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# Effect of Direct Sowing Rates on Mid-season "Rice Feng-liang-you-xiang-1"

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**Abstract:** To study the suitable seeding rate of middle-season rice sown directly in Jianghan Plain, 6 treatments were set up with different seeding rates for hybrid rice Feng-liang-you-xiang-1 which was sown directly: 22.5, 30, 37.5, 45, 52.5, 60 kg/hm$^2$, respectively and the optimum seeding rate was selected. Some initiative results were made. The seeding rate influences whole growth period, yield components, yield and relative economic output of Feng-liang-you-xiang-1 significantly. It shows a quadratic curve relationship between seeding rate and whole growth period and when the seeding rates were less than 30 kg/hm$^2$ or more than 52.5 kg/hm$^2$, the whole growth period was obviously shortened compared with that of other seeding rate. Among the yield components, panicles, grains panicles, seed-setting rate and harvest index are effected very significantly by the seeding rate, showing a linear relationship of quadratic curve; while to 1000 seed weight the influence don't reach the level of significant difference. And seeding rate shows in curve relation to yield ($y = 2.5248x^2 + 198.89x + 7620.1$); when the seeding rate is 39.387 kg/hm$^2$, the yield reaches the maximum value of 11536.95 kg/hm$^2$.

**Keywords:** Direct sowing, middle-season rice, production, seeding rate

## INTRODUCTION

Rice is a kind of high-yield and high-efficient grain crops and seeding rate is one of the important factors which affect the yield and economic returns of rice production (Li, 2004). The direct seeding cultivation of rice has the characteristics of labor saving, input saving, high-yield, high-efficient and so on (Wang *et al*., 2008; Huang *et al*., 2003). Feng-liang-you-xiang-1, bred by Hefei Fengle Seed Company Limited, is a kind of hybrid rice with high yield and high quality, which is suitable for applications in the middle and lower reaches of the Yangtze River. Studying its high yield cultivation techniques under the condition of direct seeding will tap the yield potential better and provide a reference for the production applications. For this reason, a study of direct seeding effects of different seeding rates on Feng-liang-you-xiang-1 was conducted from 2010 to 2011 and some preliminary results were obtained.

## MATERIALS AND METHODS

**Experimental material:** Feng-liang-you-xiang-1, provided by Hefei Fengle Seed Co., Ltd., was used in this experiment.

**Experimental design:** Randomized block design of six treatments were used: 22.5 kg/h m$^2$ ($A_1$), 30 kg/hm$^2$ ($A_2$), 37.5 kg/hm$^2$ ($A_3$), 45 kg/hm$^2$ ($A_4$), 52.5 kg/hm$^2$ ($A_5$), 60 kg /hm$^2$ ($A_6$). The plot size was 2×3 m. The seeds were Sown on 28, May, 7 line each plot, 30 cm per row space, with three repeats. The growth duration, yield components and yield and the relative economic output were observed during the trial period.

**Experimental site:** The test was conducted in 9 Group, Sanhong Village, Jinan Town, Jingzhou District and Jingzhou City. It belongs to the northern, subtropical monsoon humid climate area, with an annual total radiation of 4366.8-4576.2 MJ/m$^2$ and an annual sunshine time of 1823-1978 h and the sunshine rate there is 41 to 44%. The average annual temperature is 16.2-16.6°C, the frost-free period 250-267 day and the annual precipitation 1100-1300 mm. The experiment site's altitude is 34 m and the soil fertility there is medium.

## RESULTS AND DISCUSSION

**Whole growth period:** The whole growth period of Feng-liang-you-xiang-1 of different treatments were listed in Table 1.

It shows that sowing rate has some influences on the whole growth period of middle-season rice sown directly. The mean of the whole growth period of different treatments during the 2 years were 120.4d-124.9 day, with an average value of 123.05 day. Among the 6 treatments, the whole growth period of $A_3$ was the longest, while it's shortest of $A_6$. And the difference of whole growth period between different treatments reached a very significant level ($F = 15.97 > F_{0.01}$). And

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Table 1: Comparison of whole growth period

| Treatment | The whole growth period (day) 2010 (year) | 2011 (year) | Mean (day) |
|---|---|---|---|
| $A_1$ | 123.7 | 122.0 | 122.9 bBC |
| $A_2$ | 124.3 | 123.7 | 124.0 aAB |
| $A_3$ | 125.0 | 124.7 | 124.9 aA |
| $A_4$ | 125.0 | 124.3 | 124.7 aA |
| $A_5$ | 122.0 | 121.0 | 121.5 cCD |
| $A_6$ | 121.3 | 119.3 | 120.3 dD |

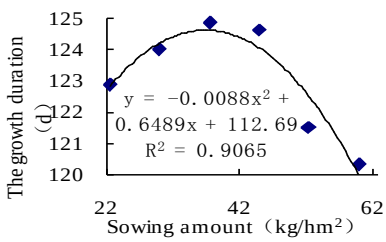


Fig. 1: Relationship between seeding rate and the whole growth period

further analysis showed that the it is a quadratic regression equation between seeding rate and whole growth period (Fig. 1):

$$y = -0.0088x^2 + 0.6489x + 112.69, R^2 = 0.9065^{**}$$

**Yield components:** The yield components of different treatments of the Feng-liang-you-xiang-1 were listed in Table 2 and 3. It showed that the panicles of different treatments ranged from $247.3\times10^4/hm^2$ to $370.5\times10^4/hm^2$, with an average value of $299.7\times10^4/hm^2$; the grains/panicles was 177.9/panicle to 245.2/panicle, with an average of 208.62/panicle; the seed setting rate was 83.31 to 88.82%, with an average of 86.99%; the 1000 seed weight was 26.0-26.67 g, with an average of 26.31 g; the harvest index was 0.495-0.545, with an average of 0.524; and the yield was 10628.5-11757.3 $kg/hm^2$, with an average of 11114.2 $kg/hm^2$. The analysis of the effects of seeding rate showed that the effects of seeding rate on panicles, grains/panicles, seed setting rate, harvest index and yield reach a very significant level ($F>F_{0.01}$), but on 1000 seed weight it is not significant ($F<F_{0.05}$).

Further analysis suggested that the relationship between seeding rate and yield is present as a quadratic curve (Fig. 2) and the equation was:

$$y = -2.5248x^2 + 198.89x + 7620.1, R^2 = 0.7482$$

When the seeding rate is 39.387 $kg/hm^2$, the yield reaches the maximum value of 11536.95 $kg/hm^2$.

There is also a liner relation of quadratic curve between seeding rate and harvest index (Fig. 3) and the equation was:

$$y = -9E - 0.5x^2 + 0.0063x + 0.4231, R^2 = 0.9519^{**}$$

Table 2: Yield components under different seeding rates-1

| Treatment | Panicles (10 $k/hm^2$) 2010 (year) | 2011 (year) | Mean | Grains/panicles 2010 (year) | 2011 (year) | Mean | Seed setting rate (%) 2010 (year) | 2011 (year) | Mean |
|---|---|---|---|---|---|---|---|---|---|
| $A_1$ | 245.1 | 249.5 | 247.3cB | 240.4 | 249.9 | 245.2aA | 87.61 | 90.02 | 88.82aAB |
| $A_2$ | 249.8 | 262.8 | 256.3bcB | 206.5 | 237.5 | 222.0bcAB | 87.05 | 89.92 | 88.49aAB |
| $A_3$ | 259.1 | 290.8 | 275.0bcB | 229.3 | 228.4 | 228.9abAB | 86.44 | 91.79 | 89.12aAB |
| $A_4$ | 259.1 | 316.2 | 287.6bB | 166.5 | 200.7 | 183.6bcB | 85.81 | 86.94 | 86.38aA |
| $A_5$ | 364.2 | 358.8 | 361.5aA | 170.1 | 218.1 | 194.1bcB | 85.28 | 86.39 | 85.84aAB |
| $A_6$ | 368.9 | 372.2 | 370.5aA | 167.4 | 188.4 | 177.9cB | 80.21 | 86.40 | 83.31bB |

Table 3: Yield components under different seeding rates-2

| Treatment | 1000 grain weight (g) 2010 (year) | 2011 (year) | Mean | Harvest index (%) 2010 (year) | 2011 (year) | Mean | Yield 2010 (year) | 2011 (year) | Mean |
|---|---|---|---|---|---|---|---|---|---|
| $A_1$ | 25.69 | 27.64 | 26.67aA | 0.53 | 0.52 | 0.525bAB | 10634.9 | 10622.0 | 10628.5dC |
| $A_2$ | 25.07 | 26.93 | 26.00aA | 0.53 | 0.53 | 0.530abAB | 11659.5 | 11461.3 | 11560.4aA |
| $A_3$ | 26.07 | 27.13 | 26.60aA | 0.54 | 0.55 | 0.545aA | 11750.3 | 11764.2 | 11757.3aA |
| $A_4$ | 25.76 | 26.57 | 26.17aA | 0.53 | 0.53 | 0.530abAB | 11244.5 | 11119.4 | 11182.0bB |
| $A_5$ | 26.35 | 26.25 | 26.30aA | 0.51 | 0.53 | 0.520bB | 11024.0 | 10830.5 | 10927.3cBC |
| $A_6$ | 26.24 | 25.97 | 26.11aA | 0.49 | 0.50 | 0.495cC | 10673.9 | 10585.8 | 10629.9dC |

Table 4: Comparison of economic output of different treatments

| Treatment | Seed input (Yuan) | Fertilizer and farm chemicals (kg/ha) | Yield (kg/ha) | Economic output (Yuan) | Relative economic output (Yuan) |
|---|---|---|---|---|---|
| $A_1$ | 1125 | 4350 | 10628.4 | 22851.1 | 17376.1 |
| $A_2$ | 1500 | 4350 | 11560.4 | 24854.9 | 19004.9 |
| $A_3$ | 1875 | 4350 | 11757.3 | 25278.2 | 19053.2 |
| $A_4$ | 2250 | 4350 | 11182.0 | 24041.3 | 17441.3 |
| $A_5$ | 2625 | 4350 | 10927.2 | 23493.5 | 16518.5 |
| $A_6$ | 3000 | 4350 | 10629.9 | 22854.3 | 16518.5 |

The data in the table are means for the 2 years; The seed price is 50 Yuan/kg and the price of rice is 2.15 Yuan/kg

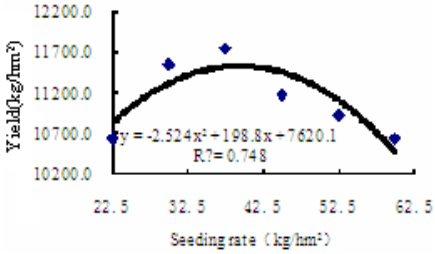


Fig. 2: Relationship of seeding rate and yield

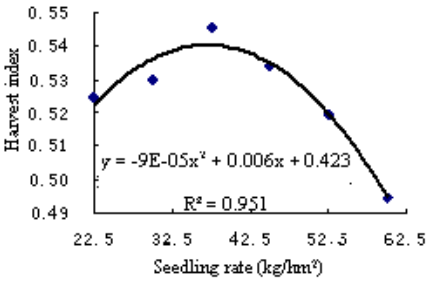


Fig. 3: Relationship of seeding rate and harvest index

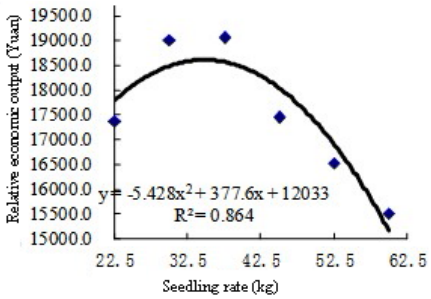


Fig. 4: Relationship of seeding rate and economic coefficient

When the seeding rate is 2.433 kg/hm$^2$, the harvest index reaches its maximum value of 0.5388.

**The relative economic output:** The relative economic outputs of different treatments were showed in Table 4. That is, the seed costs of different treatments ranged from 1125 to 3,000 Yuan/hm$^2$, with an average of 2062.5 Yuan/hm$^2$; the fertilizer and agricultural chemicals cost 4350 Yuan/hm$^2$; the income converted from yield was 22313.9 to 24691.6 Yuan/hm$^2$ and the average value was 23,330.1 Yuan/hm$^2$; the relative economic output was 14,963 to 18466.6 Yuan/hm$^2$ and the average was 16,917.3 Yuan/hm$^2$. From the analysis of the connection of seeding rate and relative economic output, a quadratic curve was found as well (Fig. 4). The concrete relationship is:

$$y = -5.4284x^2 + 377.64x + 12033,\ R^2 = 0.8644^{**}$$

When the seeding rate is 34.784 kg/hm$^2$, the relative economic output reaches the maximum 18600.86 Yuan/hm$^2$.

## CONCLUSION

Seeding rate significantly influences whole growth period, yield components, yield and relative economic output of Feng-liang-you-xiang-1. It shows a quadratic regression equation between the seeding rate and whole growth period and when the seeding rate was less than 30 kg/hm$^2$ or more than 52.5 kg/hm$^2$, the whole growth period was obviously shortened compared with that of other seeding rate. Among the yield components, panicles, grains/panicles, harvest index, seed-setting rate and harvest index are effected very significantly by the seeding rate, showing a relationship of quadratic curve; while to 1000 seed weight the influence is insignificant. And seeding rate shows in curve relation to yield ($y = 2.5248x^2 + 198.89x + 7620.1$); when the sowing rate is 39.387 kg/hm$^2$, the yield reaches the maximum value of 11536.95 kg/hm$^2$.

There are many factors affecting the yield of rice which are sown directly. Whether it shows the same regular under the condition of changes in fertilizing, water supply, temperature and sunshine resources is a problem worth to study further.

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