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# THE EVALUATION OF PROMISING RICE HYBRIDS VERSUS LOCAL VARIETIES FOR YIELD AND PEST RESISTANCE.

**El-Mowafi, H.F.[1]; M.R. Sherif[2] and E.A. Badr[3]**
[1] Field Crops Research Institute, ARC, Egypt
[2] Plant Protection Research Institute, ARC, Egypt
[3] Plant Pathology Research Institute, ARC, Egypt

## ABSTRACT

A number of field experiments was conduced at the experimental farm of Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt during 2003, 2004 and 2005 seasons to evaluate best promising hybrid combinations developed in Egypt in comparison by best local inbred varieties. The hybrid and inbred varieties were grown in a randomized complete blocks design with four replications. The objectives were:

1. To evaluate the experimental hybrids for grain yield and yield advantage over the best check variety (SH%).
2. To evaluate the hybrid rice combinations and its parental lines to stem borer infestation under field conditions and blast reaction under both field and green house conditions.

Out of 20 hybrid combinations tested against Giza 178 in 2003 seasons, 14 hybrids under normal soil conditions and 15 under saline conditions significantly exceeded the average yield, yield advantage and standard heterosis (SH%) over Giza 178.

Six of promising and released hybrids were dominated, promoted selected for further evaluation of yield and resistance to rice stem borer (RSB) and rice blast reaction in 2004 and 2005 seasons. All the six selected hybrids surpassed all the inbred check varieties with at least one ton/ha.

For resistance to stem borer, the parental lines of cytoplasmic male sterile lines, IR68886A, IR68897A, IR68902A and IR69625A and the restorer lines GZ5121R and GZ5934R were moderately resistant to stem borer. Out of 20 hybrids, two hybrids( namely SK2045H and SK2047H) were resistant to this insect. However, four hybrids, SK2032H, SK2037H, SK2046H and SK2051H exhibited moderate level of resistance. Meanwhile, out of the six promising hybrids, SK2035H was moderately resistant.

For blast resistance, the CMS lines IR68885A, IR68886A, IR68888A, IR68897A and IR68902A were resistant under both field and greenhouse conditions. On the other hand, IR69625 was susceptible under Sakha location only and susceptible to IG-1 isolate under greenhouse. However, most of the restorer lines were resistant at all locations in the field and for all three isolates under greenhouse except for Giza 175R that was susceptible. All the hybrids tested were resistant to blast under both field and greenhouse conditions.

## INTRODUCTION

Hybrid rice technology aims to increase yield by exploiting the phenomenon of hybrid vigour resulted from heterosis (Duvick, 1999). New increasing productivity is very important because the area of rice would be decreased because of shortage of water availability. In Egypt, the national

yield average is high and reached good level making it hard for more increase in yield/feddan by traditional breeding methods. Therefore , hybrid rice would present new approach since it was used in China showing an increase in yield of 20-25%.

The rice crop is affected by many serious diseases and insect pests caused by reduced genetic variability fertilizer rich, improved cultural practices and continuous rice cropping-factors for increased rice production. Chemical control of rice diseases is not very effective, especially in the tropics; and effective host plant resistance to major insect species has been identified. Therefore, rice improvement programs around the world emphasize the development of improved rice varieties possessing genetic resistance to major diseases and insects. As a result, numerous disease and insect resistant varieties with a high yield potential have been developed and used as a basic component of pest management in the rice production systems in many parts of the world (Khush, 1984 and Khush and Virmani, 1985). With the increase in hybrid rice area, concern for disease and insect problems increased. Hybrids are more vigorous in growth, show more response to fertilizers and are adaptable to different environments compared with conventional varieties. These attributes are closely associated with vulnerability to disease epidemics and insect outbreaks, therefore resistance must be a key component of any hybrid rice breeding program (Mew *et al.*, 1988).

Hybrid rice would also have an additional advantage compared to inbred rice in commercial cultivation. when a disease/insect resistance of an inbred rice cultivar breaks down. It takes few years before this line is completely withdrawn out of rice cultivation, During this period, farmers do suffer various degrees of production losses due to the susceptibility of the inbred cultivar. In the case of hybrids, the production losses can be minimized considerably by stopping the distribution of hybrid seed in the affected areas and providing the seed of a new hybrid derived by changing one or both parents possessing the required disease/insect resistance (Virmani, 1994).

The disease and insect pests which occur in hybrid rice are basically similar to those which occur in inbred rice. Rice blast is the most important disease in Egypt.

The objective of resistant variety breeding has changed from mono-resistance to multi-resistance and from disease resistance alone to disease and insect resistance. The current investigation was carried out to evaluate 20 hybrid combination for grain yield, yield advantage and standard heterosis over the best check variety. Also, the parental lines and hybrid combinations were evaluated to susceptibility to rice stem borer, and rice blast disease.

## MATERIALS AND METHODS

Field experiments were conducted at Sakha experimental farm at Rice Research and Training Center (RRTC), El-Sirw, Gemmiza and Zarzoura Research Station Farms in 2003, 2004 and 2005 seasons. The

experimental materials were grown in a randomized complete blocks design (RCBD) with four replications. This work included three main experiments.

**1. Evaluation of rice hybrids for grain yield, yield advantage and standard heterosis (SH%):**

The experiment comprised 20 hybrid combinations produced by crossing ten cytoplasmic male sterile lines (CMS) with three identified Egyptian restorers Giza 178R, Giza 181R and Giza 182R in isolated plots in hybrid rice seed production area and Giza 177, Giza 178, Sakha 101 and Sakha 104 as local inbred check cultivars. It was raised in RCBD, replicated four times during the summer season of 2003 at RRTC, Sakha, Kafr El-Sheikh, Egypt under saline conditions.

The field experiments were conduced at the experimental farm of RRTC, Sakha, Kafr El-Sheikh, Egypt during 2004 and 2005 to evaluate the best selected promising hybrid combinations in comparison with the best local inbred cultivars. The hybrids and inbred cultivars were grown in a randomized complete blocks design with four replications.

Thirty day old seedlings were transplanted with one seedling per hill for hybrid rice combinations adopting a spacing of 20 cm between rows and between plants. Each test entry consisted of 14 rows 5 m length. Observations on days to duration, plant height, 1000-grain weight and grain type were recorded on ten plants/plot$^{-1}$ taken at random from each entry in each replication.

Ten guarded rows (10 m$^2$) were harvested from each entry in each replication to determine grain yield (t/ha). The weight of the grain yield was recorded at harvest, and adjusted to 14% moisture content.

The heterosis was determined as the increase of the mean of $F_1$ hybrid over the check variety Giza 178 (i.e., standard heterosis) as follows:

Standard heterosis % (SH) = $F_1$ - Check variety/check variety x 100

Appropriate L.S.D. values were calculated to test the significance of the heterosis effects, according to the following formula, suggested by Wyanne *et al.*, 1970.

$$\text{L.S.D. for check parent} = t^{0.05}_{0.01}\sqrt{\frac{2MSe}{r}}$$

**2. Evaluation of rice hybrids for stem borer infestation:**

A sample (10 hills/plot) form each replication was randomly selected two weeks prior to harvest and the plants showing white head symptom. Stem borer infestation % estimated according to IRRI (1996) and Sherif *et al.* (1996) as follow: 0-2 = highly resistant (HR), 2.1-4 = Resistant (R), 4.1-6 = Moderately resistant (MR), 6.1-8 = Moderately susceptible (MS), 8.1-10 = susceptible (S) and . 10 = Highly susceptible (HS).

**3. Evaluation of rice hybrids for blast reaction:**

**3.1. Under field conditions:**

The entries were evaluated for leaf blast resistance at seeding stage under blast nursery condition at Sakha, Gemmiza, and Zarzoura in 2003, 2004 and 2005 seasons. Seed bed was prepared as 10.5 x 1.5 m after land preparation, leveling and adding 20 m$^3$/fed. of farmyard manure to increase blast susceptibility. Seeds were sown in the first week of July. Each seed bed

was planted with five rows of the tested entries and plants of the susceptible check variety Giza 159 at the two ends of each seed bed. Also, each five rows of the tested entries were followed alternatively by resistant or susceptible check. The test was replicated four times and the highest scores were recorded after 30-35 days from sowing. The typical blast lesions were scored according to IRRI Scale (1996).

**3.2. Under greenhouse conditions:**

All the experimental materials (genotypes) were seeded in plastic trays (30 x 20 x 15 cm), with two rows for susceptible check and spreader of Giza 159 and Giza 171 with two replications. The trays were kept in the greenhouse at 25-30°C, and fertilized with urea 46.5% (5 g/tray). Two *Pyricularia grisea* isolates races collected from Giza 171 and Giza 159 rice plants grown in the previous season were used for artificial infection of the entries in the trays. The isolates were grown and multiplied on banana medium (200 g Banana, 10g Dextrose, and 20 g Agar, 1000 ml. water) at 28°C. Rice seedlings of 21-day old, grown in the trays, were inoculated by spraying with spore suspension (200 ml containing 5 x $10^4$ spores/ml) of *P. grisea* was sprayed. The spray was practiced in the evening to avoid the retarding effect of day light on both spore germination and germ tube growth. The reaction of the tested entries to blast infection was estimated according to IRRI scale (1996) as follows: 0 = Highly resistant (HR), 1-2 = Resistant (R), 3 = Moderately resistant (MR), 4-5 = susceptible (S), and 6-9 = Highly susceptible (HS).

## RESULTS AND DISCUSSION

**I. Evaluation of rice hybrids for grain yield:**

The more recent accomplishment of the rice varietal improvement program in Egypt has been the development of local hybrid varieties which yield 15-20% more than the commercial varieties (Bastawisi *et al.*, 1998, El-Mowafi, 2001, Bastawisi *et al.*, 2003, Bastawisi *et al.*, 2005 and El-Mowafi *et al.*, 2005).

Evaluation of hybrid combinations, for heterosis breeding based three considerations, mean grain yield t/ha, yield advantage t/ha and standard heterosis % (SH%) over the best local inbred check variety accompanied with resistance to major diseases and insects would be meaningful from this point of view.

Twenty hybrid rice combinations were tested against four inbred commercial varieties, Giza 177, Giza 178, Sakha 101 and Sakha 104 under both normal and saline soils. Data in Table 1 show the yield performance, yield advantage and standard heterosis of 20 hybrids and four inbred rice varieties under both normal and saline soils. Mean yield of 20 hybrids combinations under normal soil ranged from 10.359 t/ha for SK2059H to 12.945 t/ha for SK 2010H (general mean 12.029 t/ha), whereas yield of inbred varieties ranged from 9.60 t/ha for Sakha 104 to 10.750 t/ha for Sakha 101 (general mean 10.311 t/ha). On the other hand, the mean yield of the same 20 hybrid combinations under saline soil condition in Sirw ranged from 3.315 t/ha for hybrid SK 2051 H to 5.520 t/ha for hybrid SK 2046 H

(general mean 4.411 t/ha), whereas yield of inbred varieties ranged from 2.215 t/ha for Giza 177 to 3.515 t/ha for Sakha 104 (general mean 2.963 t/ha).

**Table 1: Yield performance, yield advantage and standard heterosis of promising hybrid and inbred rice varieties under normal and saline soil conditions in 2003 season.**

| Hybrid/Inbred varieties | Parentage | Sakha (normal) | | | El-Sirw (Saline) | | |
|---|---|---|---|---|---|---|---|
| | | Yield t\ha | Yield advantage t\ha | SH% | Yield t\ha | Yield advantage t\ha | SH% |
| SK2025H | IR58025A\Giza178R | 11.764 | 1.159 | 10.9* | 4.235 | 1.155 | 37.5 |
| SK2029H | IR68888A\Giza178R | 12.268 | 1.663 | 15.7** | 5.105 | 2.025 | 65.7** |
| SK2032H | IR68899A\Giza178R | 11.980 | 1.375 | 13.0** | 4.340 | 1.260 | 40.9* |
| SK2033H | IR68902A\Giza178R | 11.938 | 1.333 | 12.6* | 5.035 | 1.955 | 63.5** |
| SK2028H | IR68886A\Giza178R | 12.533 | 1.928 | 18.2** | 4.560 | 1.480 | 48.1* |
| SK2031H | IR68897A\Giza178R | 11.285 | 0.680 | 6.4 | 4.555 | 1.475 | 47.9* |
| SK2034H | IR69625A\Giza178R | 11.934 | 1.329 | 12.5* | 4.360 | 1.280 | 41.6* |
| SK2035H | IR70368A\Giza176R | 11.446 | 0.841 | 7.9 | 4.530 | 1.450 | 47.1* |
| SK2003H | G46A\Giza178R | 12.063 | 1.485 | 13.8** | 4.490 | 1.410 | 45.8* |
| SK2037H | IR58025A\Giza181R | 11.645 | 1.040 | 9.8* | 3.370 | 0.290 | 9.4 |
| SK2045H | IR68902A\Giza181R | 12.560 | 1.955 | 18.4** | 4.585 | 1.505 | 48.9 |
| SK2046H | IR69625A\Giza181R | 12.600 | 1.995 | 18.8** | 5.520 | 2.440 | 79.2** |
| SK2047H | IR70368A\Giza181R | 12.090 | 1.485 | 14.0** | 4.780 | 1.700 | 55.2** |
| SK2051H | IR68885A\Giza182R | 11.261 | 0.656 | 6.2 | 3.315 | 0.235 | 7.6 |
| SK2053H | IR68888A\Giza182R | 11.146 | 0.541 | 5.1 | 4.815 | 1.735 | 56.3** |
| SK2056H | IR68899A\Giza182R | 12.246 | 1.641 | 15.5** | 4.300 | 1.220 | 39.6 |
| SK2055H | IR68897A\Giza182R | 12.656 | 2.051 | 19.3** | 3.575 | 0.495 | 16.1 |
| SK2058H | IR69625A\Giza182R | 11.860 | 1.255 | 11.8* | 3.720 | 0.640 | 20.8 |
| SK2059H | IR70368A\Giza182R | 10.359 | -0.246 | -2.3 | 3.983 | 0.903 | 29.3 |
| SK2010H | G46A\Giza182R | 12.945 | 2.340 | 22.1** | 5.055 | 1.975 | 64.1 |
| Giza 177 | Inbred | 10.290 | | | 2.215 | | |
| Giza 178 | Inbred check | 10.605 | check | check | 3.080 | check | check |
| Sakha 101 | Inbred | 10.750 | | | 3.040 | | |
| Sakha 104 | Inbred | 9.600 | | | 3.515 | | |
| L.S.D | 0.01 | | 1.022 | | | 1.155 | |
| | 0.05 | | 1.357 | | | 1.534 | |

**SH% = Standard heterosis { Hybrid-Local inbred check (Giza 178)x 100/Local inbred check}**
***, ** Significant at 0.05 and 0.01 probability levels**

The results of Table (1) revealed that 14 hybrids exceeded significantly the average yield of the local check Giza 178 under normal condition and ranging form 11.645 t/ha for SK 2037H with yield advantage of 1.040 t/ha and standard heterosis of 9.8% to 12.945 t/ha for SK 2010 H with yield advantage of 2.340 t/ha and SH% of 22.1% whereas, the average yield of the local variety Giza 178 under saline soil (Sirw) and yield ranged from 4.300 t/ha for SK 2056 H with yield advantage of 1.220 t/ha and SH% of 39.6% to 5.20 t/ha for SK 20463 H with yield advantage of 2.440 t/ha and SH% of 79.2%.

Among the 20 experimental hybrids presented in Table (1) and first evaluated during 2003 season, hybrids with an yield advantage of $\geq$ 1 t/ha over the highest yielding check variety were considered as promising. Six of promising and released hybrids were nominated, promoted and selected for

more evaluation for yield and resistance to stem borer and blast in 2004 and 2005 seasons.

Grain yield varied and significantly differed within the two seasons 2004 and 2005, but in general all the six selected hybrids surpassed all the inbred check cultivars with at least one ton/ha as shown in Tables (2 and 3). The highest mean values of grain yield (t/ha) were obtained by the hybrids SK2046H, SK2035H and SK2003H with values of 12.9, 11.8 and 11.3 t/ha, respectively during 2004 season and 13.3, 13.1, 12.4 and 12.5 t/ha for the same hybrid during 2005 season, respectively. The inbred varieties Sakha 101, Giza 182, Sakha 104 and Giza 178 manifested highest mean performance of 10.8, 10.7, 10.4 and 10.0 t/ha, respectively during 2004 season and 10.9, 10.6, 10.6 and 10.9 t/ha, respectively for the same varieties during 2005 season. Among the six selected hybrids for this investigation the yield advantage values over best local inbred check, Giza 178 ranged from 1.1 t/ha for SK2058H to 2.9 t/ha for SK2046H with an average of 1.7 t/ha during 2004 season and ranged from 1.1 to 2.4 t/ha for the same hybrids, respectively, with same average of 1.7 t/ha. Hybrids with a yield advantage of > 1.5 t/ha over the highest yielding check variety Giza 178 were considered as best promising combinations (Bastawisi *et al.*, 2003, Bastawisi *et al.*, 2005 and El-Mowafi *et al.*, 2005).

**Table 2: Yield performance, yield advantage and standard heterosis and ancillary traits of promising hybrid and inbred rice varieties 2004.**

| Hybrid/check | Parentage | Yield t\ha | Yield advantage t\ha | SH% | Ancillary traits | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Duration (days) | Plant height (cm) | 1000-grain weight (g) | Grain Type |
| SK2003H | G46A\Giza178R | 11.3 | 1.3 | 13** | 132.9 | 125.3 | 25.4 | Sh |
| SK2029H | IR68888A\Giza178R | 11.2 | 1.2 | 12* | 126.6 | 109.2 | 24.1 | L |
| SK2034H | IR69625A\Giza178R | 11.8 | 1.8 | 18** | 130.2 | 115.3 | 25.3 | M-Sh |
| SK2035H | IR70368A\Giza178R | 11.6 | 1.6 | 16** | 131.4 | 119.3 | 26.2 | M-Sh |
| SK2046H | IR69625A\Giza181R | 12.9 | 2.9 | 29** | 132.0 | 120.9 | 28.6 | M |
| SK2058H | IR69625A\Giza182R | 11.1 | 1.1 | 11* | 128.9 | 109.0 | 26.1 | L |
| Giza 178 | Inbred check | 10.0 | | | 137.0 | 100.8 | 21.1 | Sh |
| Giza 181 | Inbred variety | 9.7 | | | 144.4 | 100.0 | 26.9 | L |
| Giza 182 | Inbred variety | 10.7 | | | 129.0 | 98.3 | 26.3 | L |
| Sakha 101 | Inbred variety | 10.8 | | | 142.1 | 95.8 | 27.3 | Sh |
| Sakha 103 | Inbred variety | 9.4 | | | 127.3 | 100.2 | 26.0 | Sh |
| Sakha 104 | Inbred variety | 10.4 | | | 138.8 | 109.0 | 28.3 | Sh |
| L.S.D | 0.05 | | 0.9 | | 3.78 | 4.75 | 2.5 | |
| | 0.01 | | 1.2 | | 5.13 | 6.45 | 3.4 | |

**SH% = Standard heterosis { Hybrid-Local inbred check (Giza 178)x 100/Local inbred check}**
***, ** Significant at 0.05 and 0.01 probability levels**

With respect to standard heterosis % all the six hybrids showed significant positive values for grain yield. In the same time, the highest estimates were detected for the hybrids, SK2046H, SK2034HG, SK2035H and SK2003H with values of 29, 18, 16% and 13%, respectively during 2004 season and 22, 20.2, 13.8 and 14.7%, respectively during 2005 season.

Significant heterotic effects for grain yield have been reported by Rajesh Singh and Singh (2000), El-Mowafi and Abo-Shousha (2003), Swamy *et al.* (2003) and El-Mowafi *et al.* (2005). It is therefore, possible to increase rice varietal yield over inbred varieties by selecting appropriate hybrids with higher yield advantage and significantly positive standard heterosis. Hybrids matured through 126.5 to 135.0 days (mean 130.9 days) during 2004 season and 126.6 to 132.9 days (mean 130.3 days) during 2005 season compared to inbred varieties which matured in a range of 127.3 days for Sakha 103 to 144.4 days for Giza 181 during 2004 season (mean 136.4 days) and 128.2 to 144.2 days for the same varieties during 2005 season with a mean of 134.8 days. These hybrids also showed maturity advantage. Hybrids were also slightly taller or shorter in plant height and had medium or long grain with a moderate degree of acceptance for grain quality.

**Table 3: Yield performance, yield advantage and standard heterosis and ancillary traits of promising hybrid and local inbred rice varieties 2005.**

| Hybrid/Inbred varieties | Parentage | Yield t\ha | Yield advantage t\ha | SH% | Ancillary traits | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Duration (days) | Plant height (cm) | 1000-grain weight (g) | Grain Type |
| SK2003H | G46A\Giza178R | 12.5 | 1.6 | 14.7** | 130.9 | 120.0 | 25.80 | Sh |
| SK2029H | IR68888A\Giza178R | 12.3 | 1.4 | 12.8* | 127.0 | 110.3 | 24.30 | L |
| SK2034H | IR69625A\Giza178R | 13.1 | 2.2 | 20.2** | 132.4 | 114.5 | 25.28 | M-Sh |
| SK2035H | IR70368A\Giza178R | 12.4 | 1.5 | 13.8** | 133.8 | 114.3 | 25.36 | M-Sh |
| SK2046H | IR69625A\Giza181R | 13.3 | 2.4 | 22.0** | 135.0 | 117.8 | 27.96 | M |
| SK2058H | IR69625A\Giza182R | 12.0 | 1.1 | 10.1* | 126.5 | 114.2 | 26.60 | L |
| Giza 178 | Inbred check | 10.9 | | | 134.3 | 102.0 | 20.90 | Sh |
| Giza 181 | Inbred variety | 10.7 | | | 144.2 | 110.3 | 27.30 | L |
| Giza 182 | Inbred variety | 10.6 | | | 128.7 | 102.3 | 26.93 | L |
| Sakha 101 | Inbred variety | 10.9 | | | 140.0 | 100.0 | 27.30 | Sh |
| Sakha 103 | Inbred variety | 10.0 | | | 128.2 | 102.0 | 27.10 | Sh |
| Sakha 104 | Inbred variety | 10.6 | | | 133.5 | 113.4 | 27.90 | Sh |
| L.S.D | 0.05 | | 0.8 | | 1.12 | 2.31 | 2.39 | |
| | 0.01 | | 1.1 | | 1.50 | 3.09 | 3.20 | |

**SH% = Standard heterosis ( Hybrid-Local inbred check (Giza 178) x 100/Local inbred check)**
***, ** Significant at 0.05 and 0.01 probability levels**

## 2. Evaluation of rice hybrids for pests:

### 2.1. Rice stem borer:

Twenty three entries included hybrid rice parental lines (eleven cytoplasmic male sterile lines and nine restorer lines) and five local inbred checks were evaluated to white heads (WH). This symptom was more considered, as most of rice losses result from WH.

Data presented in Table 4 show that five of cytoplasmic male sterile lines (CMS), IR68886A, IR68897A, IR68899A, IR68902A and IR69625A, two of restorer lines, GZ5121R and GZ5934R and the commercial inbred varieties Giza 177 and Sakha 103 were moderately resistant to stem borer. Only two commercial inbred varieties, Sakha 101, Sakha 104 were resistant.

These two categories, resistant and moderately resistant are a source for resistance to the borer. Breeders could develop some of these materials having good yield potential and other desirable characters and could be also used in producing the resistant hybrid combinations. On the other hand, one CMS line IR6885A and three restorer lines, Giza 181, Giza 182R and IR25571R were moderately susceptible. The CMS lines IR58025A, IR68888A, IR70368A, G46A and large sigma A and the restorer lines Giza 175 and Giza 178R were susceptible or highly susceptible.

**Table 4: Relative susceptibility of hybrid rice parents, CMS and restorer lines and local inbred varieties to stem borer infestation and blast reaction during 2003.**

| Parentage | Stem borer | | Blast reaction | | | |
|---|---|---|---|---|---|---|
| | Damage % | Category | Sakha | Gimmeza | Zarzora | Mean reaction |
| **CMS Lines** | | | | | | |
| IR58025A | 13.34 | HS | 2 | 2 | 2 | R |
| IR68885A | 6.61 | MS | 2 | 2 | 2 | R |
| IR68886A | 5.53 | MR | 2 | 2 | 2 | R |
| IR68888A | 10.12 | HS | 3 | 2 | 2 | R |
| IR68897A | 5.82 | MR | 3 | 2 | 2 | R |
| IR68899A | 5.71 | MR | 5 | 2 | 3 | M |
| IR68902A | 5.49 | MR | 2 | 2 | 2 | R |
| IR69625A | 5.28 | MR | 4 | 2 | 2 | M |
| IR70368A | 8.80 | S | 2 | 2 | 2 | R |
| G46A | 9.93 | S | 2 | 2 | 2 | R |
| Large Stigma A | 13.83 | HS | 2 | 2 | 2 | R |
| **Restorers** | 8.57 | S | 4 | 4 | 4 | M |
| Giza175 R | 10.11 | HS | 2 | 2 | 2 | R |
| Giza178 R | 6.30 | MS | 2 | 2 | 2 | R |
| Giza181 R | 6.43 | MS | 2 | 1 | 2 | R |
| Giza182 R | 5.33 | MR | 2 | 2 | 3 | R |
| Gz 5121 R | 4.04 | MR | 2 | 2 | 3 | R |
| Gz 5934 R | 6.14 | MS | 2 | 2 | 2 | R |
| IR25571 R | | | | | | |
| **Inbred checks** | 5.29 | MR | 2 | 2 | 1 | R |
| Giza 177 | 2.91 | R | 6 | 4 | 5 | MS |
| Sakha 101 | 4.92 | MR | 2 | 2 | 2 | R |
| Sakha 103 | 3.68 | R | 5 | 2 | 4 | MS |
| Sakha 104 | 3.83 | R | 7 | 7 | 7 | HS |
| Giza 159 | | | | | | |
| L.S.D 0.05 | 1.12 | | | | | |
| 0.01 | 1.49 | | | | | |

Twenty hybrid combinations and four inbred entries were evaluated to the rice stem borer to screen the susceptible or highly susceptible entries to be discarded, and this breeder's could be able to develop hybrid rice with high levels of resistance and/or to tolerance to the rice stem borer (Table 5) Out of all genotypes evaluated, two hybrid combinations namely SK2045H and SK2047H and one inbred variety, Sakha 104 were resistant to this insect. In addition, four hybrid combinations, SK2032H, SK2037H, SK2046H

and SK2051H and the inbred variety Giza 177 exhibited moderate level's of resistance ranging between 4.1 to 6% WH, six hybrid combinations and Sakha 101 were moderately susceptible (6.1-8%). However, four hybrid combinations and Giza 178 suffered high levels of infestation with RSB (8.1-10%) were susceptible, and four hybrid combinations (>10%) were highly susceptible.

Giza 178 was selected as local inbred check to evaluate the hybrid combinations for advantage and for resistance to stem borer. Desirable advantage over Giza 178 was recorded by eleven hybrid and ranged form -0.3% to 7%. The desirable standard heterosis over Giza 178 ranged from -3.7% 60-86.4%. Out of 20 hybrid combinations tested six hybrids recorded significantly negative standard heterosis (Table 5). The most promising hybrids identified form this study were SK2045H (-86.4%), SK2047H (-54.3%), (SK3237H) (-41.9%), SK2046H (-38.1%), SK2051H (-32.1%) and SK2032H (-32.1%).

Six promising hybrid combinations and six of best local inbred varieties were evaluated to RSB on the basis of WH% and blast reaction during 2004 and 2005 seasons and are presented in Tables 6 and 7. One of the promising hybrids as Moderately Resistant (MR), to Rice Stem Borer (RSB), representing 4.2% and 5.8% during 2004 and 2005 seasons respectively SK2046H was moderately susceptible (MS) at the two years. However, the promising hybrid SK2034H (HR1) and SK2029H exhibited moderate susceptibility (MS) to RSB during 2004 season, while exhibited high susceptibility (HS) during 2005 season. Thus, the promising hybrid variety SK2003H was susceptible to RSB at the two years , while the hybrid SK2058H was highly susceptible. The local inbred varieties Giza 178 and Giza 182 were categorized as susceptible to RSB. ON the other hand, Sakha 101 and Sakha 104 performed as R and MR, respectively (Table 6 and 7).

**2.2. Blast disease:**

Hybrid rice parental lines and the local inbred varieties were evaluated for rice blast infection at seedling stage under blast nursery conditions in the field of the three locations, Sakha, Gemmiza and Zarzoura.

Results in Table 4 show that all CMS lines were resistant (R) at all three locations except IR68899A which was susceptible at Sakha but resistant at Gemmiza and moderately resistant at Zarzoura. However, IR69625A was found resistant at Gemmiza and Zarzoura but susceptible at Sakha; IR68888A and IR68899A were moderately resistant at Sakha and resistant at both Gemmiza and Zarzoura.

All the restorer lines were resistant at all locations, except Giza 175R was susceptible. The restorer lines GZ5121R and GZ5934R were only resistant at Sakha and Gemmiza locations and moderately resistant at Zarzoura location.

The commercial inbred varieties Giza 177 and Sakha 103 were found to be resistant at all locations, while Sakha 101 was susceptible at all locations and Sakha 104 showed susceptible reaction at both Sakha and Zarzoura and resistant at Gemmiza. The susceptible check variety Giza 159 was highly susceptible at the three locations.

**Table 5: Relative susceptibility of 20 promising hybrid rice combinations and best four local inbred rice varieties to stem borer infestation and blast disease reaction during 2003 season.**

| Hybrid/check | Parentage | Stem borer | | | | Blast Reaction | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Damage % WH | Category | advantage over Giza 178 | SH% | Sakha | Gimmeza | Zarzora | Reaction | Parent reaction |
| SK2025H | IR58025A\Giza178R | 15.9 | HS | 7.8 | 96.2** | 2 | 1 | 2[H] | R | R/R |
| SK2029H | IR68888A\Giza178R | 11.3 | HS | 3.2 | 39.5** | 2 | 1 | 1 | R | R/R |
| SK2032H | IR68899A\Giza178R | 5.5 | MR | -2.6 | -32.1** | 2 | 1 | 2 | R | R/R |
| SK2033H | IR68902A\Giza178R | 7.6 | MS | -0.5 | -6.2 | 2 | 1 | 2 | R | R/R |
| SK2028H | IR68886A\Giza178R | 10.5 | HS | 2.3 | 28.4** | 2 | 1 | 1 | R | R/R |
| SK2031H | IR68897A\Giza178R | 9.5 | S | 1.4 | 17.3* | 2 | 1 | 2 | R | R/R |
| SK2034H | IR69625A\Giza178R | 9.3 | S | 1.2 | 14.8* | 2 | 1 | 2 | R | M/R |
| SK2035H | IR70368A\Giza178R | 10.7 | HS | 2.5 | 30.9** | 2 | 1 | 1 | R | R/R |
| SK2003H | G46A\Giza178R | 8.0 | MS | -0.1 | 1.2 | 2 | 1 | 1 | R | M/R |
| SK2037H | IR58025A\Giza181R | 4.8 | MR | -3.4 | -41.9** | 2 | 1 | 1 | R | R/R |
| SK2045H | IR68902A\Giza181R | 1.1 | HR | -7.0 | -86.4** | 2 | 1 | 2 | R | R/R |
| SK2046H | IR69625A\Giza181R | 5.0 | MR | -3.1 | -38.1** | 2 | 1 | 2 | R | R/R |
| SK2047H | IR70368A\Giza181R | 3.7 | R | -4.4 | -54.3** | 2 | 1 | 2 | R | R/R |
| SK2051H | IR68885A\Giza182R | 5.6 | MR | -2.6 | -32.1** | 2 | 1 | 2 | R | R/R |
| SK2053H | IR68888A\Giza182R | 8.3 | S | 0.2 | 2.5 | 2 | 1 | 2[***] | R | R/R |
| SK2056H | IR68899A\Giza182R | 7.1 | MS | -1.0 | -12.3 | 2 | 1 | 2 | R | R/R |
| SK2055H | IR68897A\Giza182R | 7.5 | MS | -0.6 | -7.4 | 2 | 1 | 2 | R | M/R |
| SK2058H | IR69625A\Giza162R | 7.6 | MS | -0.4 | -4.9 | 2 | 1 | 2 | R | R/R |
| SK2059H | IR70368A\Giza182R | 7.8 | MS | -0.3 | -3.7 | 2 | 1 | 2 | R | M/R |
| SK2010H | G46A\Giza182R | 9.6 | S | 1.4 | 17.3* | 2 | 1 | 2 | R | |
| Giza 177 | Inbred | 5.7 | MR | -2.5 | | 2 | 2 | 2 | R | |
| Giza 178 | Inbred check | 8.1 | S | - | | 2 | 2 | 2 | R | |
| Sakha 101 | Inbred | 7.1 | MS | -1.0 | | 2 | 3 | 2 | MR | |
| Sakha 104 | Inbred | 3.7 | R | -4.5 | | 2 | 2 | 2 | R | |
| Giza 159 | Blast check | - | - | - | | 5 | 4 | 5 | S | |
| L.S.D 0.05 | | 1.1 | | | | | | | | |
| 0.01 | | 1.5 | | | | | | | | |

WH : white head

SH% = Standard heterosis { Hybrid-Local inbred check (Giza 178)x 100/Local inbred check}

*, ** Significant at 0.05 and 0.01 probability levels

Category :HR;0-2, R;2.1-4, MR; 4.1-6, MS: 6.1-8, S; 8.1-10 and HS; >10

**Table 6: Relative susceptibility of six promising hybrid rice combinations and best six local inbred rice varieties to stem borer infestation and blast reaction during 2004 season.**

| Hybrid/check | Parentage | Stem borer | | | | Blast Reaction | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Damage % | Category | advantage over Giza 178 | SH% over Giza 178 | Sakha | Gimmeza | Zarzora | Reaction | Parent reaction |
| SK2003H | G46A\Giza178R | 8.7 | S | -0.6 | 6.5 | 2 | 2 | 2 | R | M/R |
| SK2029H | IR68888A\Giza178R | 14.5 | HS | 5.2 | 55.9** | 2 | 2 | 2 | R | R/R |
| SK2034H | IR69625A\Giza178R | 11.1 | HS | 1.8 | 19.4** | 2 | 2 | 2 | R | M/R |
| SK2035H | IR70368A\Giza178R | 5.8 | MR | -3.5 | -37.6** | 2 | 2 | 2 | R | R/R |
| SK2046H | IR69625A\Giza181R | 6.9 | MS | -2.4 | -25.8** | 2 | 2 | 2 | R | M/R |
| SK2058H | IR69625A\Giza182R | 11.5 | HS | 2.2 | 23.7** | 2 | 2 | 2 | R | M/R |
| Giza 178 | Inbred check | 9.3 | S | - | | 2 | 2 | 2 | R | |
| Giza 181 | Inbred variety | 7.0 | MS | -2.4 | | 2 | 2 | 2 | R | |
| Giza 182 | Inbred variety | 8.1 | S | -1.2 | | 2 | 2 | 2 | R | |
| Sakha 101 | Inbred variety | 3.7 | R | -5.6 | | 4 | 4 | 6 | MS | |
| Sakha 103 | Inbred variety | 6.7 | MS | -2.5 | | 2 | 2 | 2 | R | |
| Sakha 104 | Inbred variety | 5.0 | MR | -4.3 | | 5 | 4 | 2 | MS | |
| Giza 159 | Inbred variety | - | - | - | | 6 | 6 | 5 | S | |
| L.S.D 0.05 | | 1.2 | | | | | | | | |
| 0.01 | | 1.6 | | | | | | | | |

**SH% = Standard heterosis { Hybrid-Local inbred check (Giza 178)x 100/Local inbred check}**

***, ** Significant at 0.05 and 0.01 probability levels**

**Category :HR;0-2, R;2.1-4, MR; 4.1-6, MS: 6.1-8, S; 8.1-10 and HS; >10**

**Table 7: Relative susceptibility of six promising hybrid rice combinations and best six local inbred rice varieties to stem borer infestation and blast reaction during 2005 season.**

| Hybrid/check | Parentage | Stem borer | | | | Blast Reaction | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Damage % | Category | advantage over Giza 178 | SH% over Giza 178 | Sakha | Gimmeza | Zarzora | Reaction | Parent reaction |
| SK2003H | G46A\Giza178R | 9.5 | S | 0.8 | 9.1 | 2 | 1 | 2 | R | M/R |
| SK2029H | IR68888A\Giza178R | 7.0 | MS | -1.8 | 20.5** | 2 | 2 | 2 | R | R/R |
| SK2034H | IR69625A\Giza178R | 6.4 | MS | -2.4 | 27.3** | 2 | 2 | 2 | R | M/R |
| SK2035H | IR70368A\Giza178R | 4.2 | MR | -4.6 | -52.3** | 2 | 2 | 2 | R | R/R |
| SK2046H | IR69625A\Giza181R | 6.3 | MS | -2.5 | -28.4** | 2 | 2 | 2 | R | M/R |
| SK2058H | IR69625A\Giza182R | 10.1 | HS | 1.3 | 14.8* | 2 | 2 | 2 | R | M/R |
| Giza 178 | Inbred check | 8.8 | S | - | | 2 | 2 | 2 | R | |
| Giza 181 | Inbred variety | 6.5 | MS | -2.3 | | 2 | 3 | 2 | R | |
| Giza 182 | Inbred variety | 7.7 | MS | -1.1 | | 2 | 2 | 2 | R | |
| Sakha 101 | Inbred variety | 3.7 | R | -5.1 | | 7 | 4 | 5 | MS | |
| Sakha 103 | Inbred variety | 7.6 | MS | -1.2 | | 2 | 2 | 1 | R | |
| Sakha 104 | Inbred variety | 5.8 | MR | -3.0 | | 6 | 2 | 4 | MS | |
| Giza 159 | Inbred variety | - | - | - | | 7 | 7 | 7 | HS | |
| L.S.D | 0.05 | | | 1.16 | | | | | | |
| | 0.01 | | | 1.56 | | | | | | |

**SH% = Standard heterosis ( Hybrid-Local inbred check (Giza 178)x 100/Local inbred check)**

***, ** Significant at 0.05 and 0.01 probability levels**

**Category :HR;0-2, R;2.1-4, MR; 4.1-8, MS: 6.1-8, S; 8.1-10 and HS; >10**

The twenty three entries evaluated for blast resistance at Sakha, Gemmiza and Zarzoura locations included 20 hybrid combinations, four best local inbred checks and Giza 159 as susceptible check for blast. Results in Table 5 show that all the 20 tested hybrids were completely resistant at the prevalent races of Sakha, Gemmiza and Zarzoura. However, the susceptible check Giza 159 showed score of 7 indicating the resistance of such tested hybrids. For blast reaction, results in Tables 6 and 7 indicated that all the six hybrid combinations tested under field condition were resistant at the three locations, in the two years. However, the local inbred varieties Giza 178, Giza 181, Giza 182 and Sakha 103 were resistant (the first three varieties were used to produce the promising hybrid combinations as male parents). On the other hand, Sakha 101 and Sakha 104 were moderately resistant to moderately susceptible. The old commercial variety Giza 159 was highly susceptible.

Eleven cytoplasmic male sterile lines (the female parents for hybrid rice combinations), seven restorer lines (male parents), four inbred varieties and Giza 159 as susceptible check variety were exposed at seedlings to artificial inoculation, under greenhouse condition with three isolates of *Puricularia grisea*, IG-1, IC-31 and IBC-45.

The CMS lines IR68885A, IR68886A, IR68888A, IR688974A and IR68902A, the restorer lines Giza 178R, Giza 181R, Giza 182R, GZ5934R and IR25571-31R and the inbred varieties Giza 177 and Sakha 103 were resistant to all inoculated isolates under greenhouse condition (Table 8). Data presented in Table 8 showed that the CMS lines IR58025A, IR68899A, IR69625A, IR70368A and the restorer line Giza 175R were susceptible to isolate IG-1, while Sakha 101 and the check variety Giza 159 were highly susceptible. However, the CMS line IR58025A and Giza 175R were susceptible to isolate IC-31. On the contrary, the inbred varieties Sakha 101, Sakha 103 and Sakha 104 were resistant to isolate IC-31.

The CMS lines IR68899A, G46A and large Stigma A, and the restorer line Giza 175R were susceptible to isolate IBC-45 while, the inbred variety Sakha 1041 was highly susceptible to this isolate.

Twelve entries, including six promising hybrid combinations and best six local inbred varieties in addition to susceptible check variety Giza 159, were evaluated for the infection with three isolates of *P. grisea* under greenhouse conditions during 2004 and 2005 seasons. Data presented in Table 9 show that all the six promising hybrid combinations and the inbred varieties Giza 178, Giza 181, Giza 182 and Sakha 103 were resistant to all isolates. On the other hand, Sakha 101 was susceptible to IG-1 isolate but resistant to IC-31 and IB-45 isolates. While, Sakha 104 was moderately resistant to IG-1 and IC-31 isolates but susceptible to IB-45 isolate. Furthermore, Giza 159 was highly susceptible to the three isolates. The study indicated that the $F_1$ rice hybrids showed a wider spectrum of blast resistance than their parents and the blast fungus isolates attacked rice cultivars Sakha 101 and Sakha 104 but did not attack the hybrids. CMS female parent IR69625A was susceptible to some isolates (Table 8) but the $F_1$ hybrid SK2034H (IR69625A/Giza 178R) was resistant (Table 9).

**Table 8: Relative susceptibility of hybrid rice parents, CMS and restorer lines and local inbred varieties to blast disease *Pyricularia grisea* reaction.**

| Parentage | Greenhouse | | |
|---|---|---|---|
| | IG-1 | IC-31 | IBC-45 |
| **CMS lines:** | | | |
| IR58025A | S | S | R |
| IR68885A | R | R | R |
| IR68886A | R | R | R |
| IR68888A | R | R | R |
| IR68897A | R | R | R |
| IR68899A | S | R | S |
| IR68902A | R | R | R |
| IR69625A | S | R | R |
| IR70368A | S | R | R |
| G46A | R | R | S |
| Large Stigma A | R | R | S |
| **Restorers** | | | |
| Giza 175 R | S | S | S |
| Giza 178 R | R | R | R |
| Giza 181 R | R | R | R |
| Giza 182 R | R | R | R |
| GZ 5121 R | MS | R | R |
| GZ 5934 R | R | R | R |
| IR25571R | R | R | R |
| **Inbred checks** | | | |
| Giza 177 | R | MR | R |
| Sakha 101 | HS | R | R |
| Sakha 103 | R | R | R |
| Sakha 104 | MR | R | HS |
| Giza 159 | HS | HS | HS |

**Table 9: Relative susceptibility of six promising hybrid rice combinations and best six local inbred rice varieties to blast disease *Pyricularia grisea* reaction.**

| | | Blast reaction | | | | |
|---|---|---|---|---|---|---|
| Hybrid/check | Parentage | IG-1 | IC-31 | IB-45 | Reaction | Parent reaction |
| SK2003H | G46A/Giza 178R | R | R | R | R | M/R |
| SK2029H | IR68888A/Giza 178R | R | R | R | R | R/R |
| SK2034H | IR69625A/Giza 178R | R | R | R | R | M/R |
| SK2035H | IR70368A/Giza 178R | R | R | R | R | R/R |
| SK2046H | IR69625A/Giza 181R | R | R | R | R | M/R |
| SK2058H | IR69625A/Giza 182R | R | R | R | R | M/R |
| Giza 178 | Inbred check | R | R | R | R | |
| Giza 181 | Inbred variety | R | R | R | R | |
| Giza 182 | Inbred variety | R | R | R | R | |
| Sakha 101 | Inbred variety | S | R | R | MS | |
| Sakha 103 | Inbred variety | R | R | R | R | |
| Sakha 104 | Inbred variety | MR | R | HS | MS | |
| Giza 159 | Variety | HS | HS | HS | S | |

The results showed that hybrids were resistant if at least one parent was resistant to the disease. The hybrids were resistant or susceptible, depending on whether the gene imparting resistance was dominant or recessive (Virmani, 1994). If both parents were susceptible, the hybrids were also susceptible.

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## تقييم هجن الأرز المبشرة بالنسبة للأصناف المحلية لصفات المحصول والمقاومة لآفات الأرز .

**حمدى فتوح الموافى[1] ، محمود رمزى شريف[2] و سيد علاء بدر[3]**

**١- معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية**

**٢- معهد بحوث مقاومة النبات- مركز البحوث الزراعية**

**٣- معهد بحوث أمراض النبات – مركز البحوث الزراعية**

أقيم عدد من التجارب فى المزرعة والبيوت الزجاجية لمركز البحوث الزراعية والتدريب فى الأرز بسخا خلال مواسم الزراعة ٢٠٠٣ ، ٢٠٠٤ ، ٢٠٠٥م بغرض تقييم أفضل التراكيب الهجينية المبشرة والتى تم تطويرها تحت الظروف المصرية مقارنة بأفضل الأصناف المستنبطة تقليديا بالتربية الداخلية. وقد تمت زراعة الهجن والأصناف المرباة داخليا فى تجارب كاملة العشوائية فى أربع مكررات.

**وكانت أهداف الدراسة:**

١- تقييم الهجن التجريبية من ناحية التفوق المحصولى وقوة الهجين القياسى% قياسا إلى أفضل الأصناف المحلية المرباة داخليا (جيزه ١٧٨).

٢- تقييم كل من السلالات الأبوية للأرز الهجين خصوصا سلالات العقم الذكرى السيتوبلازمى الوراثى والسلالات المعيدة للخصوبة لعدوى ثاقبة الساق فى الأرز تحت الظروف الحقلية وكذلك عدوى اللفحة تحت ظروف كل من الحقل والعدوى الصناعية بعزلات الفطر تحت ظروف الصوبة.

**وقد أظهرت الدراسة أنه :**

١- تفوق ١٤ هجينا من بين عشرين تركيبا هجينا تحت ظروف الأراضى العادية فى سخا ، ١٥ هجينا تحت ظروف الأراضى الملحية فى السرو فى متوسط المحصول وقوة الهجين القياسية مقارنة بأفضل الأصناف المرباة داخليا جيزه ١٧٨.

٢- أختبرت سن هجن مبشرة وجاهزة للزراعة والإحلال على النطاق التجارى لإستكمال التقييم وقد أظهرت كلها تفوقا فى الحصول على الأصناف المرباة داخليا من ١-٢ طن/هكتار.

٣- أظهرت سلالات العقم الذكرى السيتوبلازمى IR6925A, IR68902A, IR68897A, IR68886A وسلالات إعادة الخصوبة Gz5934R, Gz5121R مقاومة متوسطة لثاقبة الساق. وأظهرت الهجن SK2047H, SK2045H مقاومة لهذه الحشرة خلال موسم ٢٠٠٣م علاوة على ذلك أظهرت الهجن SK2046H, SK2037H, SK2032H والهجين SK2051H مقاومة متوسطة لثاقبة الساق فى الأرز. وخلال موسمى ٢٠٠٤ ، ٢٠٠٥م أظهر الهجين SK2035H مقاومة متوسطة.

٤- بالنسبه لمقاومة مرض اللفحة أظهرت سلالات العقم الذكرى السيتوبلازمى IR6886A, IR68885A, IR68888A, IR68897A, IR68902A مقاومة تحت كل من ظروف الحقل والعدوى الصناعية بعزلات فطرية تحت ظروف الصوبة. بينما كانت السلالة العقيمة IR69625A مصابة تحت ظروف سخا فقط ومقاومة فى الجهات الأخرى. وكذلك كانت مصابة بالعزلة IG-1 ومقاومة للعزلات الأخرى بينما كان الصنف المعيد للخصوبة جيزه ١٧٥ مصاب تحت كل الظروف. أظهرت كل الهجن مقاومة للإصابة بمرض اللفحة تحت ظروف العدوى الطبيعية والصناعية.