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SAKHA SUPER 302, A NEW EGYPTIAN SHORT DURATION AND CLIMATE RESILIENT SUPER RICE VARIETY

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ABSTRACT

The new super rice variety, Sakha Super 302 is the first Egyptian Japonica Green Super. Rice (EJGSR), a high yielding and early maturing. This variety was developed by the breeder of the national project program to develop the production of hybrid and super rice under conditions of water scarcity and climate change and his team, sponsored by the Field Crops Research Institute (FCRI), Agricultural Research Center (ARC), and the Academy of Scientific Research and Technology (ASRT), in the Arab Republic of Egypt. The variety Sakha Super 302, was developed from crossbreeding between innovative lines PTGMS 19 x EJSR 26 in 2009, then it was developed by selection using the pedigree method and confirmed in 2016 from the F_7 generation with the name of the line EJGSR 176. Preliminary, advanced, on-farm trails, DUS and VCU tests in 2017 to 2023 indicated high yield, short duration (115-120 day) and favorite agronomic and grain characteristics. The variety Sakha Super 302 was registered in accordance with ministerial resolution no. 108 issued in March 2023.The average grain yield was recorded in yield trails, on-farm experiments and farmers extension trails for Sakha Super 302 and checks varieties, Giza 177, Sakha 101, Sakha 104, Sakha 108 and Sakha Super 300 during 2019 to 2023 were 10.899, 9.375, 10.353, 9.926, 10.537 and 11.508 t/ha, respectively. Thus, the yield of Sakha Super 302 exceeded those of the checks, Giza 177, Sakha 101, Sakha 104 and Sakha 108 by 16.25%, 5.27%, 9.70% and 3.43%, respectively. On the other hand, Sakha super 302 exhibited the highest productivity for grain yield per day 91.93 kg/day/ha compared to 75.03kg, 73.69kg, 73.71kg and 76.54 kg for Giza 177, Sakha 101, Sakha 104 and Sakha 108, respectively, furthermore, it saved water consumption where it consumed 1186m^3/ha with water use efficiency (WUE) of 0.974 compared to Giza 177 that consumed about 12850m^3/ha with (WUE) of 0.730. Both rice varieties, Sakha Super 300 and Sakha super 302, gave better grain yields when planted early before May 15 and late after that date, and were significantly superior to the traditional check varieties, Giza 177, Sakha 101, Sakha 104 and Sakha 108. The new rice variety, Sakha super 302 showed better grain quality attributes compared with Giza 177, Sakha 101, Sakha 104 and Sakha 108. Altogether with high yield potential and other agronomic performance, it is expected to have a good rank among commercial rice varieties. Tests conducted at plant

protection program proved that the new super rice variety Sakha super 302 is resistant to blast and moderately resistant to stem borer.
Key words: ***Super rice, Sakha super 302, Short duration, New plant type, Climate resilient.***

INTRODUCTION

Rice is one of the most important food crops, providing more than 50% of the dietary calories consumed by more than three billion people, and it's a great important responsibility in ensuring global food security (Xie *et al* 2006 and Fu and Chang 2012).

In Egypt the 2023 season, rice crop occupies an area of about 0.685 million ha (1.63 million feddans), with a production of 6.5 million tons and average productivity of 9.491 tons/ ha (3.988 tons feddans). The total consumption was 3.3 to 3.5 million tons with an average of 40 to 42 kg/year/person of milled rice.

The goal of a plant breeder is to develop high yielding with improvement of the highly adaptable variety with respect to biotic X abiotic stresses, climate changes and also grain quality improvement with rapidly increasing population together with the limitation of cultivable area and scarcity of irrigation water, there is an urgent need to improve the productivity of the commercial rice varieties and hybrids and improve their duration, plant type and non-lodging ability. But how to achieve the next break through in rice yields remains one of the major issues for rice breeders (Su and Li, 2007). To further increase yield and improve yield capacity, breeding experts have expanded yield sink capacity. The size of sink organs to be harvested has been maximized, mainly by increasing the number of spikelets per panicle, such as in the "new plant type" known as super rice varieties have large panicles. To achieve the third leap forward for rice yield production, realizing the yield potential of super rice is an important approach to ease the pressure of population growth on the environment and natural resources, and to ensure food security (Chang *etal* 2007; Kato *et al* 2007, Peng *et al* 2008 and Fu and Chang 2012).

New plant type (NPT) lines are being developed to further increase the yield potential of rice varieties. International Rice Research Institute (IRRI) developed NPT lines, popularly termed by the media as "super rice", are expected to yield 12.5 t/ha.(Cheng *et al* 1998) However, super rice is a variety that can produce high and staple yield with low resources like water, nutrients and pesticides under adverse conditions.

Rapid population growth and economic development are putting increasing pressure on increasing food production. To further increase the yield productivity and production, several major national and international programs have been launched, including the Egyptian program, with the aim of developing "super rice" or "super hybrid rice" for breaking the yield ceiling have made a significant progress.

To further increase yield and improve yield capacity, breeding scientist's and experts have expanded yield sink capacity. That is the size of sink organs to be harvested has been maximized, mainly by increasing the number of spikelets per panicle and the heavy panicle weight trait such as in the NPT rice of the IRRI. These hybrid rice varieties, known as super rice or super hybrid rice. wi (2009) and Fu and Chang (2012). Realizing the yield potential of super rice is an important approach to ease the pressure of population growth on the environment and natural terrestrial and water resources and ensuring food security. To meet the food demand of the people in the 21st century, a super-rice program instituted aimedto increasing rice yield (Yuan 2015 and Yuan 2017). Rice yield potential has been increased by 12% in super hybrid rice cultivars as compared with ordinary hybrid and inbred cultivars. The higher grain yields in super and super hybrid rice cultivars are attributed to large panicle size coupled with higher biomass production to break the yield ceiling of rice production. Many rice countries in the world established a super rice program to develop cultivars with super high yield (Cheng *et al* 1998, Yuan 2001, Cheng *etal* 2007 and Huang *et al* 2017). Since 2014, the national project program was established to develop the production of hybrid and super rice under conditions of water scarcity and climate change, funded by the Academy of Scientific Research and Technology (ASRT) and sponsored by Agricultural Research Center (ARC), Field Crops Research Institute (FCRI), Egypt.

In addition, research studies, generation fields, crop comparison fields (preliminary yield trails and final yield trials), confirmatory experiments were conducted to evaluate the project's varietal and research outputs.

Developing early maturing rice varieties is the main target of the rice program, mainly to reduce the amount of irrigation water needed besides resistance to diseases and insects and suitability to the fertile and medium fertility soils, rice breeders at the national rice research program developed and released Giza 177 variety in 1995 (Aidy *et al* 2004) with duration of 125 days. To develop an early maturing super rice variety, crosses were conducted between PTGMS 19 elite PTGMS and local elite Egyptian Japonica super rice line EJSR 26 to maintain the short duration and high productivity besides the adaptation to medium fertility soil conditions.

The aim of this paper is to highlight on selecting, evaluating and releasing that early maturing, high yielding rice variety Sakha Super 302.

MATERIALS AND METHODS

Sakha Super 302 was selected from the PTGMS-19 X JRL 26 cross that was made in 2010. The female parent PTGMS-19 in an unreleased Egyptian Photo-thermo Sensitive Genic Male Sterile line (PTGMS) conventional short-grain with the pedigree of Nongken 58S x IR 66158-3-21 while the male parent JRL 26 is an unreleased Egyptian japonica new restorer line plant type IR65598-112 and Egypt China super rice breeding program EGSR 25 to develop super japonica and indica restorer lines (JRL and IRL).

The F_1 plants were grown in 2010 during summer nursery at the experimental farm of Sakha research station. F_2 population of hybrid plants were grown in the first week of April during summer season of 2011 under appropriate temperature and day length conditions to identify best selected fertile single plants that combine most of the useful traits. From F_3 to F_7 generations were grown in the summer seasons of 2012 to 2016 at Sakha Research Station, Egypt. Pedigree selection method was followed in handling the segregating generations. The number of selected lines were 350 resulted from 115 crosses, one of them was EJGSR 176 which is selected in the F_7 generation.

Promising japonica super lines selected, one of them EJGSR 176 were intered the preliminary yield trail during summer 2017, final yield trail 2018 and on-farm verification yield trails carried out at 15 location in the farmer's field during 2019-2022 season. The commercial varieties Sakha super 300, Giza 177, Sakha 101, Sakha 104 and Sakha 108 were used as check varieties for comparison.

Blast disease test

Rice blast disease caused by the fungus *Magnaporthe oryzae* is one of the major biological constraints of rice yield in Egypt (Aidy *et al* 1998)

Collection of rice blast samples and isolated the causal fungus of blast

The rice blast samples obtained from different governorates and cultivars are listed in Table (1). The fungus was isolated from typical blast symptoms according to Shabana *et al* (2013).

Identification of blast physiological races, effective resistance genes, and evaluated rice genotypes under greenhouse conditions

During October of season 2022, the research work was established in the rice pathology laboratory and greenhouse. Eight international differential varieties (IDV) were used to identify blast physiological races according to Atkins *et al* (1967). Ten international Japanese differential varieties (JDVs) i.e., Shin 2 (*Pi-Ks*), Toride 1 (*Pi-zt*), Tusyake (*Pi-km*), Kanto 51(*Pi-k*), Fukunishiki (*Pi-z*), Ishikarishiki (*Pii-Pi-ks*), BL-1(*Pib*), Yashiro-Mochi (*Pita*), Pi No. 4 (*Pita2*), Aichi Asahi (*Pia*) were used to determine effective resistance blast genes (Yamada *et al* 1976), as well as, six rice genotypes i.e., Giza 177, Giza 178, SK 101, SK 104, SK 108, Super 300 and Super 302 were used to evaluate its resistance level. Twenty isolates were used to inoculate each test genotype after being seeded in plastic trays (30 x 20 x 15cm). The trays were fertilized with urea (46.5% N; 5 g/tray) and housed in the greenhouse at 28±2^{o}C.

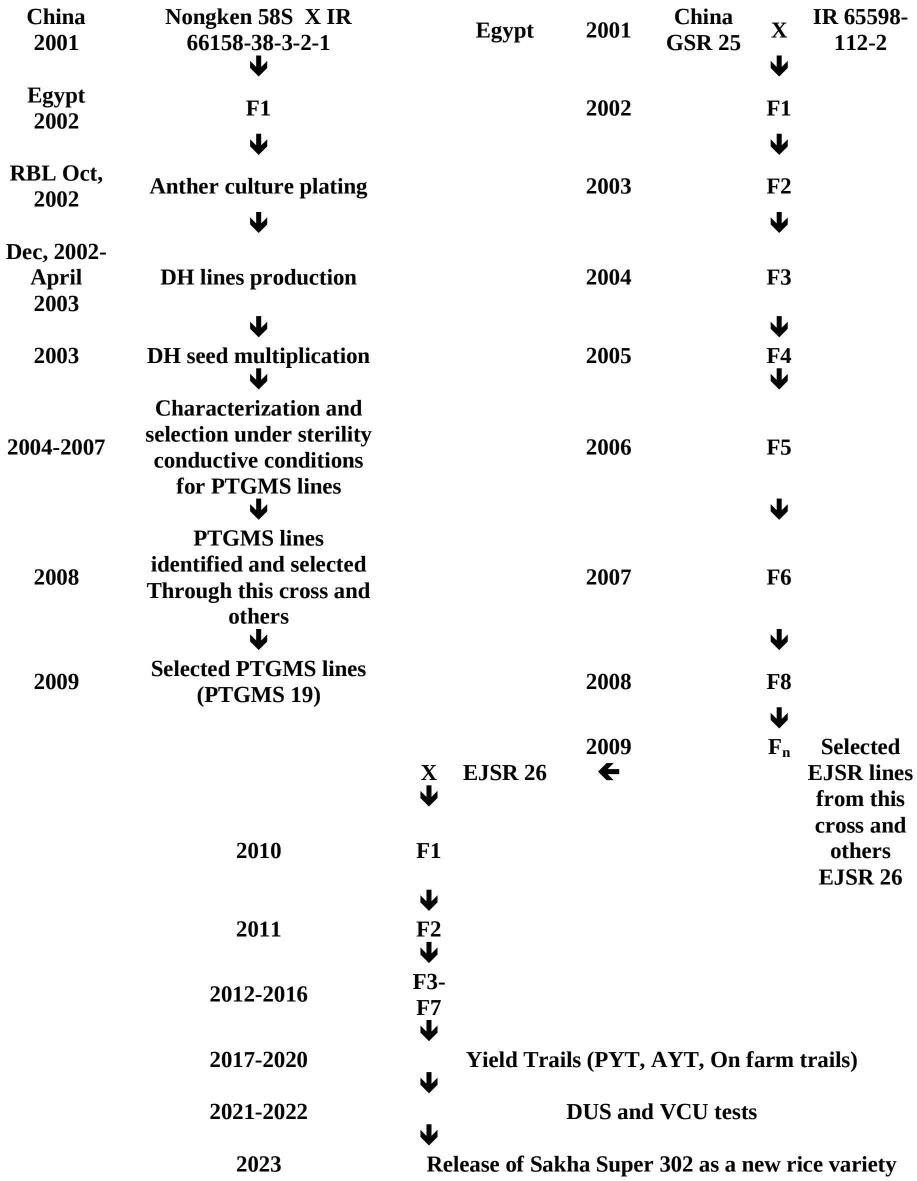

Fig. 1. Diagram and time sequence of the new released super rice variety Sakha Super302.

Table 1. Source of *Magnaporthe oryzae* isolates collected from different cultivars and governorates during 2022 season.

Governorate	No.	District	Rice cultivar
Kafrelsheikh	EG 1	Sakha	SKl01
	EG 2	Sakha	SK104
	EG 3	Miseer	SK104
	EG 4	Desouq	SKl01
	EG 5	Kallien	SK108
Gharbia	EG 6	Gemmiza	SK104
	EG 7	Gemmiza	SKl01
	EG 8	Qotour	SKl01
	EG 9	El-Mahala	SKl01
	EG 10	Qotour	SK108
Dakahlia	EG 11	Dekernes	SK l01
	EG 12	Mansoura	SK l01
	EG 13	Dekerns	SK104
Sharkia	EG 14	Kafrsaker	SK l01
	EG 15	Zagazig	SK l01
	EG 16	Zagazig	SK108
Beheira	EG 17	Itaielbarood	SKl01
	EG 18	Kafreldawar	SK 101
	EG 19	Itaielbarood	SKl04
	EG 20	Damanhour	SK108

Using an electrical spray gun, spore suspension at a concentration of ($5x10^5$ spores/ml) was inoculated seedlings at approximately 21 days after sowing. The seedlings were inoculated, kept for 24h in a moist chamber with more than 90% RH and 28±2°C, and then transferred to a greenhouse with comparable conditions.

Evaluation of rice genotypes under natural infection in blast nursery

The rice genotype EJGSR 176 (Sakha Super 302)was evaluated for rice blast infection compared to the local checks of Giza 177, SK 101, SK 104, SK 108 and SK Super 300. Seedling reactions were tested under blast nursery conditions at three locations (Sakha, Gemmiza and Zarzoura). Adult plant reaction was recorded from the 15 locations of experimental yield trials (PYT and AYT), verification yield trial (on - Farm) and extensionsites.

Disease evaluation: Using the standard evaluation system's 0–9 scale,(IRRI, 2013) blast reactions as well as the typical blast lesions were assessed seven days following inoculation under greenhouse conditions.

RESULTS AND DISCUSSION

The grain yield of the new Egyptian rice variety Sakha Super 302 was higher than the commercial varieties, Giza 177, Sakha 101, Sakha 104 and Sakha 108 under normal conditions as shown in Table (2).

Sakha super 302 is considered an early maturing variety, it recorded 119.7 days as growth duration compared to the early variety Giza 177 which recorded 124.9 days, Sakha Super 300 which recorded 138.3 days.

Overall yield average of the observational, preliminary, final and on- farm yield trails of Sakha Super 302 was 10.899 t/ha compared to 9.375, 10.353, 9.926, 10.537 and 11.508 t/ha for Giza 177, Sakha 101, Sakha 104, Sakha 108 and Super 300, respectively. This reflects an increase or superiority in yield of about 16.256, 5.274, 9.702 and 3.436% over Giza 177, Sakha 101, Sakha 104 and Sakha 108, respectively.

Table 2. Means of yield and anacilarry characters of Sakha super 302 compared to some commercial cultivars during 2019 to 2023 rice seasons.

Parameter	Entry						CV%	LSD 0.05
	Sakha Super 302	Giza 177	Sakha 101	Sakha 104	Sakha 108	Sakha Super 300		
Grain Yield (t/ha)								
2019	10.914	9.282	10.234	9.553	10.658	11.454	0.887	0.060
2020	10.691	9.413	10.115	9.877	10.448	11.520	0.694	0.041
2021	10.956	9.520	10.543	10.115	10.614	11.453	0.454	0.029
2022	10.936	9.270	10.496	10.115	10.543	11.662	0.546	0.032
2023	10.996	9.389	10.376	9.972	10.424	11.453	1.053	0.086
Mean	10.899	9.375	10.353	9.926	10.537	11.508		
Yield advantage (t/ha)		1.524	0.546	0.963	0.362	-		
Superiority%		16.256	5.274	9.702	3.436	-		
Growth Duration (day)	119.73	124.95	140.50	134.67	137.67	138.30	0.370	0.666
Productivity per day (kg)	91.03	75.03	73.69	73.71	76.54	83.21	-	-
Plant height (cm)	109.90	97.00	95.08	105.00	98.40	123.32	0.835	1.195
Panicle length (cm)	22.85	22.19	23.69	23.18	23.74	22.15	1.179	0.364
Panicles plant^{-1}	16.75	17.37	22.00	21.53	22.01	20.77	2.456	0.662
Panicle weight (g)	8.25	3.48	4.10	3.99	4.12	7.17	2.457	0.197
Spikelets panicle^{-1}	285.40	139.82	164.58	155.85	166.76	251.23	0.826	2.450
1000- Grain weight (g)	29.96	28.57	28.95	28.60	30.84	29.69	0.311	0.132
Water consumption (m^3/ha)	11186	12850	14300	13804	14042	11424	-	-
Water use efficiency	0.974	0.730	0.724	0.719	0.750	1.007	-	-
Milling (%)	73.1	72.0	70.5	70.3	72.1	73.6	2.18	0.85
Amylose content (%)	19.0	19.6	18.0	17.1	18.6	19.8	1.05	0.43

Adding grain yield productivity per day (kg/day/ha) as a parameter reflect saving of water, land and time (Balal *et al* 1985) Sakha super 302 showed the highest productivity (91.03 kg/day/ha) comparing to 75.03, 73.69, 73.71, 76.54 and 83.21 (kg/day/ha) for Giza 177, Sakha 101, Sakha 104, Sakha 108 and Sakha Super 300, respectively. Sakha Super 302 recorded the highest values of panicle weight (8.25g), spikelets/panicle (285.40), and 1000-grain weight (29.96g) compared with other five check varieties.

However, it saved water consumption where it consumed 11186 m^3/ha with water use efficiency (WUE) of 0.974 compared to Giza 177 which consumed about 12850 m^3/ha with water use efficiency (WUE) of 0.730, Sakha 101 which consumed abour 14300 m3/ha with (WUE) of 0.724 and Sakha 104 which consumed 13804 m^3/ha, with (WUE) of 0.719 while, Sakha 108 consumed 14042 m^3/h with (WUE) of 0.750.

Data in Table (2) indicated that Sakha Super 300 recorded the highest yield and surpassed all varieties where it consumed 11424 m^3/ha with a value more than unity (1.007) for (WUE). Sakha Super 302 recorded 73.1% milling recovery and low amylose content (19%).

Seed increase

In 2022, 500 head rows were grown at Sakha research station Farm. The progeny of head rows was used as a source for foundation seed. In 2023, foundation seed was grown in an area of 4.2 ha (10 fed), and the progeny from this area was used as a source of certified 1 seeds.

The comparative performance of Sakha Super 302 with Giza 177, Sakha 101, Sakha 104, Sakha 108 and Sakha Super 300 was tested under different sowing dates (Table 3) from 15 April to 15 May, which is the optimum duration of sowing for the four traditional vareties Giza 177, Sakha 101, Sakha 104 and Sakha 108. On the other hand, the late sowing beyond May 15^{th} caused significant reductions in the production of the four traditional rice varieties Giza 177, Sakha 101, Sakha 104 and Sakha 108, While the super rice varieties, Sakha Super 300 and Sakha Super 302 gave a good grain yield at the late sowing date.

Table 3. Grain yield (t/ha) of six rice varieties as affected by sowing dates.

Year	Date of sowing	Variety						CV%	LSD 0.05
		Sakha Super 302	Giza 177	Sakha 101	Sakha 104	Sakha 108	Sakha Super 300		
2019	April 15	12.043	9.258	10.543	10.020	10.733	12.257	1.136	0.078
	May 15	11.614	9.305	10.234	9.853	10.258	12.067	0.639	0.042
	June 15	9.925	6.450	7.045	6.831	6.712	10.900	0.587	0.031
2020	April 15	11.829	9.211	10.377	10.186	10.662	12.185	0.618	0.042
	May 15	11.586	9.615	10.115	9.877	10.448	12.266	0.410	0.028
	June 15	9.758	6.021	7.044	6.712	7.092	9.829	1.056	0.053
2021	April 15	11.710	9.425	10.805	10.519	10.615	12.150	0.494	0.034
	May 15	11.662	9.615	10.543	10.115	10.662	12.305	0.493	0.034
	June 15	9.496	6.020	6.354	6.140	6.402	9.758	0.376	0.018
2022	April 15	12.019	9.322	10.781	10.115	10.853	12.188	0.455	0.031
	May 15	11.781	9.139	10.496	10.115	10.543	12.233	0.356	0.024
	June 15	9.591	6.426	6.569	6.426	6.688	10.091	0.828	0.041
2023	April 15	11.805	9.449	10.543	10.329	10.591	12.067	0.662	0.045
	May 15	11.614	9.330	10.377	9.972	10.424	11.925	0.405	0.027
	June 15	9.568	6.180	6.545	5.902	6.521	10.065	2.094	0.102

Blast disease tests

Pathogenicity Test and Race Identification

Twenty Egyptian isolates were identified as three groups IC (1-3-11-13-15), ID (3-5-9-11-15) and II on the IDV in Table (4). The most occurring group was ID (55%) followed by IC (40%), and only one was identified as group II with present 5%. These results agree with the findings of that showed the distribution of races at different governorates (Kalboush *et al* 2023). Physiological races play an important role for breakdown of the promising lines and new released cultivars; especially in case of expansion in the growing areas of one or two cultivars. Many investigators studied the physiological races of the fungus at different rice-growing areas and discussed the role of physiological races in breakdown of the new promising lines (Kalboush *et al* 2023). They studied the distribution of races with different rice entries and locations and found that this new physiological race was associated with breakdown of some new rice genotypes.

Table 4. Reaction of twenty blast isolateson international differential varieties and race identification under greenhouse conditions during 2022 season.

Egyptian Isolate Number	International differential varieties								Race identified
	Raminad str3	Zenith	Np-125	Usen	Dular	Kanto 51	CI 8970s	Caloro	
EG 1	1	1	1	4	1	5	1	4	ID-11
EG 2	1	1	4	4	4	4	3	6	IC-3
EG 3	1	1	4	4	1	1	1	4	IC-15
EG 4	1	1	1	4	1	4	1	7	ID-11
EG 5	1	1	1	7	1	5	1	4	ID-11
EG 6	1	1	1	5	1	5	1	7	ID-11
EG 7	1	1	1	6	1	1	1	7	ID-15
EG 8	1	1	1	1	1	1	1	1	II
EG 9	1	1	1	5	1	5	1	7	ID-11
EG 10	1	1	4	7	4	4	1	7	IC-3
EG 11	1	1	5	4	5	4	1	4	IC-3
EG 12	1	1	1	7	7	1	7	7	ID-5
EG 13	1	1	4	4	1	1	4	4	IC-13
EG 14	1	1	1	4	1	7	1	7	ID-11
EG 15	1	1	1	5	5	7	1	4	ID-3
EG 16	1	1	5	4	1	1	1	4	IC-15
EG 17	1	1	5	4	1	4	1	5	IC-11
EG 18	1	1	1	4	1	4	4	5	ID-9
EG 19	1	1	1	7	1	1	1	7	ID-15
EG 20	1	1	4	5	7	4	7	5	IC-1
IC%= 40 ID%- 55 II% = 5									
1-2 = Resistant 3 = Moderately resistant 4-6 = Susceptible 7-9 = Highly susceptible									

R-genes efficiency of blast resistance

Blast *R*-genes in rice improvement programs are very important tools. Data in Table (5) shows the number of infected isolates on the JDVs to Egyptian rice blast fungus isolates and effective of blast resistance genes%.

Table 5. Effective gene resistance% under artificial inoculation by 20 races of *Magnaporthe oryzae* under greenhouse conditions during 2022 season.

Egyptian isolate number	Target gene									
	Pik-s	*Piz-t*	*Pik-m*	*Pik*	*Piz*	*Pii, PiK-^{s}*	*Pib*	*Pita*	*Pita-^{2}*	*Pia*
EG 1	**1**	**4**	**4**	**1**	**1**	**4**	**4**	**5**	**5**	**5**
EG 2	**1**	**3**	**7**	**4**	**1**	**1**	**4**	**4**	**4**	**4**
EG 3	**1**	**4**	**1**	**1**	**1**	**1**	**2**	**4**	**4**	**5**
EG 4	**1**	**1**	**1**	**4**	**1**	**1**	**1**	**1**	**1**	**5**
EG 5	**1**	**1**	**5**	**5**	**1**	**4**	**1**	**1**	**1**	**5**
EG 6	**1**	**4**	**5**	**5**	**6**	**1**	**1**	**4**	**5**	**5**
EG 7	**4**	**1**	**5**	**5**	**1**	**4**	**1**	**1**	**1**	**4**
EG 8	**1**	**4**	**4**	**5**	**1**	**1**	**1**	**4**	**4**	**4**
EG 9	**1**	**1**	**5**	**6**	**1**	**1**	**1**	**4**	**1**	**1**
EG 10	**1**	**4**	**1**	**1**	**1**	**1**	**2**	**1**	**4**	**4**
EG 11	**1**	**6**	**7**	**7**	**1**	**2**	**2**	**2**	**4**	**5**
EG 12	**1**	**1**	**6**	**6**	**1**	**1**	**4**	**1**	**1**	**5**
EG 13	**1**	**4**	**6**	**5**	**1**	**1**	**1**	**3**	**4**	**4**
EG 14	**1**	**2**	**5**	**5**	**1**	**1**	**3**	**4**	**5**	**5**
EG 15	**1**	**1**	**5**	**4**	**1**	**1**	**1**	**1**	**4**	**5**
EG 16	**1**	**3**	**5**	**5**	**1**	**2**	**1**	**3**	**7**	**5**
EG 17	**1**	**1**	**9**	**9**	**3**	**5**	**1**	**1**	**4**	**4**
EG 18	**2**	**4**	**7**	**7**	**1**	**4**	**4**	**4**	**7**	**5**
EG 19	**1**	**2**	**4**	**7**	**7**	**1**	**4**	**4**	**3**	**4**
EG 20	**1**	**2**	**1**	**4**	**1**	**1**	**3**	**3**	**4**	**4**
Total	**1**	**8**	**16**	**17**	**2**	**5**	**5**	**9**	**17**	**19**
Susceptible%	**5**	**40**	**80**	**85**	**10**	**25**	**25**	**45**	**85**	**95**
1-2 = resistant, 3 = moderately resistant, 4-6 = susceptible, 7-9 = highly susceptible										

The frequency of *R*- gene reaction of JDV to the 20 isolates ranged from 5.0 to 95%, which were depending on the effectiveness of the present *R*- gene. *Pi-ks* and *PizR*-genes were the highest *R*- gene effective to tested blast isolates (95 and 90%, respectively), followed by *Pii*- *PiK-s* and *PibR*-gene with present (75%). *R*- gene *Pia* was the least which had 5% resistance. The results are in agreement with those found by *PiaR*- gene which was the least effective genes under artificial infection with 70 isolates of *P. grisea* on JDVs (Anis *et al* 2022). These genes were recommended to be used by rice breeders as donors for blast resistance under Egyptian conditions. They recorded the reaction of monogenic lines to 132 isolates of rice blast, and found that the reaction ranged between zero and 97.76%, depending on the effectiveness of the present resistance gene. *Piz-5* gene was the most effective to blast isolates followed by the genes *pita-2, Pi5* (t) and then *Piz*, *Pii*, *Pi9*, *Pita-2,* and *Pit*. Thus, these genes are recommended to be used by rice breeders as donors for blast resistance under Egyptian conditions (Shabana *et al* 2013).

Five rice genotypes and the new promising line (Sakha Super 302) were inoculated with 20 identified races during October 2022 season under greenhouse conditions, during season 2022. Only Sakha 101, Sakha104 and Sakha 108 were infected by blast races, ten, six and four races out of 20 races were able to infect Sakha 101, SaKha 104 and Sakha 108 (Table 6). While Giza 177, Giza 178, Sakha Super 300 and Sakha Super 302 were resistant.

Table 6. Evaluation of rice genotypes against twenty identified blast races (11 ID, 8 IC and 1 II) under greenhouse conditions during 2022 season.

Rice genotypes	*Number of race
Sakha Super 302	0
Giza177 (R check)	0
Giza 178 (R check)	0
Sakha101 (S check)	10
Sakha104 (S check)	6
Sakha108	4
Sakha Super 300	0
S=Susceptible R= Resistance	

***Number of races which infected genotypes.**

The new promising rice was the most effective method to control blast disease in Egypt (Kalboush, 2019; Anis *et al* 2022; Kalboush *et al*2023) and the world (Ning *et al* 2020)

Evaluation of rice genotypes under natural infection in blast nursery

Results in Table (7) indicated that Sakha Super 302, Giza 177 and Sakha Super 300 were resistant to leaf and panicle blast infection compared to the old commercial varieties Sakha 101 and Sakha 104. The varieties Sakha Super 302, Giza 177 and Sakha Super 300 showed resistance reactions at three tests of the blast nursery. Also, complete resistance was found at reproductive stage at all locations of the multi locations test (Table8). Conventional breeding is mainly based on the phenotypic selection of varieties or lines in selected locations (Ashkani*et al* 2015), a process highly influenced by environmental interactions and the complexity of resistance inheritance.In this case, the breeder should consider the genotype of the plant, the race or races of the pathogen and whether theresistance is qualitative or quantitative (Wang *et al* 2017).

Table 7. Blast reaction of rice genotypes under natural infection at three locations during three seasons.

Rice genotypes	2020			2021			2022		
	Sakha	Gemmiza	Zerzora	Sakha	Gemmiza	Zerzora	Sakha	Gemmiza	Zerzora
Sakha super 302	1	1	1	1	1	1	1	1	1
Giza177	1	1	1	1	1	1	1	1	1
Sakha101	5	7	9	9	7	5	9	7	5
Sakha104	4	4	5	5	4	4	4	5	4
Sakha108	1	1	1	1	1	1	4	4	1
Sakha super 300	1	1	1	1	1	1	1	1	1

Blast reaction R:(1-2), M:(3), S:(4-6) and HS:(7-9)
R = Resistant, M = Moderately resistant, S = Susceptible and HS = Highly Susceptible.

Table 8. Evaluation of six rice genotypes at Multi-locations during 2020, 2021 and 2022 seasons.

Rice genotype	2020		2021		2022	
	R	S	R	S	R	S
Sakha super302	15	0	15	0	15	0
Giza177	15	0	15	0	15	0
Sakha101	0	15	0	15	0	15
Sakha104	0	15	0	15	0	15
Sakha108	15	0	15	0	4	10
sakhasuper300	15	0	15	0	15	0

R=No. of resistant reactions out of 15 locations
S= No. of susceptible reactions out of 15 locations

Susceptibility of rice varieties to rice stem borer (RSB)

Sakha Super 302 was evaluated to the rice stem borer, *Chilo agamemnon* in 2021 and 2022 during vegetative stage as dead hearts and after heading as white heads. Since white head is mostly responsible for losses in rice yield, their levels in Sakha Super 302, Giza 177, Sakha 101, Sakha 104, Sakha 108 and Sakha Super 300 are presented in Table (9). The lowest infestation average of the two years was recorded for Sakha Super 302 and Sakha 108 being 3.21% white heads followed by 3.40% for Giza 177, 3.50% for Sakha Super 300, 3.71% for Sakha 101 and 3.74% for Sakha 104. Thus, this variety (Sakha Super 302) could be classified as moderately resistant to rice stem borer compared to released Egyptian varieties. However, according to standard evaluation systems for rice issued by IRRI (2013).

Table 9. Evaluation of Sakha Super 302 and other checks to rice stem borer infestation (white head%) and category at three locations during 2021 and 2022 seasons.

Variety	2021			2022			Mean%	Category
	Sakha	Gimmiza	Zarzoura	Sakha	Gimmiza	Zarzoura		
Sakha super 302	3.19	3.28	2.85	3.32	3.41	3.15	3.21	MR
Giza 177	3.25	3.70	3.36	3.18	3.21	3.67	3.40	MR
Sakha 101	3.67	4.0	3.35	3.53	3.93	3.65	3.71	MR
Sakha 104	3.86	3.67	3.80	3.70	3.5	3.85	3.74	MR
Sakha 108	2.96	2.80	3.20	3.65	3.7	2.95	3.21	MR
Sakha super 300	3.27	4.10	3.21	3.26	4.0	3.18	3.50	MR

AUTHOR CONTRIBUTIONS

Breeder H.F. El-Mowafi Breeder teams, A. M. Reda, R. M. Abdallah, K. A. Attia, Dalia E. El Sharnoby, E. F. Arafat, W. A. Ahmed, Abdelrahman A. Hadifa. Conceptualization H. F. El Mowafi, A. O. Bastawisi, K. A. Attia, M. H. Amar, A. F. Abdelkhalik, A. M. Reda, R. M. Abdallah. Methodology H. F. El Mowafi, R. M. Abdallah, Samah M. Abdelkhalek, Zeinab A. Kalboush, W. E. Gabr, A. S. Hendawy, A. A. Hassan. Data curtion; writing original draft preparation A. M. Reda. Zeinab A. Kallboush, A. A. Hassan, K. A. Attia. All authors have read and agreed to the published version of the manuscript.

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سخا سوبر 302 صنف ارز سوبر مصري جديد قصيرة المدة ومقاوم للمناخ

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صنف الأرز الجديد ، سخا سوبر 302 هو أول أرز مصري سوبر ياباني الطراز عالي الإنتاجية مبكر النضج تم تطوير هذا الصنف بواسطة مربى برنامج المشروع القومي لتطوير إنتاج الأرز الهجين والأرز السوبر تحت ظروف ندرة المياه والتغيرات المناخية وفريقه العلمي برعاية معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية وأكاديمية البحث العلمي والتكنولوجيا – جمهورية مصر العربية. الصنف سخا سوبر 302 مشتق من التهجين بين السلالات المبتكرة PTGMS 19 x EJSR 26 وتم تطويره بالانتخاب باستخدام طريقة سجلات النسب وتربيته عام 2016 من الجيل السابع باسم السلالة المصرية السوبر يابانية الطراز EJGSR 176 . وقد أظهرت نتائج تجارب المقارنة المحصولية الأولية والمتقدمة والتأكيدية واختبارات التجانس DUS والقيمة الزراعية VCU فى الفترة من 2017 إلى 2023 إنتاجية عالية للصنف وفترة نضج قصيرة (115-120يوم) وصفات زراعية وخصائص حبوب مفضلة. تم تسجيل الصنف سخا سوبر 302 بموجب القرار الوزاري رقم 108 الصادر في مارس 2023م. متوسط إنتاجية محصول الحبوب فى تجارب المقارنة المحصولية والتأكيدية والحقول الإرشادية لدى المزارعين للصنف سخا سوبر 302 والأصناف المقارنة جيزة 177، سخا 101، سخا 104، سخا 108، وسخا سوبر 300 خلال

الأعوام من2019 إلى 2023 كانت 10.899، 9.375 ، 10.353، 9.926، 10.537 و11.508 طن/هكتار على التوالي. وبذلك تفوق الصنف سخا سوبر 302 في المحصول على أصناف المقارنة جيزة 177 بنسبة 16.25%، سخا 101 بنسبة 5.27%، سخا 104 بنسبة 9.70%، وسخا 108 بنسبة 3.43%. ومن ناحية أخرى، كان الإنتاج اليومي لمحصول الحبوب للصنف سخا سوبر 302 مقداره 91.93 كجم/يوم/هكتار مقارنة بـــ 75.03 كجم للصنف جيزة 177، 73.69 كجم للصنف سخا 101، 73.71 كجم للصنف سخا 104 و76.54كجم للصنف سخا 108. بالإضافة إلى توفير استهلاك المياه حيث استهلكت 11186م³/هكتار مقارنة بـــ 12850م³/هكتار وكفاءة استخدام مياه 0.730 لصنف المقارنة جيزة 177. كلاً من صنفي الأرز سخا سوبر 300 وسخا سوبر 302 أعطت محصولاً أفضل عند الزراعة المبكرة قبل أو بعد 15 مايو وتفوقت معنوياً على أصناف المقارنة التقليدية جيزة 177 وسخا 101، سخا 104 وسخا 108 أوضحت اختبارات الجودة تميز الصنف سخا سوبر 302 بالمقارنة بالأصناف التقليدية كما أوضحت اختبارات برنامج الوقاية أن الصنف سخا سوبر 302 مقاوم لمرض اللفحة ومتوسط المقاومة للثاقبات.

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