

# Performance of 32 Hybrid Rice Varieties at Pine Bluff of Arkansas

Bihu Huang<sup>1\*</sup>, Zongbu Yan<sup>2</sup>

<sup>1</sup>Department of Agriculture, University of Arkansas at Pine Bluff, Pine Bluff, USA

<sup>2</sup>AgriLife Research, TAMU, Beaumont, USA

Email: \*huangb@uapb.edu

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## Abstract

Yield test of 41 entries, 32 new hybrids, 8 male parents restorer lines and 1 inbred variety, was conducted on the farm of University of Arkansas at Pine Bluff (UAPB) in 2012. The only inbred Francis in this experiment was used as the check. Francis is a popular variety and widely used in Arkansas rice production. Results showed that the yields of 7 hybrids were 25.7% - 30.7% higher than check Francis. Hybrid 28s/BP23R had the highest yield, 10846.6 kg/hectare and over check by 30.7%. The yield of hybrid 28s/PB-24, was 10628.9 kg/hectare and over check by 28.1%. The yields of hybrid 28s/PB-22 and 33A/PB24 were 10549.8 and 10539.8 kg/hectare and over check by 27.1% and 27.0%, respectively. The sterile lines 28s, 29s, 30s and 33A have good combinability. PB2, PB5, PB12, PB22, PB23, PB24, and PB25 are good restorers and most of their hybrids were over check more than 17%. Sterile 28s has DEMG (Dominant Early Maturity Gene) which can make earlier heading hybrids by crossing with late restorer lines. Sterile 30s and 33A have no DEMG but have heat resistant gene. They can make late heading hybrids by crossing with late restorer lines PB24 and PB22 and the late heading hybrids can resistant to hot temperature. These results showed that these sterile lines, restorer lines and hybrids can be used in rice production of Arkansas in the future.

## Keywords

Performance, Hybrid Rice, Variety, Pine Bluff, Arkansas

## 1. Introduction

The rice heterosis (hybrid vigor) has been known for a long time in rice production and research. Rice cultural practices vary across the state and US environmental and economic times [1]. Utilization of hybrid rice is an important technology to meet the in-

creasing rice demand in world. Hybrid rice is more profitable, and more sustainable for yield production. Hybrid rice delivers about 15% - 20% per capita yield advantage over inbred rice and utilizing less water and pesticides to land [2] [3] [4]. The research of hybrid rice began in 1980s in USA and released first hybrid rice in 2000 by the Rice Tec company. Hybrid rice has been widely grown in the US now. It had covered about 40% of the rice acreage in Arkansas during 2012 to 2014 [5] [6] [7] [8]. The state represents about 50% of the total acres planted rice in USA.

Different germplasms from USDA (United States Department of Agriculture) world rice collection have been utilized and accessed in the hybrid breeding at UAPB since 2008. Some new sterile line, maintain lines, restorer lines and hybrids have been screened and bred from them. The identifying and evaluating activities have generated a lot of knowledge of hybrid breeding, selected resistant varieties and developed some hybrids from this research program [9]-[14]. Based on the research objectives, we had selected varieties that genotypes match up with phenotype from our previous study.

There is a period of very hot weather at the areas of Pine Bluff, Arkansas. There were 32 days with daily highest temperature over 34°C in the 52 days from June 25-August 15 in 2012 (**Table 1**). The development of panicles would be greatly affected when the panicle differentiation (PD) of rice is under this condition. The heading stage of rice growth is about 25 days after the PD stage. Therefore, early PD and heading may be a way to reduce heat-induced sterility by avoiding the period of temperature above 34°C. The best PD growing stage would be before June 25 and the best heading stage would be before July 20. It can avoid being hurt by high temperature in Arkansas. Therefore the earlier season hybrid rice varieties are also very important in the rice production. There are two ways to breed earlier season hybrids. One is using the normal sterile line which has no DEMG (Dominant Early Maturity Genes) to cross earlier heading restorer line to get earlier heading hybrids. Another way is using early maturity hybrids with DEMG (Dominant Early Maturity Genes) sterile female parent to cross with late heading restorer lines to get the earlier heading hybrids.

The later heading hybrid rice variety also can get the higher yield if their parents have heat resistant gene. They can head normally without be hurt by high temperature. Those later heading hybrid rice varieties were from none-DEMG sterile line mating late heading restorer lines.

Based on the research objectives, we selected varieties which genotypes match up with phenotype from our previous study.

## 2. Materials and Methods

32 hybrids were made from 4 sterile line 28s, 29s, 30s and 33A by separately crossing with 8 restorer lines PB-2R, PB-5R, PB-12R, PB-21R, PB-22R, PB-23R, PB-24 and PB25. 28s came from the F5 generation of the Gobo (PI-369806)/Zhenshan 97// Xiangzaoxian No. 1///Jin23, 29s came from the F6 generation of the E425 (PI-442935)//Lemont/Zhenshan 97, 30s came from the F5 generation of the Madagascar 342 (PI-317514)///Lemont/you-1//IR2061, and 33A came from the B5F1 generation of Ignap

**Table 1.** Maximum temperature of June to August 2012 in Pine Bluff, Arkansas.

Date	Daily maximum Temperature (°C)	Date	Daily maximum Temperature (°C)	Date	Daily maximum Temperature (°C)
6/1/2012	29.1	7/1/2012	37.2	8/1/2012	37.9
6/2/2012	23.5	7/2/2012	36.8	8/2/2012	36
6/3/2012	29.2	7/3/2012	33.1	8/3/2012	35.2
6/4/2012	33.7	7/4/2012	37.6	8/4/2012	36.4
6/5/2012	31.2	7/5/2012	38.1	8/5/2012	37.7
6/6/2012	27.6	7/6/2012	37.1	8/6/2012	35.6
6/7/2012	27.8	7/7/2012	38.4	8/7/2012	34.8
6/8/2012	27.2	7/8/2012	37.7	8/8/2012	35.6
6/9/2012	30.7	7/9/2012	29.1	8/9/2012	36.2
6/10/2012	30.6	7/10/2012	30.7	8/10/2012	36.4
6/11/2012	30.4	7/11/2012	30.5	8/11/2012	33.4
6/12/2012	34.2	7/12/2012	29.4	8/12/2012	29.9
6/13/2012	28.1	7/13/2012	28.7	8/13/2012	33.6
6/14/2012	28.5	7/14/2012	29.1	8/14/2012	36.2
6/15/2012	30.9	7/15/2012	29.4	8/15/2012	28.2
6/16/2012	32.1	7/16/2012	30.2	8/16/2012	30.3
6/17/2012	32.3	7/17/2012	31.8	8/17/2012	35.4
6/18/2012	32.2	7/18/2012	33.7	8/18/2012	31.3
6/19/2012	32.3	7/19/2012	35.2	8/19/2012	27.1
6/20/2012	32.8	7/20/2012	36.8	8/20/2012	28.8
6/21/2012	32.2	7/21/2012	38.7	8/21/2012	29.9
6/22/2012	33.3	7/22/2012	33.3	8/22/2012	30.5
6/23/2012	33.3	7/23/2012	32.5	8/23/2012	32.3
6/24/2012	34	7/24/2012	33.8	8/24/2012	32.2
6/25/2012	34.8	7/25/2012	34.6	8/25/2012	31.8
6/26/2012	37.6	7/26/2012	35.4	8/26/2012	31.5
6/27/2012	32.6	7/27/2012	35.8	8/27/2012	32.9
6/28/2012	35.2	7/28/2012	32.1	8/28/2012	33.6
6/29/2012	39.3	7/29/2012	37.4	8/29/2012	32
6/30/2012	38.9	7/30/2012	36	8/30/2012	34.1
		7/31/2012	40.7	8/31/2012	27.6

Catelo (PI-373138)//II-32/Jin23. PB-2R came from the F5 generation of CDR22/ Katy/Minghui63, PB-5R came from the IR64//Katy/Guiyana 50781, PB-12 came from the Katy/Minghui63/Jasmine-85, PB-21R came from the Bengal/Minghui63/Jasmine-85, PB-22R came from the Katy/Minghui63//Gui 99, PB-23R came from the Katy/Minghui63//CDR210, PB-24 came from the Katy/Minghui63//Ce64, and PB-25R came from the Katy/Minghui63//IR24.

These 32 hybrids and their 8 male parents were tested for agronomic traits and yield at the farm of UAPB in 2012. Soil texture is silt loam with PH value of 5.3. The test entries were sowed at April 16 in the greenhouse and transplanted to field with 20 days old seedlings at 10 feet long, 1 foot space row, and 3 replications for each entry. Weeds were controlled with 9.3 L ha<sup>-1</sup> of Propanil (3', 4'-dichloropropionanilide) mixed with 0.4 kg ha<sup>-1</sup> of quinclorac (3, 7-dichloroquinoline-8-carboxylic acid; Facet, BASF) when the rice were about four-leaf stage. Nitrogen fertilizer was applied pre-flood at 134 kg N ha<sup>-1</sup> at about the five-leaf stage. The flood (underground water from a well) was maintained throughout the growing season. Heading dates were recorded when 50% of the plants were headed. Panicles were harvested about 40 days after heading. Plant heights were measured at harvest. Weights of 1000 grains and seed set rate were measured. Seed set rates were calculated by seeds per panicle divided by the total spikelet per panicle. Milled rice, head rice and yield were also measured. Daily maximum temperatures were recorded by the sensor of NRCS Arkansas scan sites which is 50 meters away from field of study [15]. Average yields and stand error of the mean were analyzed by SAS 9.2.

### 3. Results

The results showed that yields of 27 hybrid rice were higher, 5 hybrids were lower and 8 restore lines were higher than check Francis (**Table 2**).

15 hybrids had yielded 20% higher than check Francis. The top 7 hybrids were 28s/PB23, 28s/PB24, 28 s/PB22, 33A/PB24, 30s/PB24, 33A/PB22, and 30s/PB23. They yielded 10846.6 kg/hectare, 10628.9 kg/hectare, 10549.8 kg/hectare, 10539.8 kg/hectare, 10490.4 kg/hectare, 10460.8 kg/hectare, and 10431.1 kg/hectare, and over CK 30.7%, 28.1%, 27.1%, 27%, 26.4%, 26%, 25.7%, respectively (**Table 2**).

The heading date of early maturity hybrids, 28s/PB23, 28s/PB24, and 28s/PB22, were July 13 or 14 and growing days of sowing to heading were 88 or 89 days (**Table 2**). These three hybrids were developed from sterile female parent 28s, which is with DEMG, by crossing with late restorer PB23, PB24, and PB22. They had higher yields than late maturity hybrids which developed from none-DEMG sterile female parent. These results indicate that their PD (the panicle differentiation stage) had avoided the high temperature period. To achieve higher yield under the similar weather condition, the PD should be before June 25 and heading stage should be before July 20. The growing stage of a variety from sowing to heading should be earlier than 90 days to achieve higher yield in the areas with high temperatures such as Pine Bluff, Arkansas.

The heading date of check Francis was July 15 and its growing stage of sowing to heading was 90 days. The hybrids 33A/PB24, 30s/PB24, 33A/PB22, 30s/PB23, 30s/PB22,

**Table 2.** Yield and heading date of Hybrid rice in UAPB 2012.

variety	Type	date to heading		Average			Over CK (%)	Rank
		Month/date	Days to head	g/plot	Kg/H	Std Err		
28s/PB23	Hybrid	13-Jul	88	438.6	10846.6	11.1	30.7	1
28s/PB24	Hybrid	14-Jul	89	429.8	10628.9	13.6	28.1	2
28s/PB22	Hybrid	14-Jul	89	426.6	10549.8	13.3	27.1	3
33A/PB24	Hybrid	5-Aug	111	426.2	10539.8	13.6	27.0	4
30s/PB24	Hybrid	24-Jul	99	424.2	10490.4	15.0	26.4	5
33A/PB22	Hybrid	1-Aug	107	423.0	10460.8	5.1	26.0	6
30s/PB23	Hybrid	24-Jul	99	421.8	10431.1	10.0	25.7	7
30s/PB22	Hybrid	24-Jul	99	410.2	10144.2	15.9	22.2	8
33A/PB25	Hybrid	7-Aug	113	407.4	10075.0	9.3	21.4	9
30s/PB25	Hybrid	25-Jul	100	405.0	10015.6	13.8	20.7	10
33A/PB12	Hybrid	1-Aug	107	405.2	10020.6	7.3	20.7	10
33A/PB2	Hybrid	2-Aug	108	404.4	10000.9	14.9	20.5	11
29s/PB22	Hybrid	18-Jul	93	403.6	9981.0	7.9	20.3	12
28s/PB12	Hybrid	12-Jul	87	403.4	9976.0	15.4	20.2	13
29s/PB5	Hybrid	16-Jul	91	403.2	9971.1	11.9	20.1	14
30s/PB5	Hybrid	22-Jul	97	402.8	9950.6	7.9	19.9	15
29s/PB24	Hybrid	19-Jul	94	397.0	9817.7	10.3	18.3	16
28s/PB25	Hybrid	14-Jul	89	395.6	9783.1	16.4	17.9	17
30s/PB2	Hybrid	21-Jul	96	393.2	9723.8	12.9	17.2	18
30s/PB12	Hybrid	23-Jul	98	391.4	9679.3	10.3	16.6	19
28s/PB5	Hybrid	11-Jul	86	383.6	9486.4	19.0	14.3	20
33A/PB23	Hybrid	3-Aug	109	383.6	9486.4	10.0	14.3	20
29s/PB2	Hybrid	16-Jul	91	378.8	9367.7	13.0	12.9	21
33A/PB5	Hybrid	3-Aug	109	378.8	9367.6	9.5	12.9	21
29s/PB12	Hybrid	17-Jul	92	373.2	9229.2	12.4	11.2	22
28s/PB2	Hybrid	11-Jul	86	370.4	9159.9	15.1	10.4	23
29s/PB25	Hybrid	21-Jul	96	366.8	9071.0	13.6	9.3	24
29s/PB23	Hybrid	18-Jul	93	328.4	8121.3	12.7	-2.1	34
33A/PB21	Hybrid	23-Jul	98	323.2	7992.7	13.0	-3.7	35
30s/PB21	Hybrid	23-Jul	98	310.4	7676.2	13.7	-7.5	36
29s/PB21	Hybrid	19-Jul	94	294.8	7290.4	8.4	-12.2	37
28s/PB21	Hybrid	12-Jul	87	290.2	7176.6	21.3	-13.5	38
PB24	Restorer (male)	11-Aug	117	358.2	8858.2	3.8	6.7	25
PB12	Restorer (male)	2-Aug	108	356.6	8818.7	4.6	6.3	26
PB23	Restorer (male)	8-Aug	114	356.2	8808.8	7.0	6.1	27
PB5	Restorer (male)	6-Aug	112	353.8	8749.5	4.4	5.4	28
PB25	Restorer (male)	8-Aug	114	349.4	8640.6	7.3	4.1	29
PB2	Restorer (male)	7-Aug	113	345.0	8531.9	14.1	2.8	30
PB22	Restorer (male)	6-Aug	112	338.8	8378.6	7.9	1.0	31
PB21	Restorer (male)	21-Jul	96	338.2	8363.7	5.8	0.8	32
Francis	Inbred(CK)	15-Jul	90	335.6	8299.4	8.9	/	33

33A/PB25, 30s/PB25, 33A/PB12, 33A/PB2, and 30s/PB5 were late heading in from July 24-August 5 and their growing stage of sowing to heading were 111 days, 99 days, 107 days, 99 days, 99 days, 113 days, 100 days, 107 days, 108 days, and 97 days, respectively. They were 21 days, 9 days, 17 days, 9 days, 9 days, 13 days, 10 days, 17 days, 18 days, and 7 days later than check Francis, respectively. They headed in the highest temperature time but still had higher yields which were over check Francis 27%, 26.4%, 26%, 25.7%, 22.2%, 21.4%, 20.7%, 20.7%, 20.5%, and 19.9%, respectively (Table 2). These 10 hybrids showed heat tolerant may indicate the existing of heat resistant genes.

Table 3 (horizontally) listed the average yields of hybrids from the same sterile line crossed with 8 different restorer lines, PB2, PB5, PB12, PB21, PB22, PB23, PB24, and PB 25. Hybrids developed from sterile line 30s had the highest average yield of 9763.9 kg/hectare and over CK 17.6%. Hybrids developed from sterile line 33A had the second high yield of 9743.0 kg/hectare and over CK 17.4%. Hybrids from sterile line 28s was the third high yield of 9700.9 kg/hectare and over CK 16.9%. The last was hybrids from sterile line 29s with an average yield of 9106.2 kg/hectare and over CK 9.7% (Table 3).

Table 3 (Vertically) listed the average yields of hybrids for the same restorer line crossed with 4 different sterile lines, 28s, 29s, 30s, and 33A. Hybrids from PB-24 crossed with the 4 sterile lines had the highest average yield 10369.2 kg/hectare and over CK 24.9%. It was also over male parent PB24 by 17.1%. Hybrids from PB22 crossed with the 4 sterile lines had the second high average yield of 10284.0 kg/hectare and was over CK by 23.9%. It was also over male parent PB22 by 22.2%. Hybrids from PB25 crossed with the 4 sterile lines had the third average yield of 9736.2 kg/hectare

Table 3. Yields of restore and the average yield of same restorer crossing with different sterile lines.

Restorer	Yield (kg/h)	Sterile 1 (28s)		Sterile 2 (29s)		Sterile 3 (30s)		Sterile 4 (33A)		Average Yield of Hybrids		Over Ck %	Rank
		Hybrid (♀ / ♂)	Yield (kg/ha)	Yield (kg/ha)	Std Err								
PB2	8531.9	28s/PB2	9159.9	29s/PB2	9367.7	30s/PB2	9723.8	33A/PB2	10000.9	9563.1	186.7	15.2	7
PB5	8749.5	28s/PB5	9486.4	29s/PB5	9971.1	30s/PB5	9950.6	33A/PB5	9367.6	9693.9	156.1	16.8	6
PB12	8819.0	28s/PB12	9976.0	29s/PB12	9229.2	30s/PB12	9679.3	33A/PB12	10020.6	9726.3	182.2	17.2	4
PB21	8363.7	28s/PB21	7176.6	29s/PB21	7290.4	30s/PB21	7676.2	33A/PB21	7992.7	7534.0	186.6	-9.2	8
PB22	8378.6	28s/PB22	10549.8	29s/PB22	9981.0	30s/PB22	10144.2	33A/PB22	10460.8	10284.0	133.3	23.9	2
PB23	8808.8	28s/PB23	10846.6	29s/PB23	8121.3	30s/PB23	10431.1	33A/PB23	9486.4	9721.4	604.5	17.1	5
PB24	8858.0	28s/PB24	10628.9	29s/PB24	9817.7	30s/PB24	10490.4	33A/PB24	10539.8	10369.2	186.1	24.9	1
PB25	8640.6	28s/PB25	9783.1	29s/PB25	9071.0	30s/PB25	10015.6	33A/PB25	10075.0	9736.2	230.5	17.3	3
Average	8643.8		9700.9		9106.2		9763.9		9743.0				
Std Err	70.2		415.9		337.3		315.7		288.9				
Over CK (%)	4.1		16.9		9.7		17.6		17.4				
Rank			3		4		1		2				

Ck (francis) = 8299.4 Kg/Ha

and was over CK by 17.3%. It was also over male parent PB25 by 12.7%. Hybrids from PB12 crossed with the 4 sterile lines had the fourth average yield of 9726.3 kg/hectare and was over CK by 17.2%. It was also over male parent PB12 to 10.3%. Hybrids from PB23 crossed with the 4 sterile lines had the fifth average yield of 9721.4 kg/hectare and was over CK 17.1%. It was also over male parent PB23 by 10.4%. Hybrids from PB5 crossed with the 4 sterile lines had the sixth average yield was 9693.9 kg/hectare and was over CK 16.8%. It was also over male parent PB5 to 10.8%. Hybrids from PB2 crossed with the 4 sterile lines had the seventh average yield of 9563.1 kg/hectare and was over CK by 15.3%. It was also over male parent PB2 to 12.1%. Hybrids from PB21 crossed with the 4 sterile lines had the lowest average yield of 7534.0 kg/hectare and was lower CK by 9.2%. It was also 9.9% lower than male parent PB21 (**Table 3**).

Plant heights of 32 new hybrid varieties were 105 cm - 126 cm, and their 8 restorer parents were 99 cm - 118 cm. The most hybrids were taller than the male parents. Seed set of most hybrids were 79.3% - 91.5% except the hybrids from PB21 crossed with 4 sterile lines. The seed set rate of hybrids developed from PB21 were 64.6% - 75.2% and the seed set rate of their parent PB21 was 74.8%. The milling rice of 32 new hybrids were 68.2% - 72.5% and 70.9% for check Francis. Head rice of 32 new hybrids were 48.4% - 61.7% and lower than Check Francis (62.6%). The grain weight of the 32 new hybrids were 26.6 - 32.4 g/1000 grain and over check Francis (21.3 g/1000grain) by 24.9% - 52.1% (**Table 4**).

#### 4. Discussions

28s is a very good sterile line with DEMG and has good combining ablating trait with most restorers. It can be used in making early heading hybrids which can avoid the high temperature period and obtain a high yield. Heading days of its hybrids should be 86 - 89 days and about 20 days earlier than male restorer. 30s is very good sterile line with none-DEMG and has good combining ablating trait with most restorers. It can be used in making later heading hybrids which should be resistant to high temperature. The heading days of its hybrids were 97 - 100 days and 10 days earlier than male restorer. 33A is also very good sterile line with none-DEMG which can be used in making later heading hybrids which should be resistant to high temperature. The heading days of its hybrids were 108 - 113 days which as same as male restorer.

PB24 and PB22 are good restorers and have good combining ablating trait with all 4 sterile lines.

Hybrid 30s/PB5 is a short plant height hybrid (105) cm and can be used in higher fertilizer condition. The yield of 5 new hybrids 28s/12, 28s/23, 29s/PB22, 30s/PB23, and 33A/PB22 were over check Francis by 20% - 36% respectively. But their plant heights were tall (120 - 126 cm) and could be lodging. They could better be used under the low fertility condition such as organic rice field. Most of the hybrids were about 110 cm and they can adapt in not high fertility condition.

The head rice rates of most hybrids were lower. But there were still some good hybrids with higher head rice rate. The head rice rate of 28s/PB-2 was %59.9%, the head

**Table 4.** Some other treats of hybrids and male parents.

Entry No.	Name	Type	Plant height (cm)	Seed set (%)	Milling rice (%)	Head Rice (%)	Grain Weight (g/1000 seeds)
1	28s/PB2	hybrid	115	87	70.2	59.9	28.5
2	28s/PB5	hybrid	112	82.2	68.9	57	30.1
3	28s/PB12	hybrid	121	85.6	71.5	61	31.4
4	28s/PB21	hybrid	124	65.9	71	59.8	31.5
5	28s/PB22	hybrid	116	94	70	57.7	30.4
6	28s/PB23	hybrid	124	91.3	69.1	57.9	31.1
7	28s/PB24	hybrid	112	90.8	70.8	61.7	29.9
8	28s/PB25	hybrid	112	84	72.5	59.5	27.9
9	29s/PB2	hybrid	117	85.2	70.5	58.2	29.6
10	29s/PB5	hybrid	114	87.2	70.3	57.2	30.1
11	29s/PB12	hybrid	112	81.6	70.4	59.8	30.5
12	29s/PB21	hybrid	125	70.4	69.2	56.6	30.7
13	29s/PB22	hybrid	122	87.9	69.6	56.2	30.6
14	29s/PB23	hybrid	120	85.5	68.2	53.9	31.2
15	29s/PB24	hybrid	116	86.3	69.5	54.2	31.2
16	29s/PB25	hybrid	110	89.1	68.5	57.9	29.6
17	30s/PB2	hybrid	115	79.8	68.5	56.9	26.6
18	30s/PB5	hybrid	105	86.3	67.3	54.6	28.1
19	30s/PB12	hybrid	120	83.6	70.7	59.4	29.1
20	30s/PB21	hybrid	126	64.6	68.3	54.2	30.2
21	30s/PB22	hybrid	115	92.2	68.3	55.1	31.1
22	30s/PB23	hybrid	124	87.4	68.2	56.9	30.4
23	30s/PB24	hybrid	110	89.2	69	55	30.3
24	30s/PB25	hybrid	121	84.4	69.5	54.7	30.8
25	33A/PB2	hybrid	119	83.2	69.8	56.3	30.4
26	33A/PB5	hybrid	118	88.7	69.1	48.4	30.4
27	33A/PB12	hybrid	111	78.3	68.2	56.9	31.4
28	33A/PB21	hybrid	122	75.2	68.4	57.6	30.5
29	33A/PB22	hybrid	121	84.4	69.5	54.7	30.8
30	33A/PB23	hybrid	121	86.6	69.4	56.8	30.4
31	33A/PB24	hybrid	124	84.7	70.3	56.7	32.4
32	33A/PB25	hybrid	125	85.6	70.3	56.2	31.2
33	PB2	male	118	72.9	70.3	55.1	29.3
34	PB5	male	103	75.9	71.4	56.4	32.6
35	PB12	male	99	73.3	72.2	54.6	32.2
36	PB21	male	116	74.8	69.6	56.2	28.7
37	PB22	male	107	75.8	68.9	57.3	31.5
38	PB23	male	115	75.2	70.3	54.8	33.8
39	PB24	male	114	72.1	69.4	53.5	33.3
40	PB25	male	118	77.4	70.2	53.7	31.8
41	Francis(CK)	Inbred	101	76.8	70.9	62.6	21.3

Planting date: April 16

rice rate of 28s/PB12 was 61%, the head rice rate of 28s/PB 21 was 59.8%, the head rice rate of 28s/PB24 was 61.7%, the head rice rate of 28s/PB25 was 59.5%, and the head rice rate of 29s/PB12 was 59.8%, the head rice rate of 30s/PB 12 was 59.4%. 28s was a good sterile line for hybrid rice with higher head rice rate. PB12 was a good restore line for hybrid rice with higher head rice rate. They can be used selectively in the breeding and the seed production.

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