Research Article
Effects of Sowing Date, Basic Seedling, Nitrogen Rate and Field Water on Early Rice "Liangyou 9168"

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Abstract: To study the influence of different culture conditions to the growth and yield, an orthogonal experiment was conducted with four factors-sowing date, basic seedling, nitrogen rate and water depth and three levels (L934) about early rice Liangyou 9168 in Jingzhou for 3 years. The results indicated that: (1) Sowing date showed significant effect on growth period, there was a linear negative correlation between sowing date and growth period ($y = -0.685x + 127.54$, $R = 0.9986**$). (2) Sowing date and nitrogen rate showed a highly significant effect on yield, the early rice yield of sowing on March 20 was the highest in the experimental range, there was a linear positive correlation between nitrogen rate and yield ($y = 0.5963x + 393.43$, $R = 0.9709**$). (3) The best combination of cultural factors for early rice was treatment 5 of sowing on March 19, basic seedling for $67.5×104$ kg/hm^2, nitrogen amount of 93.58 kg/hm^2 and field water just covering mud.

Keywords: Basic seedling, early rice, field water, nitrogen rate, sowing date

INTRODUCTION

Rice is one of the three major crops in the world, and about 65% of population in China mainly feed on rice (Cheng and Zhang, 2003). At the same time, early rice is an important part of grain production in China, Planting the early rice can improve the utilization and productivity of the paddy. Rice yield not only depends on high-quality varieties but also on matched cultivation measures. A great number of studies show that sowing date (Liao and Guan, 2001; Qiu *et al*., 2000; Li *et al*., 1998), basic seedling number (Huang and Ding, 2011; Su *et al*., 2008), nitrogen rate (Peng *et al*., 2002; He *et al*., 2008) and field water (Zhang and Shao, 2006; Shao and Liu, 2007) have great influence on early rice yield. The typical characteristics of early indicia hybrid rice "Liangyou 9168" were high-yield, high-quality, lodging resistance, which was selected by Hubei "Jingchu seed" industry Co., Ltd. In order to fully tap the productive potential of the varieties, we have studied the effect to early rice "Liangyou 9168" of sowing date, basic seedling, nitrogen rate and field water from 2009 to 2011 in Jianghan plain and study the impact on the growth duration and yield.

MATERIALS AND METHODS

Test material: Tested cultivar is "Liangyou 9168", which is provided by Hubei "Jingchu seed" industry Co., Ltd.

Experimental design: The experiment adopted orthogonal design and chose L9 (3^4) orthogonal tables. We choose sowing date, basic seedling, nitrogen rate and field water as experimental factors, respectively. The sowing period includes March 8, March 19 and March 28 three levels. The basic seedling includes $67.5×10^4$, $135×10^4$ and $202.5×10^4$ plant/ha, respectively. The nitrogen rate have 34.5, 69 and 103.5 kg/ha, respectively. The field water has three levels which are field water just cover the mud, water depth of 5 and 10 cm when transplanting. The pilot schemes of three years are completely sameness.

This test adopted dry farming cultivation rice with film mulching. When seeding age was 30 days, we transplanted, and the transplanting size was 13.3×16.7 cm, the area of each plot was 12 m^2. Spacing method of plastic membrane was applied to experiment plots in Yangtze University. Previous crop and the compound fertilizers (N:P:K = 16:16:16) amount of 750 kg/ha

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Table 1: Comparisons of phenophase of different years and treatments mm-dd

Treatments	Sowing Date	Heading date			Maturity			Whole growth period (day)			Average (day)
		2009	2010	2011	2009	2010	2011	2009	2010	2011	
1	3/8	6/8	6/13	6/11	7/10	7/15	7/13	124	129	127	126.7
2	3/8	6/7	6/14	6/12	7/11	7/17	7/12	125	131	126	127.3
3	3/8	6/11	6/15	6/13	7/13	7/18	7/11	127	132	125	128.0
4	3/19	6/13	6/18	6/19	7/15	7/21	7/19	118	124	122	121.3
5	3/19	6/13	6/17	6/17	7/15	7/20	7/19	118	123	122	121.0
6	3/19	6/15	6/17	6/18	7/17	7/19	7/18	120	122	121	121.0
7	3/28	6/14	6/22	6/21	7/16	7/24	7/21	110	118	115	114.3
8	3/28	6/15	6/19	6/20	7/16	7/22	7/20	110	116	114	113.3
9	3/28	6/16	6/19	6/19	7/17	7/22	7/19	111	116	113	113.3

Table 2: Comparisons of economical character of different years and treatments

| Treatment	Effective panicle (million years/667m²)	Grain number per year (grain)	Setting percentage (%)	Thousand-grain weight (g)	Yield (kg/667 m²)
1	15.6	141.1	78.0	23.9	381.2
2	16.0	147.5	78.8	23.5	404.7
3	18.1	150.1	78.6	23.9	422.6
4	18.1	172.6	83.0	23.9	467.9
5	19.3	164.0	83.1	24.2	474.6
6	17.5	156.4	82.0	23.7	442.9
7	17.1	160.6	81.4	23.3	441.6
8	16.6	148.8	77.1	24.0	411.7
9	17.7	161.2	81.2	23.5	446.1

The data were average of 3 years
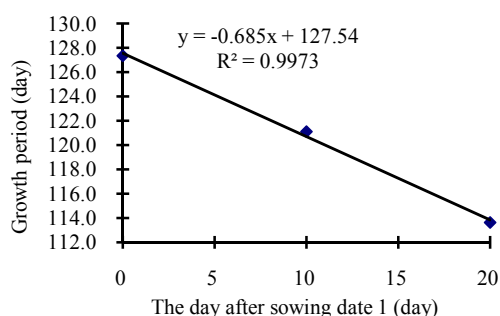
Fig. 1: Relationships between the length of rice growing period and sowing date

applied as the basic fertilizer. All treatments were applied complex manure twice as tillering fertilizer 5 days and 12 days after the transplanting. During the growth period, we surveyed and recorded sowing date, heading date, maturity and whole growth period. Beyond that, we sampled and investigated economic characters in mature period.

The experiment was done in practice bases for teaching at Yangtze University in Jingzhou. Northern subtropics monsoon climate of Jingzhou City category, warm moistly, the total annual solar radiation is from 4366.8 to 4576.2 MJ/m², respectively. The annual sunshine hours are from 1823 to 1978. Sunshine rate is 41-44% and mean annual temperature is 6.2-16.6°C. Change at the annual frost-free period 250-267 days and annual precipitation 1100-1300 mm. Testing ground is 900 m above sea level and moderate-fertility soil.

RESULTS AND DISCUSSION

The development process: The development process of the different treatments is listed in Table 1. We can see growth period of the different treatments are quite different, there are some differences between years too. The comprehensive three-year data shows that average development process range from 113.3 to 128 day. Apparently, there is a difference of 14.7 day.

The variance analysis indicated that sowing date had significant effect on growing period ($F_\alpha = 252.8222 > F_{0.01}$). As can be seen from Fig. 1, the growth
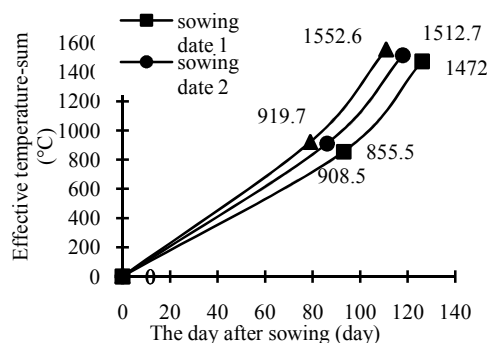

Fig. 2: Relationships between the length of rice growing period and sowing date
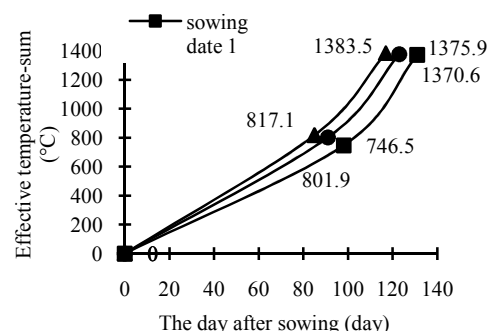

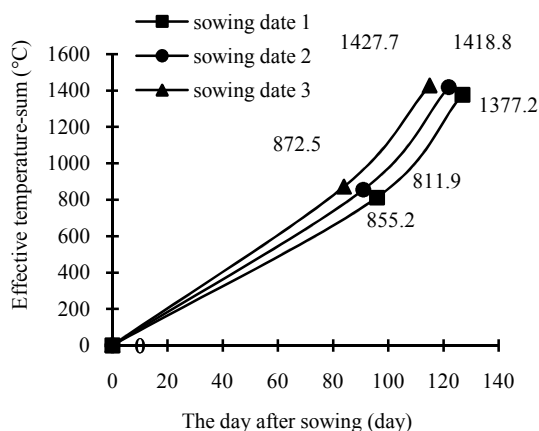Fig. 3: Changes of temperature-sum of growth process in 2010

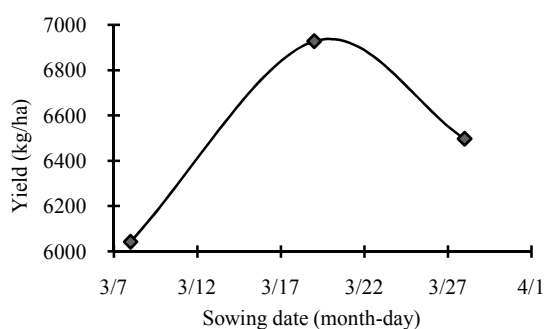Fig. 4: Changes of temperature-sum of growth process in 2011

Fig. 5: Relationships between sowing date and yield

Table 3: Comparison of yield of different treatments

Treatment	Average yield (kg/hm²)	Significant level 5%	1%
5	7118.6	a	A
4	7019.6	a	AB
9	6692.0	b	BC
6	6644.0	b	BC
7	6624.5	bc	BC
3	6338.7	cd	CD
8	6175.1	d	D
2	6070.2	d	DE
1	5717.3	e	E

Table 4: Comparison of yield of different years

Year	Average yield (kg/hm²)	Significant level 5%	1%
2009	6634.5	a	A
2010	6533.1	a	AB
2011	6298.8	b	B

period will decrease with the delay of sowing date. There was a negative correlation between them, when sowing date delayed for 10 days, the growth period shortened 6.8 day (y = -0.685x + 127.54; R = 0.9986 **). As can be seen from Fig. 2, 3 and 4 (the data points are the accumulated temperature of heading stage and maturity stage, respectively), There was little difference of effective accumulated temperature of heading date and maturity between different sowing dates, and the
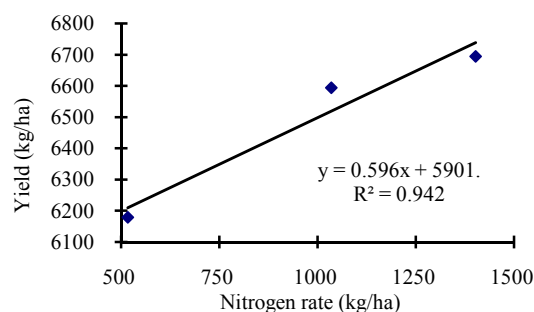

Fig. 6: Relationships between nitrogen rate and yield

coefficient of variation was 4.09 and 1.06%, respectively. The average temperature of growth period of latter two sowing date was higher, the accumulation of effective accumulated temperature can be done in the short period of time, so the whole growth period was significantly shorter.

The effect of the years on growing period sowing date also reached significant level ($F_\alpha = 38.4881 > F_{0.01}$), the effect of density, nitrogen rate and the water are not significant. This showed that sowing date was the most important factors affecting the growth period.

Economical characters: It can be seen from Table 2, there is obvious difference in yield components of treatments. Among 9 treatment combinations, the effective panicles distribution was 235×10^5-290.5×10^5/ha, treatment 5 was the most and treatment 1 was the least. The grain number per ear distribution was from 141.1 to 172.6, treatment 4 was the most and treatment 1 was the least. The setting percentage distribution was at 77.1-83.1%, treatment 5 was the highest and treatment 8 was the lowest. The thousand-grain weight distribution was at 23.2-24.2 g, treatment 5 was the most and treatment 7 was the least. The yield distribution was from 5718 to 7119 kg/ha. Comprehensive analysis of economic traits, treatment 5 is superior to the others.

Yield of different treatments and years are shown in Table 3 and 4, Table 3 shows that the differences of treatment yield reached a significant level.

Among them, the yield of treatment 5 is the highest with 7118.6 kg/ha, there were a significant difference (p<0.01) between treatment 5 and treatment 9, 6, 7, 3, 8, 2, 1.

The second one is treatment 4 with the yield of 7019.6 kg/ha. There were a significant difference (p<0.01) between treatment 4 and treatment 3, 8, 2, 1. The third one is treatment 9 with the yield of 6692.0 kg/ha. There were a significant difference (p<0.01) between treatment 9 and treatment 8, 2, 1. The yield of treatment 1 is lowest with 5717.3 kg/ha. It can also be seen from Table 4, the yield of 2009 is the highest with 6634.5 kg/ha, the lowest one is 2011 with 6298.8 kg/ha, and the difference between them is greatly significant.

The variance analysis showed that sowing date had a very significant influence on the yield (F_α =

Table 5: Range analysis of yield

Factor	level 1	level 2	level 3	Min.	Max.	Range R	Adjusted R $'$
Sowing date	6042.07	6927.35	6497.12	6042.07	6927.35	885.28	797.34
Density	6453.77	6454.60	6558.17	6453.77	6558.17	104.40	94.03
Nitrogen rate	6178.72	6593.92	6693.90	6178.72	6693.90	515.18	464.01
Field water	6509.23	6446.20	6511.10	6446.20	6511.10	64.90	58.45

Min.: Minimum; Max.: Maximum

$58.0102 > F_{0.01}$), and nitrogen rate's influence on the yield was very significant ($F_\alpha = 22.0913 > F_{0.01}$), while density and moisture's influence on the yield didn't reach the significant level. This showed that sowing date and the amount of nitrogen fertilizer are most important factors affecting the yield.

Further analysis on the relationship between sowing date, nitrogen rate and yield found that: the yield of early rice planting around March 20 was the highest, in the experimental range (Fig. 5); nitrogen application and yield showed a positive linear correlation (Fig. 6) within the experimental range, the yield increased 0.5963 kg for each additional 1 kg of the nitrogen application rate, ($y = 0.5963x + 5901.5$; $R = 0.9709^{**}$).

In addition, the effect of the year on the yield reached a very significant level ($F_\alpha = 8.7752 > F_{0.01}$), which indicated that with same species and same cultivation in different years, the rice yield will fluctuate, due to temperature, rainfall and sunshine. While the overall trend and the best production combination changed little.

In order to sift the best combination, the data of yield was assessed by using range analysis (Table 5), the results showed that the Range (R) of sowing date ranked first, and the second one was nitrogen, which is consistent with the result of variance analysis. Density and field water's range R are little, so sowing date and nitrogen should be considered first when choose the best cultivation combination. Learned from the range analysis table, the optimal level of sowing date is level 2, the nitrogen's level 3 is the optimal level. With the orthogonal table, it was known that treatment 5 ($A_2B_2C_3D_1$) was the best cultivation combination, with the highest yield of the nine combinations.

CONCLUSION

The results of repeated trials of three years showed that:

- Sowing date showed significant effect on growth period, with the delay of sowing date, the growth period was short, there was a linear negative correlation between sowing date and growth period ($y = -0.685x + 127.54$, $R = 0.9986^{**}$).
- Sowing date and nitrogen rate showed a highly significant effect on yield, the early rice yield of sowing on March 20 was the highest in the experimental range, there was a linear positive correlation between nitrogen rate and yield ($y = 0.5963x + 5901.5$, $R = 0.9709^{**}$). Among the nine treatments, treatment 5 ($A_2B_2C_3D_1$) was the best combination, with the highest yield. Due to changes in weather conditions between years, the year's effect on the growing period and yield of early rice was very significant; the reaction of different combinations of other early rice varieties needs further study

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