Evaluation on the Growth of Super-Dwarf Rice under LED Lights for Space Agriculture

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Introduction

Space agriculture needs to be considered to supply food for space crew who stay in a space station over an extended period of time. Though rice is a staple food for many people in the world, not much research on rice cultivation in space has been conducted. It is because the plant height of standard rice cultivars is relatively long and needs a lot of space. In addition, rice plants need higher light intensities for greater yield. For these reasons, it is difficult to establish facilities for rice culture in the limited space. To overcome this problem, we suggest the use of super-dwarf rice. Kozonosumika is the smallest glutinous rice variety in the world. This compact size with the height of about 20 cm is suitable for cultivation in such a narrow space. We report the yield and characteristics of the super-dwarf rice plants grown under LED lights.

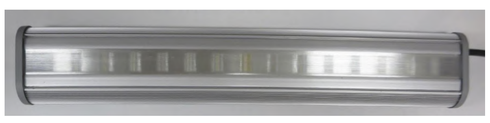
Materials and Methods

The six types of LED lights selected from 16 LED lights with different wavelengths and PPFD were used. Seeds of Kozonosumika were sown on early May 2018 and 2019, and the 10 seedlings were transplanted in a plastic container (length 315 x width 105 x height 50 mm) filled with paddy soil on early August. The rice plants were cultivated on wire shelves with light period of 13 h provided by LED lights in a laboratory at 28 ℃ until late November.

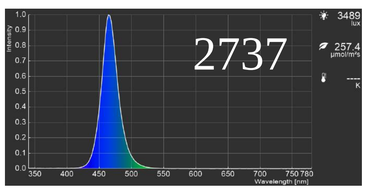
Results

The yield was different depending on the wavelength and PPFD of LED lights. The maximum yield was RGBIR, and the average yield for two years was 286.2 g/m^2.

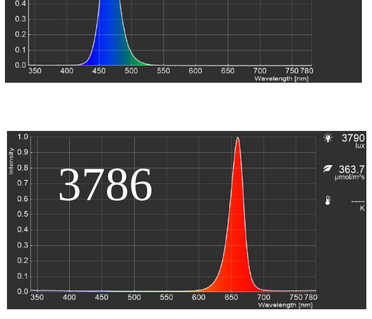
LED lights Spectral distributions and PPFD of six LED lights.



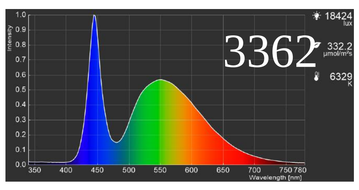
A 470



B 660



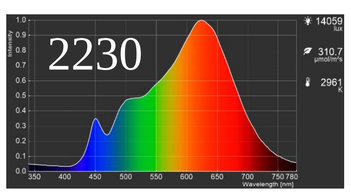
C 6500

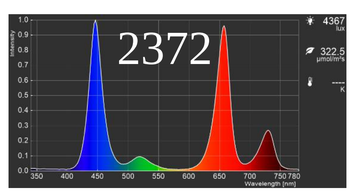


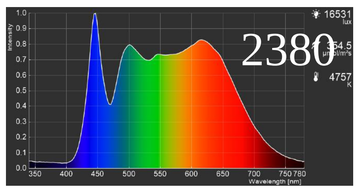
D GWW

E RGBIR

F SUN







Measured at the center of 10 mm under LED lights. Unit : µmolm^{-2}s^{-1}

Cultivation overview

29 Aug. 2019

26 Oct. 2019

B 660 C 6500

D GWW F SUN E RGBIR A 470

16 Nov. 2019

Comparison of growth properties of rice plants under six LED lights.

LED lights	Year	Plant height (cm)	Culm length (cm)	Panicle length (cm)	Number of tillers	Number of panicles	Number of grains	Weight of aboveground parts (g)	Grain yield (g/m^2)	Average grain yield (g/m^2)	Ranking
A 470	2018	11.1	3.1	7.4	14.6	8.0	26.0	2.545	199.4	237.1	2
	2019	12.2	4.1	8.6	16.6	8.6	38.8	2.452	274.9		
B 660	2018	10.9	3.6	7.5	20.6	5.8	24.8	2.606	175.1	94.2	5
	2019	11.5	2.2	5.5	15.2	3.2	2.0	2.124	13.3		
C 6500	2018	9.3	2.6	5.9	19.8	5.4	11.4	2.215	77.7	61.8	6
	2019	10.0	2.5	6.0	18.4	6.2	7.6	2.392	45.9		
D GWW	2018	12.2	3.1	7.4	17.2	5.6	20.6	2.590	148.1	131.9	4
	2019	12.1	3.2	7.0	17.6	7.8	19.4	2.705	115.7		
E RGBIR	2018	12.7	3.7	8.2	17.0	7.2	28.6	2.959	210.8	286.2	1
	2019	12.5	4.1	8.6	21.8	9.6	53.0	3.135	361.6		
F SUN	2018	11.2	2.8	6.9	18.4	4.6	18.2	2.475	131.1	213.2	3
	2019	11.5	3.7	7.8	19.8	11.6	46.2	3.416	295.2		

Conclusion

Super-dwarf rice plants can be grown from seedlings to harvest under the LED lights. It was proved that super-dwarf rice plants can grow under monochrome LED lights of blue.