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Metabolic Inhibition of ^{32}P and ^{14}C-Glucose Nutrient in HPGMR (Nong Ken 58A, Sinica Rice) Induced by Long Day to Male Sterile

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Abstract

A study has shown that: (1) In the early stage of pollen development of Hubei photopeiod sensitive genic male sterile rice i.e.HPGMR, the absorption of ^{32}P which is the basis of the metabolism of nucleic acid in spikelets of panicle under long day induction is less than that in short day induction, while they are similar in the late stages. (2) The ^{14}C-glucose accumulation in panicle induced by long day is declined along with the pollen degeneration from 37.38% at the early uninucleat stage to 4.96% at the ripe stage of pollen, but it is reverse in shor tday induction from 7.58% at the late uninucleat stage to 40.58% at matural or filling stage of pollen. It can be considered that long day induction to male sterile of HPGMR (NK58A) at formation stage of pollen mother cell effects on ^{32}P and/or nucleic acid metabolism which are primarily limited by long day induction, then on ^{14}C metabolism after late uninucleate stage.

Keywords rice, Hupei photoperiod sensitive genic male sterile rice(NK58A), long day induction, ^{32}P, ^{14}C

1 Introduction

Rice is a short day plant which can be flowering and male fertile under short day photoperiod induction, but the HPGMR is male sterile under long day induction. The Nong Ken 58A (HPGMR, Sinica Rice) can become male sterile under long day photoperiod induction during the secondary branch and spikelet differentiation stage after short day treatment from the seedling stage up to panicle primodium initiation. Male sterile rice plant can be crossed with mary rice varieties and the grain yield is increased by 20～30% compared with the conventional rice varieties. That is first investigation made by Mr. Shi Ming-song(1981, 1985～1987)[1～4].

2 Materials and Methods

The research materials were HPGMR (Nong Ken 58A) (*Oryza sati-*

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va L., Sinica Rice). After short day (8h/day) treatment before panicle primodium initiation, some rice plants were treated under long day (14h/day) from the secondary branch differentiation until heading. The compensational light intensity is about 1500 lux. The methods were:

1. Samples were taken according to the methods of Prof. Ding (1983)[6] and Dr. Yoshoda S. (1981)[6] at differentiation stage of spikelets (0), formative stage of pollen mother cell (Ⅰ), early uninucleate stage (Ⅱ) late uninucleate stage (Ⅲ), binucleate stage (Ⅳ), trinucleate stage (Ⅴ) and matural(filling) stage of pollen (Ⅵ) of microsporogenesis.

2. Determination of ^{32}P and ^{14}C-glucose metabolic products refer to the methods of Wang et al. (1983, 1987, 1988)[7~9]

3. Investigation of heading date and grain filling percentage.

3 Research Results

3.1 Fertility characters

Table 1 shows that under long day photoperiod induction the delayed heading date, low filled grain percentage and aborted pollens of HPGMR are comparison with those of SD and CK treatment(Fig. 1~6). So HPGMR really has a photoperiod sensitive genic male sterile characters.

Tab.1 Heading date and grain filling percentage of HPGMR under different photoperiodic conditions

Samples'	LD		SD		CK		LD*
No.	HD	%	HD	%	HD	%	HD
1	06/02/87	0.00	05/24/87	31.03	05/28/87	16.67	0.00
2	〃	0.00	〃	40.00	〃	12.33	0.00
3	〃	1.35	〃	51.25	〃	50.00	0.00
4	〃	0.00	〃	81.16	〃	9.15	0.00
5	〃	0.00	〃	40.00	〃	23.08	0.00
6	〃	7.69	〃	41.77	〃	48.51	0.00
7	〃	0.00	〃	51.90	〃	14.77	0.00
8	〃	0.00	〃	33.33	〃	31.25	0.00
9	〃	0.00	〃	26.67	〃	59.26	0.07
10	〃	0.00	〃	41.79	〃	37.50	0.00
11	〃	0.00	〃	48.10	〃	33.33	0.00
12	〃	0.00	〃	35.14	〃	83.33	0.00
13	〃	3.85	〃	44.71	〃	42.68	0.00
14	〃	0.00	〃	32.05	〃	59.30	0.00
15	〃	1.54	〃	32.91	〃	7.14	0.00
16	〃	0.00	〃	28.21	〃	40.48	0.00
17	〃	0.00	〃	47.37	〃	49.35	0.00
18	〃	0.00	〃	33.33	〃	29.63	0.00
19	〃	0.00	〃	27.72	〃	50.00	0.00
20	〃	0.00	〃	43.43	〃	66.32	0.00
Average		0.76		40.59		38.19	0.00

LD = long day induction; SD = short day induction;
LD* = SD ratooning tillers under LD, 1988; HD = Heading date;
% = grain filling percentage

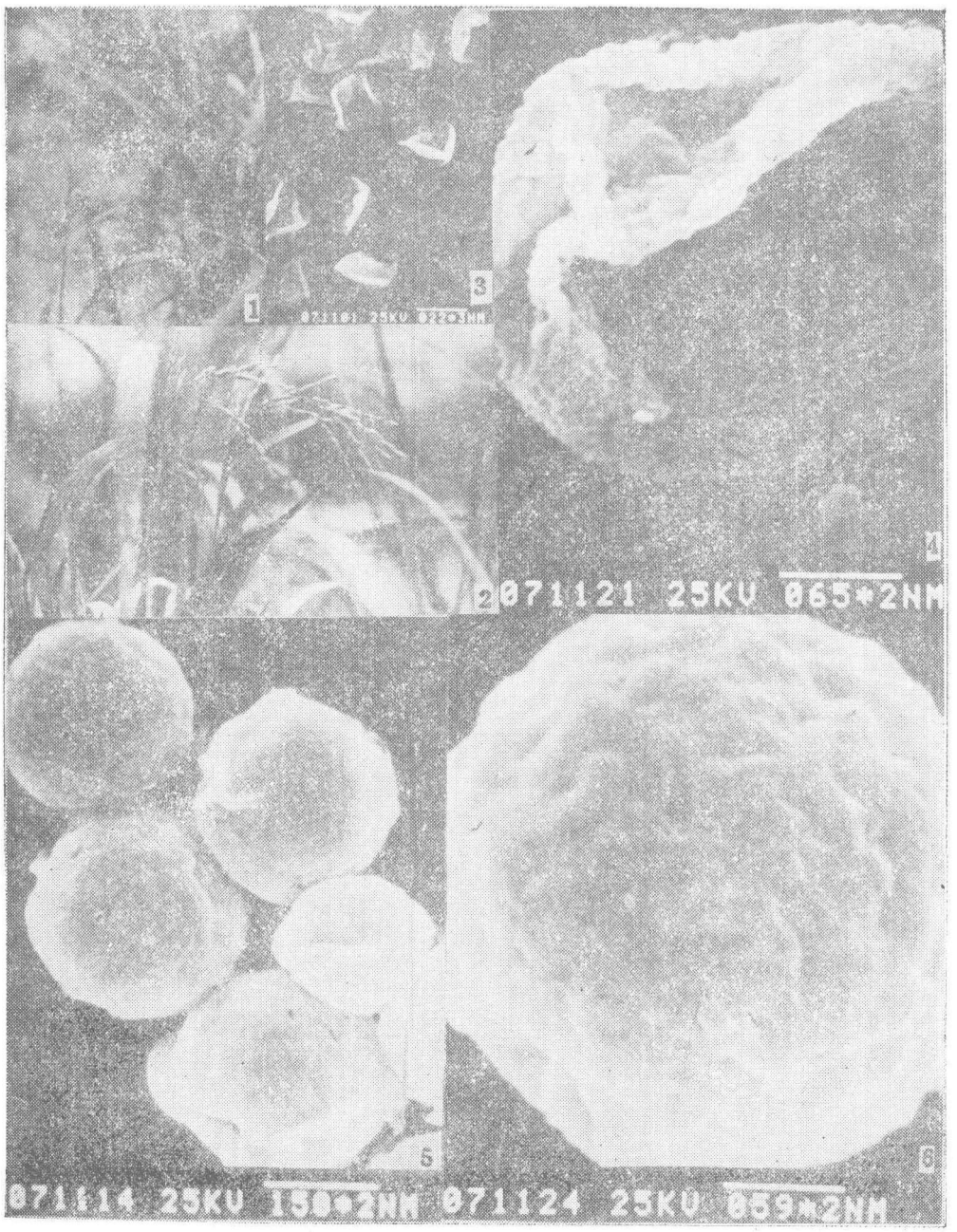

Fig. 1 Male-sterile plant of HPGMR under long day induction

Fig. 2 Fertile ylant of HPGMP under short day induction

Fig. 3～4 SEM-morphology of aborted pollens of HPGMR under long day induction

Fig. 5～6 SEM-morphology of the fertile pollens of HPGMR under short day induction

3.2 ^{32}P absorption and fertility changeability

Figure 7 indicates the two peaks of ^{32}P concentrated (cpm/50mg) in panicles at early uninucleate stage and binucleate stage, but the two vallelys of ^{32}P at formation stage of pollen mother cell and late uninucleate stage of HPGMR (Nong Ken 58A) induced by LD treatment. The efficiency of short day induction has two peaks and two deep vallelys of ^{32}P accumulated in panicles in inverse compared with the somples of LD induction. The ^{32}P low concentration (%) in panicles of treated samples induced by long day is a microsporogenesis stage Ⅰ-Ⅲ than that of SD treated samples (Fig. 8). Especially, the close relation between ^{32}P absorption and fertile changeability has been at PMC formation stage.

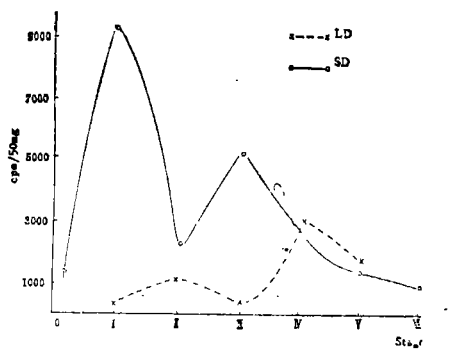

Fig.7 Variance of the ^{32}P-element absorption in the panicle of HPGMR under long day (LD) and short day (SD) inductions at different stages of microsporogenesis
0 = differentiating stage of spikelets;
Ⅰ = formative stage of pollen mother cell;
Ⅱ = early uninucleate stage;
Ⅲ = late uninucleate stage;
Ⅳ = trinucleate stage;
Ⅴ = filling stage of pollen;
cpm = counters per minute (ib)

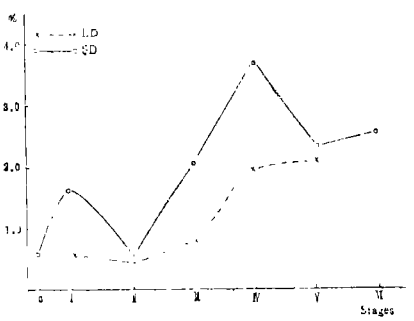

Fig. 8 Variance of the ^{32}P-element distribution in HPGMR under long day (LD) and short day (SD) inductions at different stages of microsporogenesis
% = (Panicle ^{32}P-absorption)/(Total ^{32}P-absorption)

3.3 ^{14}C-glucose distribution and fertility changeability

The figure 9 and 10 show that under LD condition the samples have high concentration and percentage of ^{14}C-glucose metabolic products at the microsporogenesis stage Ⅱ, but decline from Ⅲ to ripe pollen stage, in which the SD treated plants have high ^{14}C-glucose concentration and percentage. Therefore there is fertility changeability in treated plants

from SD to LD induction. We can see the LD induced to male sterile in ^{14}C metabolic products after late uninucleate stage of microsporogenesis.

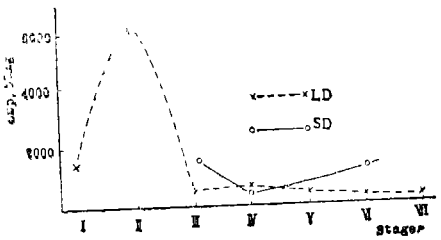

Fig. 9 Variance of the ^{14}C-glucose absorption in the panicle of HPGMR under long day (LD) and short day (SD) inductions at different stage of microsporogenesis

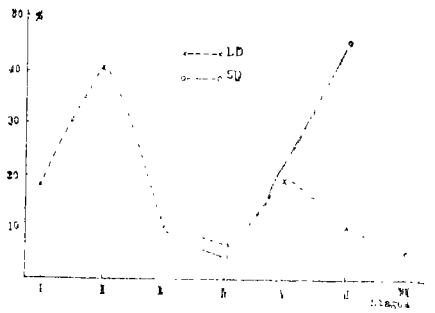

Fig. 10 Variance of the ^{14}C-glucose distribution in HPGMR under long day (LD) and short day (SD) inductions at different stages of microsporogenesis
% = (Panicle ^{14}C-glucose absorption)/ (Total ^{14}C-glucose absorption)

4 Discussion and Conclusion

HPGMR has photoperiod sensitive response to long day induction during the secondary branch differentiation to pollen mother cell formation stage and becomes male sterile. This is a typical example of physiological genetics. The metabolic inhibitions in plant nutrition of ^{32}P and ^{14}C appear as same as the three line hybrid rice[8~10]. Contents of ^{14}C-glucose metabolic products have decreased from Ⅲ stage of microsporogenesis in male sterile plants. Long day induced to male sterile of rice plant primarely effects on ^{32}P and nucleic acid metabolism at formative stage of PMC and on ^{14}C metabolism from late uninucleate stage.

HPGMR test materials and research results open a question to rice crop plant. That may be had two photoperiod induction stage, one is from vegetative growth stage to panicle primodium initiation i.e. the first photoperiod induction stage, the other is at the process of microsporogenesis development i.e. the second photoperiod induction stage. This new problem needs much research. If most plants at microsporogenesis have second photoperiod induction i.e. male sterile photoperiod, we can nse these male sterile material plants to cross with the other male fertile materials of the same plant varieties. The hybrid plant (F_1) has hybrid heterosis and the economic yield or grain yield can be increased about 20~30% over to the conventional plant varieties.

References

〔1〕 Shi Mingsong, *Agricultural Sci. of Hupei*, 1981, 7, 1～3

〔2〕 Shi Mingsong, *Scientia Agricultura Sinica*, 1985, 2, 44～48

〔3〕 Shi Mingsong, *Acta Genetica Sinica*, 13 (1986), 2, 107～112

〔4〕 Shi Mingsong, *Journal of WUHAN U. Special Issue on HPGMR*, 1987,7, 2～6

〔5〕 Ding Ying, *Agricultural Print Sinica*, 1983, 265～290

〔6〕 Shouich yoshida, *Fundamentals of Rice Crop Science*, 1981, IRRI

〔7〕 Wang Yongrui et al., *Scientia Agricultura Sinica*, 1983, 3, 15～20

〔8〕 Wang Yongrui et al., *J. Plant Nutrition*, 1987, 10(9～16), 1623～1630

〔9〕 Wang Yongrui et al., *Hybrid Rice*, IRRI (Proceedings of the International Symposium on Hybrid Rice, Oct. 6～10 1986, Changsha, Hunan, China), 1988, 282

〔10〕 Wang Yongrui, Supplement to the ACTA Scientiarum Naturalium Universitatis Sunyatseni, Supplement (11), 1987, 128～133

光敏感核不育水稻^{32}P和^{14}C营养代谢障碍

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摘　要

采用光敏感核不育水稻“农垦58A”为材料，从苗期至幼穗分化3期栽培在短日照条件下，从幼穗分化3期至抽穗期，每天补充光照长度至14小时，光强为1500Lux；另部份植株则控制在8小时光照条件下生长发育。

光照长度处理后，分别测定^{32}P、^{14}C-葡萄糖同化物在幼穗的分布（%），并分别在颖花分化期、花粉母细胞分化期、单核早期、单核晚期、双核期、三核期和花粉充实期进行取样分析。

结果表明，试验材料在长日诱导下，作为核酸代谢基础的^{32}P在花粉母细胞形式期颖花的分布和比活性，比在短日诱导下的下降，但从小孢子发育Ⅳ期起则几乎相近。长日诱导的颖花^{14}C-葡萄糖同化物比活性和在幼穗的分布，随花粉发育而于单核晚期起开始下降，至花粉成熟期仅为4.96%。试验结果认为，长日诱导光敏感核不育水稻花粉不育首先是在花粉母细胞形成期^{32}P或核酸合成代谢发生障碍，然后于小孢子发育的单核晚期^{14}C-同化产物的生理代谢障碍。在短日诱导条件下花粉可育，花粉粒充实，结实率较高。长日条件下诱导花粉不育，花粉粒不充实，属碘败不育花粉，抽穗期延长，结实率0～0.76%。

关键词　光敏核不育水稻“农垦58A”，长日诱导，^{32}P，^{14}C。

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