significant shorter than that of 11-hour-daylight.

Table 1 The effects of shading treatment on tassel time of *C. lacryma-jobi* L.

Cultivars	Treatment Period	Light (hours)	Tassel Date	Tassel Days	Whole Growth Period (Days)	Short-Day Promotion Ratio (%)
Beijing	Three-leaf	8	Jun. 6	51	104	16.39
		11	Jun. 8	53	108	13.11
	Five-leaf	8	Jun. 12	57	104	6.56
		11	Jun. 13	58	106	4.92
	Eight-leaf	8	Jun. 16	61	108	0
		11	Jun. 16	61	120	0
	CK1	~14	Jun. 16	61	108	-
Nanjing	Three-leaf	8	Jun. 8	60	106	9.09
		11	Jun. 9	61	116	7.57
	Five-leaf	8	Jun. 14	66	105	0
		11	Jun. 14	66	109	0
	Eight-leaf	8	Jun. 13	65	108	1.52
		11	Jun. 14	66	120	0
	CK2	~14	Jun. 14	66	109	-
Ya’an	Three-leaf	8	Jun. 9	61	104	10.29
		11	Jun. 14	66	122	2.94
	Five-leaf	8	Jun. 13	65	107	4.41
		11	Jun. 13	65	106	4.41
	Eight-leaf	8	Jun. 15	67	108	1.47
		11	Jun. 14	66	106	2.94
	Ck3	~14	Jun. 16	68	141	-
Shandong	Three-leaf	8	Jun. 8	63	106	12.50
		11	Jun. 16	68	122	5.56
	Five-leaf	8	Jun. 14	66	121	8.33
		11	Jun.15	67	106	6.94
	Eight-leaf	8	Jun. 20	72	121	0
		11	Jun. 20	72	120	0
	CK4	~14	Jun. 30	72	150	-

Note: CK1-CK4 was the corresponding control classes of different cultivars.

Surprisingly, in regards to the interactions of each factor (Table 3), there are no interactions between cultivar and treatment period. There is an interaction between cultivar and treatment time. In addition, the plant height of Nanjing, Beijing, and Ya'an cultivars treated with 8 hours daylight in three- and five-leaf periods is shorter than that of 11 hours daylight treatment, while Shandong cultivar was opposite (Table 4). The plant height of the four cultivars treated with 8 hours daylight in the eight-leaf period was shorter than those of the 11 hours daylight and control treatment. This indicated that the length of shading time had obvious impact on the height of *Coix*, while the differences between the different treated periods

Table 2 The remarkable level among the factors of each treatment.

Source of Variation		Tassel Day (mean)	Plant Height (mean)	No. of Leaf	Tillers (Mean)
Cultivars	Beijing	66.53aA	113.86cC	13.14cC	4.81aA
	Nanjing	65.52aA	112.00cC	13.47cBC	4.92aA
	Ya'an	65.18aA	134.06aA	14.47aA	4.77aA
	Shandong	64.23bB	123.50bB	13.94bB	4.18bB
Treatment period	Three-leaf	63.40bB	114.92cB	13.21cB	4.96aA
	Five-leaf	66.81aA	121.79bA	13.85bA	4.54bA
	Eight-leaf	66.98aA	125.85aA	14.21aA	4.50bA
Treatment time	8 hrs	63.10cC	110.58cC	13.31bB	4.68aA
	11 hrs	65.52bB	115.85bB	13.40bB	4.75aA
	ck	68.56aA	136.13aA	14.56aA	4.56aA

Table 3 The interactions of shading treatment on tassel time, plant height, leaf number, and effective tillers of *C. lacryma-jobi* L.

SOV	df	Tassel Time				Plant Height (cm)				No. of Leaf				Effective Tillers			
		SOS	MS	FV	SL	SOS	MS	FV	SL	SOS	MS	FV	SL	SOS	MS	FV	SL
Set	3	43.58	14.53	1.57	0.20213	678.02	226.01	3.34	0.02207	4.58	1.53	2.32	0.08002	5.39	1.80	2.31	0.08046
A	3	381.52	127.17	13.71	0.00000	11108.74	3702.91	54.76	0.00000	36.35	12.12	18.39	0.00000	12.39	4.13	5.31	0.0019
B	2	392.67	196.33	21.16	0.00000	2934.38	1467.19	21.70	0.00000	24.68	12.34	18.73	0.00000	6.17	3.08	3.97	0.02183
C	2	718.17	359.08	38.70	0.00000	17457.04	8728.52	129.09	0.00000	46.89	23.44	35.59	0.00000	0.88	0.44	0.56	0.57127
A×B	6	21.50	3.58	0.39	0.88641	262.74	43.79	0.65	0.6919	4.04	0.67	1.02	0.41487	3.61	0.60	0.77	0.59181
A×C	6	383.50	63.92	6.89	0.00000	2047.74	341.29	5.05	0.00014	3.17	0.53	0.80	0.5712	2.90	0.48	0.62	0.71194
B×C	4	317.92	79.48	8.57	0.00001	1958.58	489.65	7.24	0.00003	12.99	3.25	4.93	0.00111	4.83	1.21	1.55	0.19192
A×B×C	12	69.42	5.78	0.62	0.81806	824.97	68.75	1.02	0.43918	4.63	0.39	0.59	0.84998	8.22	0.69	0.88	0.56782

Note: SOV-Source of variation; SOS-Sum of squares; MS-Mean square; FV- F value; SL- Significance level.

Table 4 The variance analysis of shading treatment on plant height, leaf number, and effective tillers of *C. lacryma-jobi* L.

Cultivars	Plant Height (cm)							No. of Leaf							Effective Tillers						
	Three-leaf		Five-leaf		Eight-leaf		CK1	Three-leaf		Five-leaf		Eight-leaf		CK2	Three-leaf		Five-leaf		Eight-leaf		CK3
	8 hr	11 hr	8 hr	11hr	8 hr	11hr	~14 hr	8 hr	11 hr	8 hr	11hr	8 hr	11hr	~14 hr	8 hr	11 hr	8 hr	11hr	8 hr	11hr	~14 hr
Beijing	94.38	108.86	115.50	120.12	107.88	123.71	129.33	12.14	13.00	13.75	13.00	14.57	14.29	15.67	4.65	4.38	4.38	3.75	3.63	3.63	3.75
Nanjing	93.38	94.00	115.71	113.17	97.63	104.13	131.30	13.50	13.43	14.25	14.25	14.75	14.88	15.25	5.33	5.32	4.50	4.13	3.50	3.40	3.75
Ya'an	113.25	115.25	130.50	136.50	126.00	137.63	149.75	12.40	12.80	13.67	13.71	13.57	13.43	15.00	4.28	4.25	4.00	3.78	3.88	3.88	3.87
Shandong	104.38	102.25	123.86	120.75	105.00	127.63	130.33	11.38	11.88	12.86	13.00	13.25	13.50	15.25	4.45	4.38	3.63	3.13	3.25	3.15	3.25

Table 5 The effects of the different treatment and cultivar on the yield and the yield character of *C. lacryma-jobi* L.

Different Treatment		Effective Panicle (ten thousand/hm^2)	Grains Per Panicle （grains/panicle）	1000-grain weight (g)	Grain Setting Rate（%）	Production（kg/hm^2）	Main Stem（mean）		Spike (mean)	
							1000-grain weight	Grain Number	1000-grain weight	Grain Number
Cultivars	Shandong	18.44bB	20.50cC	159.75aA	45.43abA	3971.46aA	158.64aA	23.22cC	160.86aA	17.78bB
	Ya'an	21.14aA	26.60bB	83.19cC	45.87abA	2576.51dC	81.73cB	32.45bB	84.64bB	20.67aAB
	Nanjing	21.76aA	27.04Bb	88.50bB	43.19bA	2903.15cC	88.90bB	32.54bB	88.10bB	21.64aA
	Beijing	21.27aA	38.39aA	86.21bcBC	47.03aa	3498.19bB	87.44bB	57.14aA	84.97bB	19.64abAB
Treatment Period	Tree-leaf	21.94aA	28.39aA	101.00bB	45.29aA	3386.94aA	100.16bB	36.04aA	101.85bB	20.75aA
	Five-leaf	20.10bA	28.30aA	106.14aA	46.43aA	3191.94aA	106.88aA	37.71aA	105.41aAB	18.90aA
	Eight-leaf	19.91bA	27.71aA	106.09aA	44.43aA	3133.67aA	105.49aAB	35.27aA	106.68aA	20.15aA
Treatment Time	8 hours	20.74aA	26.7bA	103.80aA	43.56bA	3275.79abAB	103.19aA	34.81aA	104.40aA	18.65aA
	11 hours	21.02aA	27.42abA	105.62aA	45.36abA	3399.21aA	104.88aA	34.25aA	106.36aA	20.08aA
	CK	20.19aA	30.26aA	103.82aA	47.22aA	3036.99bB	103.45aA	39.45aA	103.18aA	21.06aA

were relatively small. There are no interactions among cultivars, treatment periods, and treatment time.

Based on the above analysis, it shows that the effects of photoperiod on the plant height were the most significant in three-leaf period treated by 8 hours daylight. Therefore, photoperiod of three-leaf period was more sensitive to daylight than the other periods, and longer shading resulted in more clearly defined effects.

3.2.2 Effects of shading on the leaf numbers of C. lacryma-jobi L.

For a given cultivar, there were no significant changes among the different treatment periods during the entire growth process (Figure 1). The changes initially increased and then slowly leveled. It took the least time for the three-leaf period to reach the maximum value of time than those of other treatments, but the maximum leaf number of three-leaf period was less than the control and other treatments. The trend of the five-leaf period was similar to that of the three-leaf, and there was no significant difference between the eight-leaf and the control. This indicated that the effects of the shading treatment have similar patterns for different cultivars.

Table 3 shows that there were interactions between the shading treatment period and treatment period. The leaf number of Shandong cultivar treated by 8 hours daylight was less than that of 11 hours daylight treatment while the Beijing cultivar had an opposite trend. The leaf number of Nanjing cultivar treated by 8 hours daylight of three- or five-leaf period, was less than that of 11 hours daylight treatment, while the result of the eight-leaf period was the opposite. Regardless of the cultivar type, the leaf number of the three-leaf period was less than that of the five-leaf and eight-leaf period when exposed to 8 or 11 hours daylight. This showed that the three-leaf period treatment had the greatest impact on the leaf number.

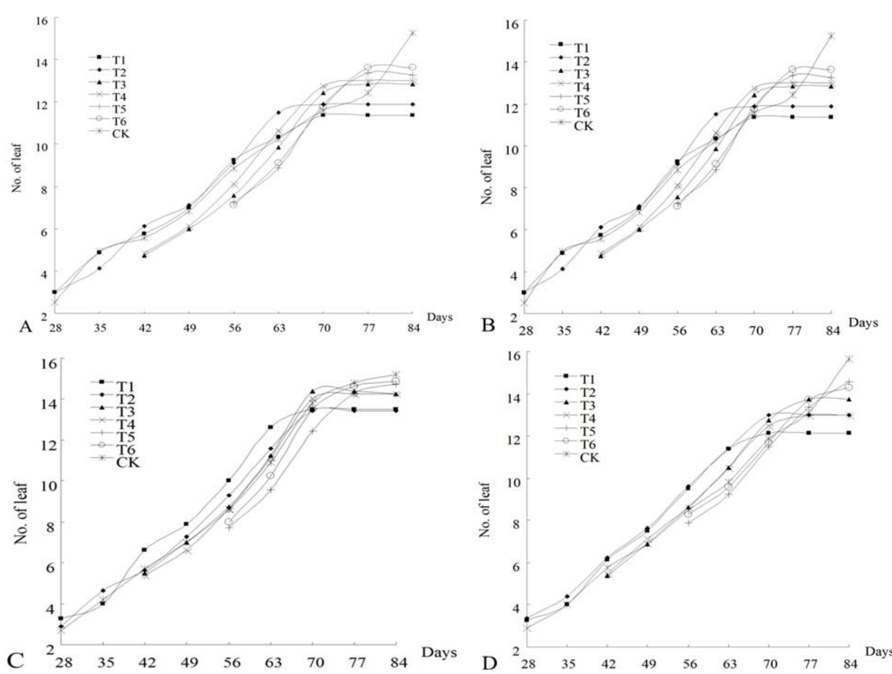

Fig. 1. The dynamic curve of different cultivars’ leaf number (A: Beijing, B: Nanjing, C: Ya’an, D: Shandong).

Interestingly, Table 2 shows the shading treatment had great impact on the final number of leaves. Beijing cultivar had the least number of leaves, with an average of 13.14. The Ya'an cultivar was the highest

(14.47). The analysis of variance showed that the number of leaves of Ya'an cultivar was significantly higher than that of other cultivars. In different treatment periods, the number of leaves in three-leaf, the five-leaf, and eight-leaf periods was very significantly less than control. The number of leaves in three-leaf period was significantly less than the other two periods, and the eight-leaf period had the largest number of leaves, with an average of 14.21. The three-leaf period was at least, with an average of 13.21. This indicates that the photosensitive three-leaf period treatment was higher than that of five-leaf and eight-leaf periods. For different treatment times, the average leaf number of 8 and 11 hours daylight treatment were extremely significant less than control. However, there is no significant difference between 8 and 11 hours of daylight treatment, as the mean of 8 hours daylight treatment was slightly smaller less than that of 11 hours daylight treatment.

By analysis of the final leaf number of shading treatment on *Coix*, the effect of the three-leaf period treated by 8 hours daylight was more significant. This illustrated that both the southern and northern cultivar of three-leaf period was much sensitive to daylight than the five-leaf and eight-leaf periods. However the sensitivity of Beijing cultivar was stronger than the other cultivars and this is in line with the analysis of the short-day promotion rate.

3.2.3 Effects of shading treatment on the effective tillers of C. lacryma-jobi L.

As shown in Fig.2, changes in trends first increased, then decreased, and finally leveled. It took the least time to achieve the maximum value of time at the three-leaf treatment than those of the other treatments. However, the maximum tiller number between five-leaf and eight-leaf period was not significant. The average maximum tiller number of three-leaf period was more than any other treatment. *Coix* generally started tillering at three-leaf period. This indicated that three-leaf period shading treatment had influence on *Coix* tiller, and the rate of three-leaf period was faster and reached the maximum rate, then decreased sharply, while the tiller number of three-leaf period was greater than those of five-leaf and eight-leaf periods. This suggests that shading treatment could promote *Coix*tillering and the effects were the same to the different cultivars.

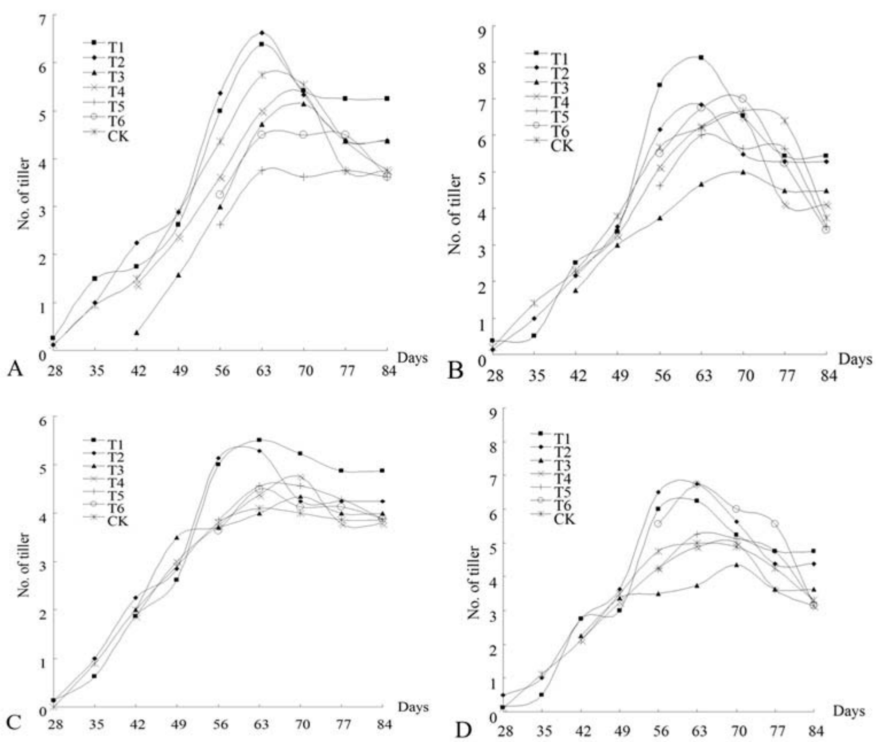

Fig. 2.The dynamic curve of different cultivars' tiller number. (A: Beijing cultivar, B: Nanjing cultivar, C: Ya'an cultivar, D: Shandong cultivar)

The effects of shading treatment on the effective tillers of *C. lacryma-jobi* L. is summarized in Table 4, and the remarkable level among the factors of each treatment is listed in Table 2. By variance analysis of the different cultivars, the effective tillers of Shandong cultivar were found to be significantly less than the other three cultivars, while the difference among the other three cultivars was insignificant. The tiller number of Shandong cultivar was a smaller amount and this may be due to genetic characteristics and unrelated to photoperiod treatment. By analysis of different treatment periods, effective tillers of three-leaf shading treatment were more significant than that of five-leaf and eight-leaf period treatment. The mean effective tillers of three-leaf period treatment were also higher than that of control. Therefore, three-leaf period of shading treatment could promote the effective tiller number. The five-leaf and eight-leaf period of treatment was not significant. By analysis of different treatment time, it showed that the effective tillers of 8 hours and 11 hours daylight treatment did not have significant changes, and both treatments were also not significant difference from the control. This indicated that the length of treatment time had no effect on the number of effective tillers.

Similarly, as shown in Table 3, there is no interaction among cultivar, treatment period, and treatment time. This showed that photoperiod had impact on the effective tillers number, and it had little effect on the duration time.

3.2.4 Effects of shading on yield character of C. lacryma-jobi L.

Based on the analysis of the constituent elements of yield, shading treatment had a certain impact on grain weight and effective panicle number. The *Coix* yield depended product of grain weight, panicle grain, and effective tillers. From the previous analysis, the effective panicles had no relation to the length of the shading but rather the shading period (the tiller number was more than any other period). From the overall analysis of Table 5, the shading treatment had increase on the yield but the increase was not significant.

Under the different shading treatment conditions, the different cultivar yield and yield components showed great differences. Different treatments had inconsistent impact on the yield due to different factors. 1000-grain weight of Shandong cultivar was the highest, but effective panicles and grains per panicle were the lowest; Beijing cultivar had more effective panicles, and grain rate was relatively high, but the yield was not the highest; Shandong cultivar had the highest yield due to the genetic characteristics, and mainly because this cultivar had large grain with thick shell.

For the different treatment period of the same cultivar, effective panicle of the three-leaf period was the highest, but 1000-grain weight was lowest. There was no significant effect on panicle. The overall analysis of the yield of the three treatments shows no significant difference from the control. Based on the data for treatment time, treatment had no significant effect on the yield components, but the grain rate of 8 hours daylight was significantly different contrasting to control. The final yield of shading treatment was higher than that of control, but it didn’t show significant difference.

From the data in Table 5, 1000-grain weight of Shandong cultivar was significantly higher than that of the other cultivars on both main stem and spike while grain number of Shandong cultivar was significantly lower than that of the other three cultivars. This may be a reason why 1000-grain weight of Shandong cultivar was higher but the yield was less. In addition, the main stem grain number of Beijing cultivar was significantly higher than that of Nanjing and Ya'an cultivars, but the difference among the spike grain number of these three cultivars were not significant.

In different treatment periods, 1000-grain weight of five-leaf period of shading treatment was significantly higher than the other treatment periods on both main stem and spike. For spike grain numbers, there was no difference among the three treatments, which indicated that this had no impact on *Coix* grains. The 1000-grain weight of control was higher than that of treatment. For the grain number, there was no significant difference between treatment and control. This showed that the duration of the shading treatment had little effect on the *Coix* grain weight or grain number.

Based on the above analysis, shading treatment had inconsistent impact on 1000-grain weight and grain number in different periods and different time. Thus leading to the effect of its production was also inconsistent. Moreover, it indicated that shading treatment had no significant impact on the final yield of *Coix*. Therefore it was impossible to shorten the length of a certain daylight period to increase the yield of *Coix*.

These results are consistent with the study of Gui-Ru Zhang [16] about photoperiod effect on soybean yield. Some cultivars decreased significantly in grain number and grain weight per plant, while other cultivars did not change or there was an increasing trend after shading treatment. Therefore, the photoperiod of *Coix* daylight cycle is very complex, and the relationship between the yield factors and photoperiod need further study.

4. Discussion and Conclusion

As a typical photoperiod approach, the shading treatment has long been widely used on many field crops, flowers, and vegetables. However, there are few studies on the effect of photoperiod on *Coix* growth. According to previous studies, shortening or extending the number of daylight hours can induce the early or late flowering of plants. This measure provides a great opportunity for breeders to influence flower germination. Horticulturists can take advantage of new photoperiod treatment techniques to enrich the flower market, to improve the ornamental value, and further increase the production yield of off-season vegetables to maintain the health and well-being of people.

In this experiment, two treatment times and three periods were designed to study the effects of photoperiod treatment on *Coix*. Analysis from the number of tillers, the final number of leaves, and plant height, etc. showed that the effects of Shandong and Beijing cultivars in a five-leaf period were greater than those of Ya'an and Nanjing cultivars. These findings indicate that the photosensitive period of southern cultivars begins earlier than that of the northern cultivars, while the northern cultivars may have longer duration periods than southern cultivars.

Photoperiod has an earlier effect on Southern cultivars than the northern cultivars. By analysis of short-day promotion rates, photosensitivity intensiveness follows Beijing cultivar, Shandong cultivar, Ya'an and Nanjing cultivars, respectively. Four cultivars of the three-leaf period showed an increase in the number of tillers and a reduction in the number of leaves, plant height, flower semination time, and growth period as compared to that of the five-leaf and eight-leaf period.

Our results are consistent with the study of Yu Yulin [17] on Mexican corn, which reported that the flowering period of Mexican corn's main stem was drastically reduced after 9 and 11 hours of daylight treatment. Gui-Ru Zhang [16] also found that the total number of leaves treated by 8 hours of daylight was less than that of natural daylight. Therefore, without reducing the yield, we believe that the dwarf *Coix* should be stronger than taller stalk on lodging resistance, and it will additionaly have earlier flowering and a shorter growth period. Furthermore, it will also reduce agricultural consumption, increase the yield per unit area, and enhance the income. In conclusion, the results demonstrate that shading treatment shortens the growth of *Coixlacryma-jobi* L. and accelerates its transition from nutritive to reproductive growth, but ultimately has little influence on product yield.

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