

Comparative Study of Effects of Illumination with Xenon or Sulfur Lamp on Development of Wheat Plants

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The emission of microwave sulfur lamp is mainly composed of visible light. This lamp producing little infrared radiation, has high light efficiency, long lifespan and less power consumption. In comparison with xenon lamp, growing under sulfur lamp apparently postponed jointing, increased the number of tillers, accelerated root growth of wheat. Relatively, xenon lamp evidently promoted heading and grain maturation. The development characteristics of wheat plant under sulfur lamp were more similar with that in natural condition.

Key Words: xenon lamp, sulfur lamp, joint, tiller, wheat

INTRODUCTION

Light is important to plant development. It is not only the energy source for photosynthesis, but also one of the most crucial factors determining plant photomorphogenesis. With the development of scientific and modern agricultural technology, crops could be grown following law of plant development in controllable environments, in which reasonable illumination condition should be carefully provided. Among commonly used agricultural lamp are xenon and metal halide lamp. Because little has been considered for acquisitions of plant development, traditional lamp are not well-designed in spectrum. The manufacturers of new agricultural lamp should keep their eyes closely on characteristics of plant development in order to design successful lamp fitting plant growth. Microwave sulfur lamp, appearing in light source market recently, has high illuminating efficiency and low energy consumption. It is different from xenon lamp mainly in producing little infrared radiation. Different effects of illumination on development of

wheat plant were observed, providing valuable knowledge for development of agriculture.

MATERIAL AND METHOD

Experiments were carried out in man-made climatic room from April to December in 2001. Plump seeds of Wheat(cv. Yangmai 158) were soaked in tap water for 24 hours and planted in concocted soil(turf:earth=1:1,V/V) after germination. Plants were grown in growing container, illuminated with $160-180 \mu \text{mol photons m}^{-2}\text{s}^{-1}$ for 16h at 22°C and then kept in darkness for 8h at 18°C to finish one growing day cycle. Xenon and microwave sulfur lamp were produced by the Electric Light Source Corporation, Fudan University.

Numbers of joints, tillers were counted on 29th, 40th and 50th day respectively. 5 plants were randomly chosen. Their roots were washed clean with tap water, exterior water of plants was absorbed with tissue paper before measurement. Fresh roots, stems and leaves were cut and weighted with Yamato CY-300 electronic balance. Fresh samples were put into oven at 90°C for 40min and then 70°C for 12hr. During the process of dryness, samples were weighted at intervals of 2h. Dry weights were taken when weights kept constantly.

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RESULTS AND DISCUSSION

No obvious differences was found in the content of Chl a, Chl b and net photosynthetic rate between wheat plants grown under xenon and sulfur lamp (data not shown). Dates for wheat began to joint, tassel and maturate under xenon lamp were apparently earlier than that under sulfur lamp (table 1).

Table 1. Effects of illumination with xenon or sulfur lamp on jointing, tasselling and grain matruing of wheat plants

Lamp	Days from seed planting (days)		
	Jointing	Tasselling	Grain maturation
Xenon	24	35	80
Sulfur	36	56	110

The number of tillers increased markedly under sulfur lamp. The average tiller numbers under sulfur lamp on 29th, 40th and 50th day after planting were 0.7, 2.0 and 2.7 respectively. However, those under xenon lamp were only 0, 0.3 and 1.3 respectively. On the contrary, the joint number per plant under xenon lamp were more than that under sulfur lamp, they were 1.8 or 3.4 on the 29th or 40th day after planting, while that of plants under sulfur lamp were only 0 or 1 (Figure 1).

The fresh or dry weight of either top (or) root part of wheat was also different for two lamps (Fig. 2). After 29 or 40 days from planting, the fresh (or) dry weight of top part

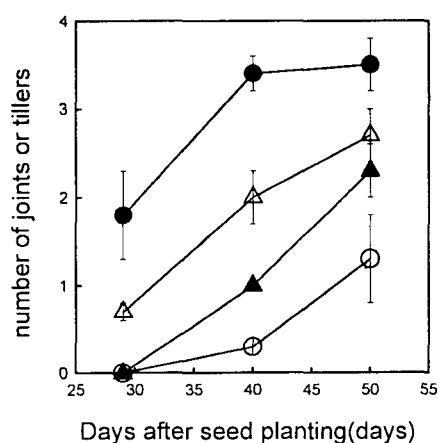


Fig 1. The effects of illumination with xenon or sulfur lamp on the number of joints or tillers of wheat plants. ●joint, xenon,▲joint, sulfur,○tiller, xenon, △ tiller, sulfur

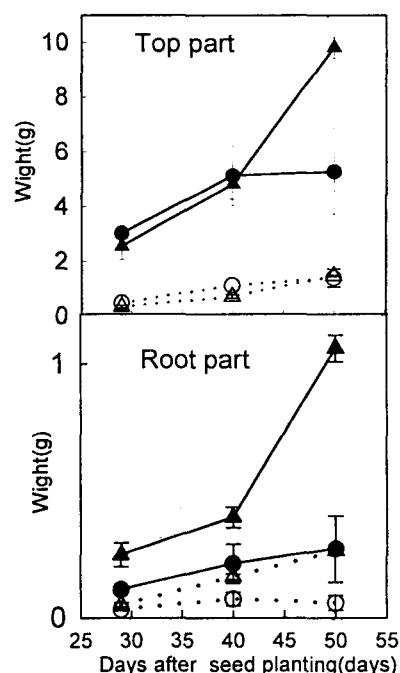


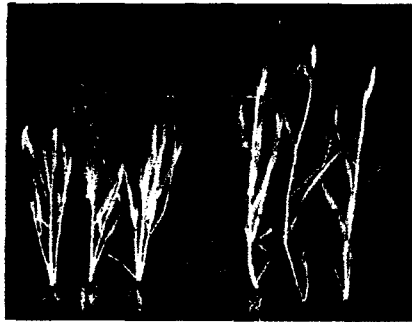
Fig 2. The effects of illumination with xenon or sulfur lamp on the FW and DW of top part or root part of wheat. ● xenon , FW,▲ sulfur, FW, ○ xenon, DW △sulfur, DW

illuminated with sulfur lamp was 2.549(0.332) or 4.824(0.703) g/plant respectively, while that with xenon lamp was 3.015 (0.461) or 5.267 (1.113) g/plant. In contrast to the top part, the fresh weight of root of wheat grown with sulfur lamp was significantly higher than that with xenon lamp on each sampling date. The fresh weight of root with xenon lamp were 0.111, 0.213 and 0.271g/plant respectively on the 29th, 40th and 50th day after planting, but being 0.248, 0.396 and 1.062g/plant with sulfur lamp respectively. The dry weight of root part using sulfur lamp was also higher than that grown using xenon lamp on every sampling date. Illumination of xenon lamp evidently promoted the growth of top part, but the root part of wheat was likely to be promoted by illumination of sulfur lamp.

Effects of illumination of lamp on yield of individual plant were further investigated(data not shown). It was shown that wheat grown with sulfur lamp produced more tillers (Table 1) and caused head longer and heavier (Fig3), accordingly resulted high yield of individual plant than with

xenon lamp.

It was observed that there is a great difference for developmental processes between wheat grown in natural condition and man-made climatic room. Comparatively, wheat under sulfur have longer tillering period and results



Sulfur Xenon
(40d after planting)



Sulfur Xenon
(grains maturation)

Figure 3. Effect of illumination with sulfur lamp or xenon lamp on jointing, tillering and maturation of wheat plants

more tillers, and illumination with sulfur lamp favors wheat development better than xenon lamp.

Above experiments further indicated that xenon lamp with intense infrared radiation significantly advanced joint initiation, reduced the number of tillers, and accelerated heading and flowering. The number of heads, heads length, number of grains per head, head weight and total grain weight per head evidently decreased(data not shown).

Main differences between two lamp lies in the infrared emission (long wave). Light composition influences plant hormone and other substances in metabolism[1], which regulates wheat plant development[2]. Difference in jointing and tillering under two lamp was possibly resulted from the regulatory effect of light composition.

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