Iran Agricultural Research 6: 45-56 (1987).

NOTE

USE OF LIGHT IN SEED POTATO STORAGE[1]

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ABSTRACT

The effects of light and darkness under cold and warm storage on potato (*Solanum tuberosum* L. cv. Cosima) were studied in two experiments in 1983 and 1984. In the first experiment warm storage increased loss in weight and number of sprouts per tuber. In the field, it resulted in earlier emergence, higher plant vigor, and earlier flowering but had no effect on yield. Storage under light increased the number of sprouts, and under warm storage prevented the excessive growth of sprouts. In 1984, effects of illumination throughout storage, during the last five weeks, complete darkness and storage in burlap sacks were studied under cold and warm conditions, using the same cultivar. Warm temperature increased loss in weight, average length of sprouts and that of the dominant sprout, enhanced emergence and flowering but decreased the number of stems per plant. Illumination throughout storage increased the number of sprouts per tuber and number of stems per plant. Both light durations decreased the average length of sprouts and that of the dominant sprout. It may be concluded that illumination can make storage under warm condition possible.

تحقیقات کشاورزی ایران
۶(۱۳۶۶):۴۵-۵۶

استفاده از تنور در انبارداری سیب زمینی بذری

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خلاصه

درطی دوآزمایش شرایط انبارداری سیب زمینی بذری کوزیما بررسی گردید. درسال ۱۳۶۱

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اثرات نور و تاریکی تحت شرایط سرد و گرم مطالعه شد. انبارگرم افت وزن غده‌ها و تعداد چشم بیدار شده در هر غده را افزایش داد و در مزرعه نیز باعث تسریع در سبز شدن، رشد اولیه بیشتر و گلدهی زودتر گردید ولی روی عملکرد تاثیری نداشت. روشنائی سبب افزایش تعداد چشم بیدار شده در هر غده شده و در انبار گرم از رشد بیش از حد جوانه‌ها جلوگیری نمود. در سال ۱۳۶۲ اثرات روشنایی در تمام طول مدت انبارداری، روشنائی در ۵ هفته آخر انبارداری، تاریکی مطلق و انبار نمودن در گونی در تحت شرایط سرد و گرم مطالعه گردید. دمای بالا افت وزن غده‌ها، میانگین طول جوانه‌ها و طول جوانه غالب را افزوده، سبب تسریع در سبز شدن در مزرعه و گلدهی شد و تعداد ساقه در بوته را کاهش داد. روشنائی در طول مدت انبارداری تعداد چشم بیدار شده در غده و تعداد ساقه در بوته را افزود. هر دو تیمار روشنائی میانگین طول جوانه‌ها و نیز طول جوانه غالب را کاهش داد. میتوان چنین نتیجه‌گیری نمود که استفاده از نور، انبارداری سیب زمینی بذری کوزیما در شرایط گرم را امکان پذیر میسازد.

INTRODUCTION

In storage of seed potato (*Solanum tuberosum* L.), effort is made to prevent the excessive growth of the sprouts, minimize the loss in weight and lower the amount of shrinkage. The storage conditions suggested for seed potatoes require a temperature of about 4° C, 90% relative humidity, and lack of light (9, 11). Considering the potato acreage in Iran which is about 115250 ha (1) there is need for storage facilities for about 230000 tons of seed potatoes for a duration of 5-6 months. However, the capacity of the present standard cold storages available for potatoes in the country is extremely limited and the traditional facilities for potato storage such as the basements and field trenches lack the suitable conditions and result in appreciable losses. According to some of the recent studies at the International Potato Center (CIP), it seems that the above mentioned standard conditions are not necessary. The field performance of potato plants from seeds stored in simple, inexpensive stores, under diffused day-light, at 25°C, was similar to those kept at 4° C (5). The diffused light was specially beneficial with storage temperatures of 11-14° C. The advantages over the storage under complete darkness were: increase in sprout number with short, green and sturdy characteristics; elimination of desprouting, reduction in storage losses; earlier and more uniform emergence and higher yields (3, 5, 7, 10). Moreover, storage under light

and ambient temperature eliminates the need for pre-sprouting. Although higher moisture losses are expected under warmer conditions, losses of up to 20% with no effect on field emergence and yield have been reported (6). Increase in resistance to *Erwinia carotovora* subsp. *carotovora* (7, 8) and increase in yield (3, 5, 7) have been reported when seeds were stored under diffused light. Regarding the intensity of light, experiments show that low intensities are adequate to control excessive sprout growth and further increase in intensity results in little additional effect (6, 8). This work was carried out to investigate the possibility of avoiding the expensive cold storage facilities through the use of light during the storage period.

MATERIALS AND METHODS

The study consisted of two experiments. In Experiment I in 1983, a cold (4 ± 2°C) and a warm (16 ± 1°C) store rooms were selected each divided in two sections. One section was kept completely dark and the other one was illuminated for 12 hr per day with 3.5 foot candle of florescent light. In each section, 40 kg of cured tubers (about 70 g each) of Cosima cultivar were stored in wooden flats for four months. At the end of storage period, measurements were taken on loss in weight, number of sprouted eyes per tuber and average length of sprouts of each tuber. The tubers were then kept at 18 ± 1°C and 3.5 foot candle light for three weeks prior to planting. In the field, the tubers from each treatment were planted in plots of three rows 11 m in length, using a randomized complete block design, with four replications. The he standard cultural practices were followed. Maturity was determined by examination of the skin of the tubers. The following measurements were taken during the growing season and at harvest: percent emergence 20, 30 and 40 days after planting, plant vigor (by rating) 28 days after planting, percent of plants at bloom 54 days after planting and yield per plot.

In 1984, Experiment II was carried out using a split plot design with three replications. The main plot consisted of two levels of temperature, i.e., cold (4 ± 2°C) and warm (17 ± 2°C). The sub-plots were assigned to four levels of light treatment: (i) 12 hr illumination per day throughout the storage period, (ii) 12 hr illumination per day during the last five weeks, (iii) complete darkness and (iv) storage in burlap sacks in complete darkness. For each treatment 40 kg of cured tubers (about 70 g each) of Cosima cultivar were used. For the first three levels of light treatment, the tubers were kept in wooden flats. After four months of storage, the following measurements were taken: percent diseased tubers, loss in weight, number of sprouted eyes per tuber, average length of sprouts per tuber and length of the dominant sprout. The tubers from each sub-plot (24 in total) were then planted in the field using a randomized complete block design with three replications. Each plot consisted of three rows, 10 m long. The following measurements were taken: percent emergence 20, 30 and 40 days after planting; percent of dead plants (due to diseases) at harvest; yield per plant and per plot. In the laboratory, the percentage of tubers infected with *Pseudomonas solanacearum* and *Fusarium* sp., the two most common diseases in the area, were determined.

For all the characters measured as percentages, except for loss in weight, the analysis of variance was done after the arcsine transformation of the data. No analysis of variance was done for vigor.

RESULTS AND DISCUSSION

Experiment I

Measurements taken at the end of storage are presented in Table 1. There is an increase in loss of weight and in number of sprouts due to warm temperature. Light increased the number of sprouts especially under cold conditions. Regarding

Table 1. Means of different characteristics measured at the end of the storage period, in Exp. I, 1983.

Treatment	Loss in wt %	No. of sprouts/tuber	Average length of sprouts/tuber cm
Cold-dark	5.0 ± 0.4	0.0	0.0
Cold-light	6.9 ± 1.7	2.8 ± 2.3	0.3 ± 0.1
Warm-dark	14.6 ± 0.5	3.5 ± 0.3	5.2 ± 1.2
Warm-light	12.3 ± 0.2	4.2 ± 0.5	1.1 ± 0.1

the length of sprouts, it seems that only under warm storage, light prevents excessive growth of sprouts. The means for the measurements taken in the field are given in Table 2. There was no significant interaction between temperature and light for any of the characteristics. Warm storage resulted in an earlier emergence, higher plant vigor, earlier flowering but with no effect on yield; whereas light had no significant effect on any of these characteristics.

Experiment II

The means for different characteristics measured during storage period are presented in Table 3. Warm temperature increased percent diseased tubers, loss in weight, average length of sprouts and length of the dominant sprout. Regarding the effects of light, illumination throughout the storage increased number of sprouted eyes per tuber. Similar results have been reported by others (3, 7, 10). The average length

Table 2. Means of different characteristics measured in the field, in Exp. I, 1983[†]

Treatment	Emergence % (days after planting)			Plant vigor[‡]	Plants at bloom[§]	Yield per plot
	20	30	40		%	kg
Temperature						
Cold	3.7b	23.8b	96.3	1.4	10.9b	105.2
Warm	20.5a	28.2a	95.0	3.3	40.8a	104.1
Illumination						
Dark	10.6	25.7	96.2	2.1	28.4	100.3
Light	13.5	26.3	95.1	2.5	23.2	109.1

[†]Mean comparisons were done at 5% level, using Student Newman Keuls' test.
[‡]Twenty eight days after planting, rated from 1 to 4, in increasing vigor.
[§]Fifty four days after planting.

Table 3. Means of different characteristics measured at the end of the storage period, in Exp. II, 1984[†]

Treatment	Diseased tubers %	Loss in wt %	No. of sprouted eyes/tuber	Average length of sprouts/tuber cm	Length of dominant sprout cm
Temperature					
Cold	1.5b	5.6b	2.2	0.2b	0.3b
Warm	3.0a	15.1a	2.7	4.3a	5.8a
Illumination					
Throughout storage	2.2	11.3a	3.0a	1.0b	1.4d
Last 5 wk of storage	2.2	10.2ab	2.5b	1.3b	1.9c
Complete darkness	2.7	11.2a	2.3bc	3.8a	5.0a
Burlap sacks	1.9	8.7b	1.9c	3.0a	3.8b

[†]Mean comparisons were done at 5% level, using Student Newman Keuls' test.

of sprouts was decreased by illumination throughout and during the last five weeks of storage. Similar results were obtained by other investigators (3, 7, 8, 10). Illumination, especially throughout the storage, decreased the length of the dominant sprout which is in accordance with the results reported by Potts (10). Storage in burlap sacks resulted in the least amount of loss in weight. There was an interaction between light and temperature with respect to average length of sprout and the length of the dominant sprout (Table 4). In both cases illumination had no effect under the cold temperature, whereas under the warm conditions there was a decrease in length with an increase in duration of illumination. This interaction could be due to the opposite effects of light and warm temperature on the physiological age of tubers, with the former delaying (4) and the latter advancing (2) the aging. Booth *et al.* (3) and Potts (10) studying the effect of diffused light under only warm temperature obtained similar results. The means for different characteristics measured in the field are presented in Table 4. Warm temperature enhanced emergence and date of bloom, decreased the number of stems per plant, but had no effect on yield. The effect of warm temperature on emergence and flowering can be attributed to its effect on aging the tuber seeds (2). The only effect of light was an increase in number of stems per plant due to illumination throughout storage. However, earlier emergence and some increase in yield have been reported by others due to the use of diffused day light (3, 5, 7). The discrepancy regarding the effect of light on yield could be due to the differences in cultivars and the storage conditions. In this experiment, artificial light, a temperature of about 17°C and no desprouting was used, whereas others used diffused day light, a temperature of about 11-14°C and applied desprouting. There was an interaction between light and temperature regarding the percent of emergence and number of stems per plant, with a negative relation between duration

Table 4. Treatment means for characteristics showing interaction between temperature and illumination, in Exp. II, 1984[†]

Treatment combination		During storage		In the field			
				Emergence % (days after planting)			
Temperature	Illumination	Average length of sprouts cm	Length of dominant sprouts cm	20	30	40	No. of stems/plant
Cold:	Throughout storage	0.3d	0.3e	8.5c	73.0cd	92.3ab	4.6a
	Last 5 wk of storage	0.2d	0.2e	8.5c	74.9c	90.9ab	4.4a
	Complete darkness	0.3d	0.4e	4.4c	63.6d	86.2b	3.9bc
	Burlap sacks	0.2d	0.2e	3.0c	71.7cd	90.2ab	4.2ab
Warm:	Throughout storage	1.7c	2.4d	45.1b	81.3b	91.3ab	3.8bc
	Last 5 wk of storage	2.4c	3.7c	54.5ab	86.6ab	93.0ab	3.5c
	Complete darkness	7.2a	9.7a	60.4a	90.8a	94.7a	3.8bc
	Burlap sacks	5.8b	7.5b	47.1b	84.2ab	92.9ab	3.4c

[†]Mean comparisons were done at 5% level, using Student Newman Keuls' test.

of light and percent emergence only under warm conditions. Regarding the number of stems, however, complete darkness decreased the number only under cold condition (Table 4). There was no correlation between the number of sprouts on the tubers (Table 3) and the number of stems in the field (Table 5).

From the results of the two experiments it can be concluded that illumination especially under warm storage conditions has beneficial effects regarding the number and length of sprouts. Moreover, the use of light makes storage under warm conditions feasible, which in turn enhances emergence and maturity. The treatments had no significant effect on yield. However, this could be due to manual planting of the tubers, thus avoiding the breakage of the long sprouts resulting from dark treatments. With mechanical planting, however, the better condition of the sprouts due to light treatment might result in a significant increase in yield.

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Table 5. Means of different characteristics measured in the field, in Exp. II, 1984[†]

Treatment	Emergence % (days after planting)			Plant vigor[‡]	No. of stems/ plant	Plants at bloom[§] %	Dead plants %	Yield/ plant kg	Yield/ plot kg	infected tubers %	
	20	30	40							bacteria	fungi
Temperature											
Cold	6.1b	70.8b	89.9b	2.5	4.3a	27.7b	18.9	1.2	76.8	11.3	14.9
Warm	51.8a	85.7a	93.0a	3.3	3.6b	44.0a	22.2	1.1	87.5	10.6	19.7
Illumination											
Throughout storage	26.8	77.2	91.8	2.8	4.2a	33.3	17.8	0.9	80.5	10.0	15.4
Last 5 wk of storage	31.5	80.7	91.9	3.2	3.9b	39.5	20.8	1.0	82.3	7.8	19.6
Complete darkness	32.4	77.2	90.4	2.8	3.8b	33.2	22.7	1.1	81.1	13.2	17.3
Burlap sacks	25.0	78.0	91.5	2.8	3.8b	37.4	20.8	1.6	84.7	12.8	16.9

[†]Mean comparisons were done at 5% level, using Student Newman Keuls' test.

[‡]Forty six days after planting, rated from 1 to 4, in increasing vigor.

[§]Seventy days after planting.

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