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不同施氮量对两系杂交中籼稻产量和衰老的影响

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摘 要：以超高产水稻品种丰两优香 1 号为材料，在常规大田生产条件下，分析不同氮肥用量对两系杂交中籼稻产量、氮肥农学利用效率以及功能叶衰老的影响。结果表明，施氮量在 0~255 kg·hm^{-2}范围内，两系稻产量、群体质量和氮肥农学利用效率随施氮量增加而提高，以 255 kg·hm^{-2}施氮处理的产量最高(11786.4 kg·hm^{-2})、氮肥农学利用率最大；施氮量增加到 300 kg·hm^{-2}，产量、群体质量和氮肥农学利用率均下降。氮素营养影响水稻衰老进程，适宜施氮量(255 kg·hm^{-2})和较高氮肥农学利用率，能保证两系杂交中籼稻齐穗后功能叶不早衰，有利于后期植株光合能力提高和光合产物积累，使后期物质积累贡献率提高，为获得高产奠定基础。

关键词：两系稻；氮肥；产量；衰老
中图分类号：S147.2; S511 **文献标识码：**A **文章编号：**1672–352X (2014)01–0110–06

Effects of different nitrogen levels on two-line indica hybrid rice yields and senescence

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Abstract: Super high-yielding rice variety Fengliangyouxiang 1 was used to analyze the impact of different nitrogen application rates on group characteristics, nitrogen agronomic utilization and functional leaf senescence of two-line medium indica hybrid rice under the condition of conventional field test. The results showed as follows: when the nitrogen rate was in the range of 0-255kg·hm^{-2}, two-line hybrid rice production, population quality and nitrogen agronomic utilization increased along with the increase of nitrogen application rate; when the nitrogen application treatment was of 255 kg·hm^{-2}, it had the highest yield (11786.4 kg·hm^{-2}) and the maximum nitrogen agronomic utilization; when the nitrogen rate increased from 255 to 300 kg·hm^{-2}, the production, population quality and nitrogen agronomic utilization decreased. Rice aging process was affected by nitrogen nutrition. The optimum nitrogen application rate (255 kg·hm^{-2}) and a relatively high nitrogen agronomic utilization could ensure that the functional leaves of the two-line medium indica hybrid rice would not premature aging after the full heading, which is favorable for enhancing plant photosynthetic capacity and the accumulation of photosynthetic products at later stage, increasing the material accumulate contribution rate in later period, so as to lay a foundation for high yield.

Key words: two-line indica hybrid rice; nitrogen fertilizer; yield; senescence

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1

1 材料与方法

1.1 材料

1

1.2 试验设计

2012

28.4 g·kg-1 (N) 1.8 g·kg-1

(P) 21. 5 mg·kg-1 , (K) 48. 6mg·kg-1

pH6. 2 4 A

(CK) B N 210 kg·hm-2 C

N 255 kg·hm-2 D N 300 kg·hm-2

3 18 m^2 12

$P_2O_5$75 kg·hm-2 K_2O120

kg·hm-2

50% N 60%

N 10% 30%

4 25

5 30 30 cm × 13 cm

1.3 测定项目与方法

1.3.1 分蘖动态 10

1.3.2 干物质和叶面积

3

LI-COR

LI-3000A

105 80

1.3.3 叶片净光合速率 0 d

10 d 20 d 30 d

LI-6400XT

(LI-COR)

CO_2 350 μL·L-1 30

1200 μmol·m-2·s-1

1.3.4 其他相关生理指标 SPAD

SPAD-502 (MDA)

Hodges [9]

(SOD) Beers [10]

1 min H_2O_2

(POD) [11] 1 min g

(CAT)

[12] NBT

50% 1

1.3.5 产量及产量构成因素

10

1.3.6 氮肥农学利用率 =

- / × 100

1.4 数据分析

DPS

2 结果与分析

2.1 不同施肥水平对两系水稻产量和群体质量影响

2.1.1 对产量和氮肥农学利用率的影响 1

255 kg·hm-2 11786.4 kg·hm-2

255 kg·hm-2

210 kg·hm-2 300

kg·hm-2

255 kg·hm-2

P 0.05

2.1.2 对若干群体质量指标的影响 1

C D B

A

A 65.8% B 63.5% C 62.3% D 55.0%

2

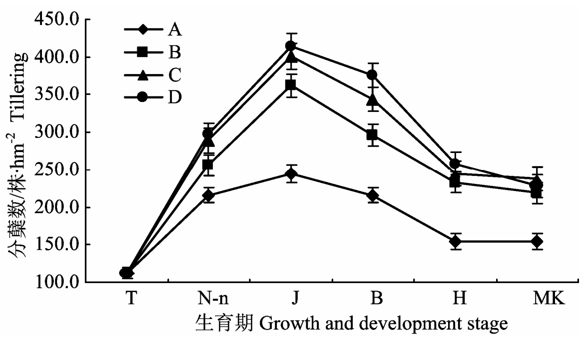
D LAI7.8 C LAI 7.5 B A(66.7% D 54.5%
LAI 6.9 A LAI 6.3 B 52.1% C 44.1%

表 1 不同施氮量对水稻产量及其氮肥农学利用率的影响

Table 1 Effects of rice yield and nitrogen agronomic efficiency under different nitrogen levels

Treatment	(×10^4/hm^2) Panicles	Spikelets per panicle	(×10^4/hm^2) Spikelets	/% Filled-grain percentage	/g 1000-grain weight	/kg·hm^-2 Harvested yield	Nitrogen agronomic efficiency
A CK	154.5[a]	176[a]	27192.0[a]	86.7[a]	26.5[a]	5433.1[a]	-
B	219.5[b]	184[b]	40388.0[b]	86.3[a]	27.1[a]	7671.0[b]	12.4[a]
C	238.5[b]	246[c]	58671.0[c]	85.6[a]	27.2[a]	11786.4[c]	28.2[b]
D	227.5[b]	247[c]	56192.8[c]	84.7[a]	27.1[a]	10178.7[d]	17.6[c]

5% Note: Different small letters mean significant difference at the 5% level .



T N-n J
B H MK M:
T: Transplanting stage; N-n: Critical leaf-age for productive tillers; J: Jointing; B: Booting; H:Heading; MK:Milky stage; M:Maturity. The same below.

图 1 不同处理下水稻茎蘖动态变化

Figure 1 Dynamic changes of stem and tiller numbers of rice plants under different nitrogen levels

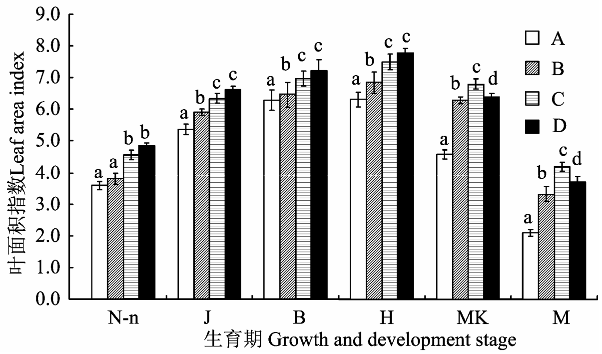


图 2 不同处理下水稻叶面积指数动态变化

Figure 2 Dynamic changes of leaf area index(LAI) of rice plants under different nitrogen levels

3

D C B A CK
P 0.05

C D B A CK

P 0.05

C
46.8% D 44.7% B 43.5% A 40.5%
255 kg·hm^{-2}

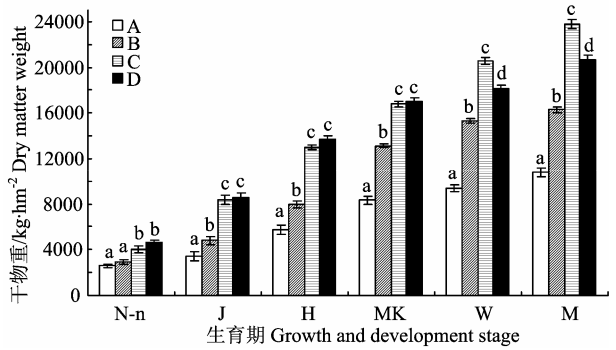


图 3 不同处理下水稻各生育期干物质积累动态变化

Figure 3 Dynamic changes of dry matter weight of rice plants under different nitrogen levels

2.2 不同施氮量对两系水稻齐穗后功能叶绿素含量和净光合速率的影响

4
30 d
61.7% CK 41.8% B 24.4%
C 33.7% D 10 d

D A CK

B C

20 d 30 d C

P 0.05

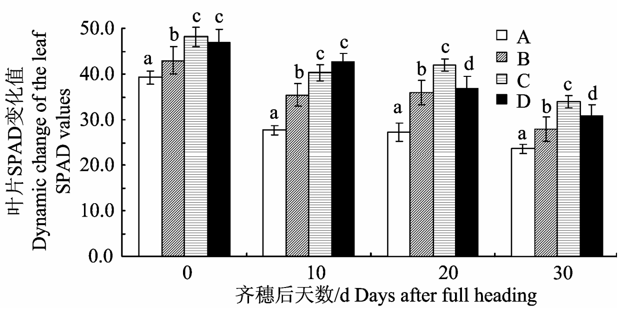


图 4 不同处理下水稻抽穗后功能叶叶绿素（**SPAD** 值）含量的变化

Figure 4 Changes of chlorophyll content (value of SPAD) in functional leaves after full heading

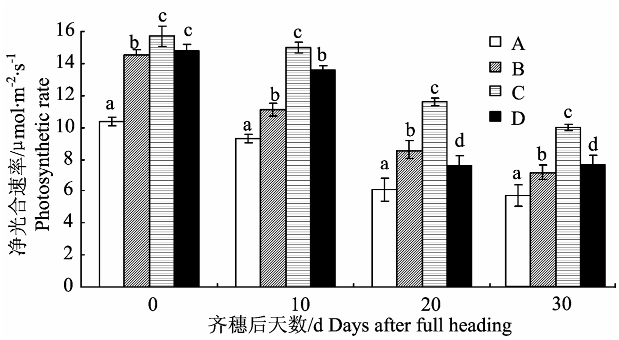


图 5 水稻抽穗后功能叶净光合速率的变化

Figure 5 Changes of photosynthetic rate in functional leaves after full heading

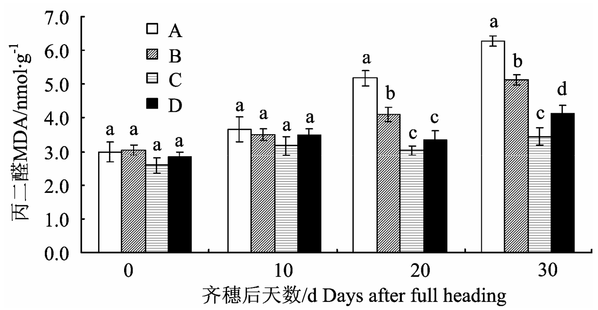


图 6 水稻抽穗后功能叶丙二醛的变化

Figure 6 Changes of MDA in functional leaves after full heading

80% 90%

[13] 5

10.39 μmol·m^{-2}·s^{-1} CK 13.51 μmol·m^{-2}·s^{-1}

B 14.7 μmol·m^{-2}·s^{-1} C 14.85 μmol·m^{-2}·s^{-1}

D 30 d 4.7 μmol·m^{-2}·s^{-1} CK

7.09 μmol·m^{-2}·s^{-1} B 9.98 μmol·m^{-2}·s^{-1} C 7.61

μmol·m^{-2}·s^{-1} D 54.3% 47.5%

32.1% 48.6% C

10 d 20 d 30 d

C

P 0.05

(1)

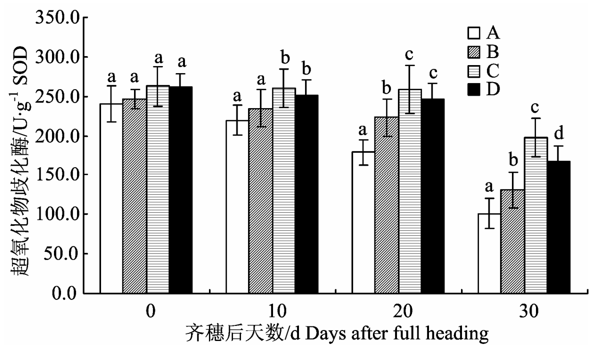


图 7 水稻抽穗后功能叶超氧化物歧化酶活性的变化

Figure 7 Changes of SOD in functional leaves after full heading

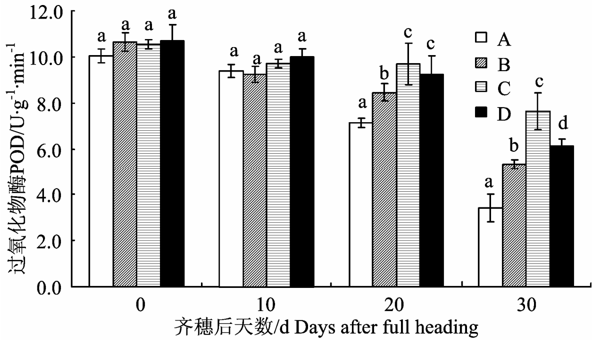


图 8 水稻抽穗后功能叶过氧化物酶活性的变化

Figure 8 Changes of POD in functional leaves after full heading

2.3 不同施肥水平对两系水稻齐穗后功能叶活性氧清除系统的影响

2.3.1 对丙二醛（MDA）含量的影响 MDA

6

MDA

20 d 30 d B A CK

MDA D C

30 d MDA ,

5.28 nmol·g^{-1} CK 4.63 nmol·g^{-1} B 3.45 nmol·g^{-1} C 4.12 nmol·g^{-1} D C MDA P 0.05 C

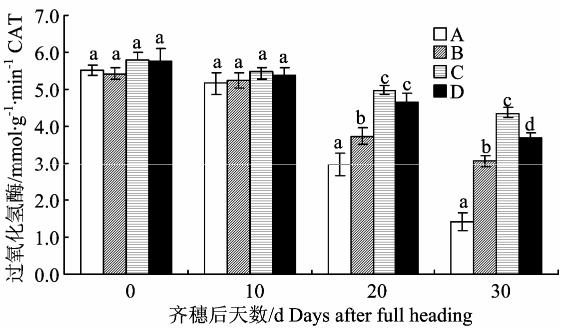


图 9 水稻抽穗后功能叶过氧化氢酶活性的变化

Figure 9 Changes of CAT in functional leaves after full heading

2.3.2 对内源保护酶活性的影响 SOD [14] 7 SOD

C SOD 30 d C SOD 96.0% CK 51.1% B 18.7% D P 0.05 255 kg/hm^2 SOD

POD H_2O_2 H_2O_2 8 POD 10 d POD 10.33 U·g^{-1}·min^{-1} CK 10.46 U·g^{-1}·min^{-1} B 10.54 U·g^{-1}·min^{-1} 10.70 U·g^{-1}·min^{-1} 10 d 9.5 U·g^{-1}·min^{-1} CK 9.35 U·g^{-1}·min^{-1} B 9.6 U·g^{-1}·min^{-1} C 9.77 U·g^{-1}·min^{-1} D 30 d C POD 91.2% CK 22.1% B 20.0% D P 0.05

表 2 水稻功能叶衰老生理性状与氮素农学利用率的相互关系

Table 2 Relationships between nitrogen agronomic efficiency and physiological characteristics of functional leaves senescence

Physiological characteristics of functional leaves	Full heading	10 d 10 days after full heading	20 d 20 days after full heading	30 d 30 days after full heading
Chlorophyll content	0.9677**	0.9658**	0.9836**	0.9789**
Photosynthetic rate	0.9487**	0.9596**	0.9215**	0.9431**
MDA content	-0.9125**	-0.9246**	-0.9341**	-0.9425**
SOD activity	0.8927**	0.9234**	0.9157**	0.9321**
POD activity	0.9340**	0.8975**	0.9624**	0.9087**
CAT activity	0.8975**	0.9325**	0.9244**	0.9126**

* ** 5% 1%

Note : * and** mean significant difference at the 5% and 1% probability levels , respectively.

CAT H_2O_2 SOD POD 9 CAT 10 d CAT 30 d C CAT 207.1% CK 42.3% B 18.3% D P 0.05

2.4 两系水稻齐穗后功能叶生理特性与氮肥农学利用率的相关性

2 SOD POD CAT MDA SOD POD CAT

3 小结与讨论

[15]

[16]

$0 \sim 300\ kg \cdot hm^{-2}$

$255\ kg \cdot hm^{-2}$ ($11786.4\ kg \cdot hm^{-2}$)

$300\ kg \cdot hm^{-2}$

SOD POD

[17]

SOD POD

MDA

$0 \sim 255\ kg \cdot hm^{-2}$

$255\ kg \cdot hm^{-2}$ $300\ kg \cdot hm^{-2}$

$255\ kg \cdot hm^{-2}$

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