GENETIC ANALYSIS AND SELECTED LINES FOR BLAST RESISTANCE (*PYRICULARIA ORYZAE*) IN CROSSES BETWEEN SOME AMERICAN AND EGYPTIAN RICE VARIETIES

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ABSTRACT

Genetic analysis of F_2 and F_3 population in this study can categorize into two groups according to segregation ratios. The first group, segregated in a ratio of 15 (R) to 1 (S). The ratio 15 (R) to 1 (S) suggested that two genes of leaf blast resistance were segregating in this cross. In addition, the same results were found in F_3 generation and confirmed that two genes were controlling the blast resistance in this cross. On the other hand, the second group of F_2 and F_3 population gave a segregation of 3 (R) to 1 (S) and produced from crosses of resistant Egyptian varieties (Giza177 and Sakha102) with the American susceptible varieties (L204 and M202). In conclusion, results of segregation ratio in group one (15 R to 1 S) in F_2 and F_3 generations suggested that Sakha102 (Egyptian variety) carried two dominant resistance genes for leaf blast (e.g., A and B), while the susceptible variety 98-Y-116 (American) carried their recessive alleles. While in the second group, which gave segregation ratio 3 to 1 in F_2 and F_3, the data suggested that the genetic constitution of resistant variety Giza177 could be governed by one dominant gene (AAbb). The analysis of the variance showed significant differences among the genotypes for all characters and expressed considerable range of variation. Promising lines resistant to leaf blast and with high yield were achieved. This increase in the yield due to mainly increasing panicle characters, i.e. 1000-grain weight and panicle weight which gave higher values than the parents and also higher than the used Egyptian varieties. Generally, these selected lines could be used for hybridization as a donor to transfer these good characters for induction improved new varieties.

INTRODUCTION

Rice blast caused by *Pyricularia oryzae* is one of the most destructive diseases of rice (*Oryza sativa* L.). The information on the genetics of blast resistance is required for effective breeding for blast resistance and for better understanding of the interaction between *Pyricularia oryzae* and the rice plant (Yu, *et al.*, 1987). However, breeding for blast resistance is an ideal method and an economical way for blast control (Bastawisi, 1988; Correa and Zeigler 1995; Aidy *et al.*, 2000 and El-Malky, 2004). In Egypt, most varieties were produced through conventional breeding and the researcher concentrated on hybridization for breeding to new blast resistance varieties like Giza171 and Giza172. But after many years became susceptible due to the change of blast races (Balal *et al.*, 1977 and Bonman and Rush 1985).

Inheritance of resistance to blast controlled by major genes or alleles with qualitative effects and complete resistance to race specific (Kiyosawa *et al.*, 1983). While, the second type of resistance controlled by minor genes or allele with quantitative effects (McCouch *et al.*, 1994).

The objective of this investigation were 1) genetic analysis of qualitative inheritance for genes of blast resistance in F_2 and F_3 generations and 2) to evaluate selected lines for blast resistance and agronomic traits.

MATERIALS AND METHODS

Plants of F_2 and F_3 of four crosses between American varieties (M204, M202 and 98-Y-116) were used as highly susceptible varieties. Two Egyptian (Giza177 and Sakha102) were used as resistant varieties. The crosses and F_1 were conducted in the experimental farm of Dr. David J. Mackill, Department of Agronomy and Range science, University of California, Davis CA95616-8515, USA. While, the F_2, F_3 and selected lines were evaluated at the experimental farm of Rice Research and Training Center (RRTC), Sakha, Kafer El-Sheikh, Egypt, during the rice growing seasons 2004, 2005 and 2006. The F_2 and F_3 populations were planted and each one from F_2 and F_3 consisted of more than 200 plants and the spreader susceptible variety (Giza159) was grown around the experiments and high doses of fertilizer were added to increase infection rate. Blast reaction was recorded according to the standard evaluation system for rice (IRRI, 1996) in scale of 0-9 (score 0-3 is resistance, while score 4-9 is susceptible). On the other hand, the selected lines were arranged in a randomized complete block design experiment with three replications. Agronomic characters; namely: heading date, plant height, number of tillers/plant, grain yield/plant, 1000-grain weight, panicle weight, number of panicles/plant, number of filled grains/panicle and panicle length were recorded among the selected lines.

The statistical analysis

Analysis of variance was computed by **IRRISTAT** program. While, heritability percentage was estimated on a plot basis as the ratio of genotypic variance and phenotypic variance, according to Allard (1960). Phenotypic and genotypic coefficients of variability were calculated, according to Burton (1951) and Gamble (1962), while Chi-Square (X^2) calculated according to (Gomez and Gomez 1976).

RESULTS AND DISCUSSION

1- Genetic analysis:

Field reactions were estimated for F_2 and F_3 populations in this study and the data were showed in Table 1. F_2 and F_3 generations data can categorized into two groups according to segregation ratios. The first group, which produced from 98-Y-116 American susceptible variety and Sakha102 Egyptian resistant variety segregated in a ratio of 15 (R) to 1 (S). The ratio 15 (R) to 1 (S) suggested that two genes of leaf blast resistance were segregating in this cross. In addition, the same data was found in F_3 generation and it confirmed that two genes were controlled in blast resistance in this cross. On the other hand, the second group of F_2 and F_3 population gave a segregation of 3 (R) to 1 (S) and produced from crosses of resistant Egyptian varieties (Giza177 and Sakha102) with the American susceptible varieties (L204 and M202). The F_2 and F_3 of these crosses indicated that the resistance transferred from Egyptian varieties that carried one major gene for resistance to blast disease. These results were in agreement with those of Maximos, 1974; Balal *et al.*, 1977; Shaalan *et al.*, 1977; Kiyoswa *et al.*, 1983; Aidy, 1984; Maximos *et al.*, 1985; Yu *et al.*, 1987; Mackill and Bonman., 1992; Shi *et al.*, 1994; Pan *et al.*, 1996; Abd El-Khalek, 2001; El Malky, 2004 and Nagaty *et al.*, 2006.

In conclusion results of segregation ratio in group one (15 R to 1 S) in F_2 and F_3 generations suggested that Sakha102 (Egyptian variety) carried two dominant resistance genes for leaf blast (e.g., A and B), while the susceptible variety 98-Y-116 (American) carried their recessive alleles. While, in the second group, which gave segregation ratio 3 to 1 in F_2 and F_3 the data suggested that the genetic constitution of resistance variety Giza177 could be carried by one dominant gene (AAbb).

2- Analysis of variance and genetic parameters:

The analysis of variance (Table 2) showed significant differences amongst the genotypes for all characters and expressed considerable range of variation. Further, it is also observed that genotypic and phenotypic variance exhibited almost similar trend of variability (Table 3). The maximum range of variation was observed for number of filled grain per panicle followed by grain yield per plant, plant height, number of unfilled grains per panicle, 1000-grain weight and heading date (days) (Table 3) revealed that better scope for the genetic improvement in these characters.

Estimates of heritability ranged from 43.18 for (blast reaction) to 97.54 for (1000-grain weight) for trails (Table 3). In general, high estimates for heritability was observed for all characters. However, 1000-grain weight character expressed maximum heritability (97.54%) followed by heading date (days) (96.65%), plant height (96.10%), panicle weight and number of filled grains per panicle. This may be attributed to varying extent of environmental components of variation involved in these characters. Similar results of high heritability were reported by (Patil, *et al.*, 1993; Genesan, *et al.*, 1996; Hammoud, 2004 and El-Wahsh and Hammoud 2007).

3- Mean of economic characters:

Means of the parents and selected lines for blast resistance and agronomic characters are presented in Table (4). American parents were highly susceptible, while Egyptian parents were resistance. On the other hand, the selected lines were resistance except the lines numbers (1, 2 and 21) were susceptible (Table 4). This in turn suggested that resistance character transfer to offspring from Egyptian varieties. As for grain yield per plant, all selected lines were higher than the parents and ranged from (48.33gm to 86.61gm). The best selected lines were numbers (9, 18, 7, 12, 5, 8, 39 and 11) gave 86.16, 81.88, 78.29, 77.67, 74.11, 73.39, 72.92 and 71.71 gm, respectively. This increase in the yield due to increasing in panicle characters (1000-grain weight and panicle weight) which gave higher values than the parents under study and also higher values than the Egyptian varieties. Generally, these selected lines could be used for hybridization as donors to transfer these characters for improving new varieties.

Table (1): Phenotypic, genotypic ratio and X^2 value in F_2 and F_3 segregations.

Crosses	F_2 generation				F_3 generation			
	Phenotypic ratio R: S	Genetic ratio R : S	X^2	Prob. value	Phenotypic ratio R: S	Genetic ratio R : S	X^2	Prob. value
98-Y-116/Sakha102	231:14	15:1	0.588	0.75-50	169:16	15:1	0.496	0.75-0.50
L204/Giza177	116:37	3:1	0.358	0.95-0.90	99:38	3:1	0.599	0.50 0.25
M202/Giza177	91:25	3:1	0.734	0.50-0.25	82:26	3:1	0.049	0.975-0.950
M202/Sakha102	86:31	3:1	0.211	0.90-0.75	73:25	3:1	0.413	0.90-0.75

Table (2): Analysis of variance for agronomic for characters and blast reaction.

S.O.V	d.f	Heading date (days)	Plant Height (cm)	No. of tillers/plant	No. of panicles/plant	Grain yield /plant (gm)
Replication	2	32.96	17.69	43.60	38.52	184.90
Genotypes	49	122.74**	231.99**	77.21**	66.696**	255.85**
Error	98	1.368	3.010	2.675	2.894	7.049

Continued.

S.O.V	d.f	1000-grain weight (gm)	Panicle weight (gm)	Panicle length (cm)	No. of filled grains /panicle	No. of unfilled grains / panicle	Blast Reaction
Replication	2	1.266	0.138	0.432	2.69	8.820	0.247
Genotypes	49	111.261**	1.149**	5.694**	1277.85**	75.762**	5.300**
Error	98	0.908	0.022	0.555	22.07	4.385	1.002

Table 3: Genetic parameters of variation for agronomic characters and bla: reaction.

Parameters	Heading date (days)	Plant height(cm)	No. of tillers/plant	No. of panicles /plant	Grain yield /plant (gm)
Genotypic	39.52	74.32	23.06	19.34	78.23
Phenotypic	40.90	77.33	25.74	22.23	85.28
Heritability (bs)	96.65	96.10	89.58	86.99	91.73
Mean	135.4	94.38	23.57	22.15	62.74
Minimum	123.33	81.30	16.00	15.33	42.85
Maximum	145.00	111.40	36.67	33.33	86.61
Range	21.67	30.10	20.67	18.00	43.76

Continued.

Parameters	1000-grain Weight (gm)	Panicle weight (gm)	Panicle length (cm)	No. of filled grains /panicle	No. of unfilled grains /panicle	Blast Reaction
Genotypic	36.17	0.361	.34	403.79	20.86	0.76
Phenotypic	37.08	0.382	1.89	425.86	25.25	1.76
Heritability (bs)	97.54	95.00	70.89	94.81	82.61	43.18
Mean	32.31	3.77	20.28	116.81	10.34	2.41
Minimum	21.40	2.36	17.80	82.67	3.00	1.66
Maximum	43.83	5.06	23.56	186.33	30.00	8.00
Range	22.43	2.70	5.76	103.66	27.00	6.34

Table (4): Mean of economic characters of 50 lines and five varieties for 11 characters

No.	Genotypes	Heading date (days)	Plant height (cm)	No. of tillers/ plant	No. of panicles/ plant	Grain yield/ Plant (gm)
1	SKC23808-2-1-5-3-1-1-2	125.00	108.60	23.33	21.67	63.09
2	SKC23808-2-1-5-3-1-2-1	124.00	105.60	24.67	22.33	59.35
3	SKC23808-28-4-1-3-1-1-1	133.33	111.40	31.67	30.33	58.54
4	SKC23808-28-4-1-3-1-1-2	130.66	111.13	36.67	32.67	69.92
5	SKC23808-28-4-1-3-1-2-1	130.33	108.80	31.00	29.33	74.11
6	SKC23808-125-2-3-5-1-1-1	129.66	91.57	32.33	31.00	65.80
7	SKC23808-125-2-3-5-1-1-2	144.00	87.07	22.67	21.67	78.29
8	SKC23819-189-1-1-2-2-1-1	143.00	86.13	21.67	20.00	73.39
9	SKC23819-189-1-1-2-2-2-1	139.66	89.67	24.33	22.33	86.61
10	SKC23819-189-1-1-2-2-2-3	139.00	90.83	21.33	20.33	61.71
11	SKC23819-192-2-2-1-1-2-1	140.00	84.57	35.00	33.33	71.71
12	SKC23819-192-2-2-1-1-2-2	142.00	82.80	25.33	23.67	77.67
13	SKC23819-192-2-2-1-1-2-3	145.00	81.87	23.00	21.00	59.12
14	SKC23819-192-2-2-1-1-2-4	140.00	82.00	23.33	21.67	63.89
15	SKC23819-192-2-2-1-1-2-5	141.66	81.30	29.00	27.00	55.28
16	SKC23819-192-2-2-1-2-1-1	129.00	88.17	26.00	24.33	65.73
17	SKC23819-192-2-2-1-2-1-2	129.66	87.30	27.33	26.00	62.15
18	SKC23819-192-2-2-1-2-2-1	128.00	82.40	25.67	24.33	81.88
19	SKC23819-192-2-2-1-2--2-2	127.00	87.97	31.33	30.33	56.95
20	SKC23819-192-2-3-2-2-1-1	143.66	86.37	20.00	19.00	68.02
21	SKC23819-192-2-3-2-2-1-2	143.33	89.23	26.33	25.33	52.40
22	SKC23819-192-2-3-2-2-1-3	143.00	89.93	26.33	24.67	65.20
23	SKC23819-192-2-3-2-2-1-4	143.33	93.90	23.67	21.67	52.54
24	SKC2319-192-2-3-2-2-2-1-1	140.00	86.60	27.33	26.00	59.60
25	SKC2319-192-2-3-2-2-2-2-2	138.33	87.53	27.00	25.67	63.18
26	SKC2319-192-3-1-1-1-4-1-1	136.00	88.80	20.33	18.67	65.27
27	SKC2319-192-3-1-1-1-4-2-2	138.66	89.93	21.33	20.67	63.87
28	SKC2319-192-3-1-1-1-5-1-1	137.66	85.77	21.67	21.00	59.25
29	SKC2319-194-1-2-1-1-1-1-1	138.00	89.30	24.00	22.00	62.58
30	SKC2319-194-1-2-1-2-1-1-1	139.00	83.37	19.00	19.00	66.49
31	SKC2319-194-1-2-1-2-1-4-1	130.66	100.63	24.67	23.33	65.30
32	SKC23822-330-3-2-2-2-2-1	138.66	101.70	17.33	17.00	62.07
33	SKC23822-330-3-2-2-2-3-1	142.00	102.43	19.67	18.33	66.16
34	SKC23822-330-3-2-2-2-3-2	138.00	100.50	16.67	16.00	65.36
35	SKC23822-330-3-2-2-2-3-2	138.00	106.70	17.33	16.67	63.17
36	SKC23822-330-3-2-2-2-3-3	139.66	100.97	21.67	20.00	58.10
37	SKC23822-330-3-2-2-2-4-1	140.00	97.67	20.33	19.67	66.59
38	SKC23824-422-3-3-3-1-1-1	127.00	90.40	23.00	21.67	58.28
39	SKC23824-422-3-3-3-1-1-2	125.33	89.80	21.33	21.00	72.92
40	SKC23824-422-3-3-3-1-2-1	127.33	94.83	22.33	21.67	69.65
41	SKC23824-422-3-3-3-2-1-1	136.66	93.13	17.33	16.67	50.48
42	SKC23824-422-3-3-3-2-1-2	136.33	100.50	17.00	16.33	69.47
43	SKC23824-422-3-3-3-2-1-3	138.33	102.53	16.00	15.33	54.27
44	SKC23824-422-3-3-3-2-1-4	138.00	102.90	17.33	17.00	48.33
45	SKC23824-422-3-3-3-2-1-5	138.00	102.07	34.67	31.33	67.64
46	98-Y-116	129.00	103.67	20.33	18.33	48.57
47	Sakha102	124.33	106.67	21.00	19.00	50.84
48	L204	127.33	103.00	19.67	17.00	45.60
49	Giza177	123.33	98.00	19.00	18.00	48.57
50	M202	131.00	101.00	19.00	16.00	42.85
L.S.D.		1.895	2.811	2.650	2.756	4.302

Continued

No.	Genotypes	1000-grain weight	Panicle weight (gm)	Panicle length (cm)	No. of filled grains /panicle	No. of unfilled grains / panicle	Blast Reaction
1	SKC23808-2-1-5-3-1-1-2	26.60	4.08	20.56	123.67	9.00	4.00
2	SKC23808-2-1-5-3-1-2-1	23.90	4.58	21.16	186.33	9.67	4.00
3	SKC23808-28-4-1-3-1-1-1	29.26	3.96	21.23	117.00	18.00	2.00
4	SKC23808-28-4-1-3-1-1-2	27.16	4.55	22.26	133.33	9.67	2.00
5	SKC23808-28-4-1-3-1-2-1	29.63	3.82	21.76	155.67	15.00	2.00
6	SKC23808-125-2-3-5-1-1-1	29.40	3.27	19.00	98.33	5.00	2.00
7	SKC23808-125-2-3-5-1-1-2	25.80	3.11	19.33	85.00	3.00	2.00
8	SKC23819-189-1-1-2-2-1-1	37.33	3.41	20.00	103.67	6.33	2.00
9	SKC23819-189-1-1-2-2-2-1	37.30	4.20	18.53	115.33	9.00	2.00
10	SKC23819-189-1-1-2-2-2-3	42.26	4.26	19.43	113.00	12.67	2.00
11	SKC23819-192-2-2-1-1-2-1	32.33	3.94	17.80	98.00	10.00	2.00
12	SKC23819-192-2-2-1-1-2-2	41.60	3.23	18.26	86.67	9.00	2.00
13	SKC23819-192-2-2-1-1-2-3	41.33	4.07	19.20	96.67	8.00	2.00
14	SKC23819-192-2-2-1-1-2-4	43.76	3.77	20.26	91.00	3.00	2.00
15	SKC23819-192-2-2-1-1-2-5	43.83	3.69	18.06	96.33	5.00	2.00
16	SKC23819-192-2-2-1-2-1-1	42.06	3.44	20.26	108.67	8.00	2.00
17	SKC23819-192-2-2-1-2-1-2	30.23	3.05	18.33	85.33	7.00	2.00
18	SKC23819-192-2-2-1-2-2-1	29.80	3.26	20.00	82.67	3.67	2.00
19	SKC23819-192-2-2-1-2--2-2	28.10	3.63	21.00	104.33	9.00	2.00
20	SKC23819-192-2-3-2-2-1-1	26.40	4.58	19.00	128.67	3.67	2.00
21	SKC23819-192-2-3-2-2-1-2	36.40	4.43	20.26	130.33	11.00	4.00
22	SKC23819-192-2-3-2-2-1-3	36.33	4.82	19.96	140.33	7.33	2.00
23	SKC23819-192-2-3-2-2-1-4	33.70	4.56	20.30	116.67	6.33	2.00
24	SKC2319-192-2-3-2-2-2-1-1	37.10	4.27	19.06	111.67	12.00	2.00
25	SKC2319-192-2-3-2-2-2-2-2	37.80	5.06	20.33	134.00	5.33	2.00
26	SKC2319-192-3-1-1-1-4-1-1	38.16	3.99	21.96	120.33	5.00	2.00
27	SKC2319-192-3-1-1-1-4-2-2	39.76	3.18	19.40	115.33	4.33	1.66
28	SKC2319-192-3-1-1-1-5-1-1	38.70	4.02	19.06	110.00	10.00	2.00
29	SKC2319-194-1-2-1-1-1-1-1	37.46	4.48	20.23	131.33	14.33	2.00
30	SKC2319-194-1-2-1-2-1-1-1	36.73	3.84	20.30	113.00	9.00	2.00
31	SKC2319-194-1-2-1-2-1-4-1	32.60	4.01	20.23	123.33	10.00	2.00
32	SKC23822-330-3-2-2-2-2-1	31.90	3.71	19.26	132.00	15.00	2.00
33	SKC23822-330-3-2-2-2-3-1	25.00	3.99	20.33	141.33	13.00	2.00
34	SKC23822-330-3-2-2-2-3-2	25.90	4.11	19.26	137.00	15.33	2.00
35	SKC23822-330-3-2-2-2-3-2	24.46	4.15	19.40	138.00	14.00	2.00
36	SKC23822-330-3-2-2-2-3-3	26.43	4.43	19.16	113.00	16.00	2.00
37	SKC23822-330-3-2-2-2-4-1	24.20	3.30	20.00	143.33	18.00	2.00
38	SKC23824-422-3-3-3-1-1-1	21.40	2.52	18.03	88.00	3.33	1.67
39	SKC23824-422-3-3-3-1-1-2	30.80	3.44	22.00	109.33	12.00	2.00
40	SKC23824-422-3-3-3-1-2-1	30.36	3.53	22.06	122.33	14.00	2.00
41	SKC23824-422-3-3-3-2-1-1	30.13	3.04	20.50	87.33	30.00	2.00
42	SKC23824-422-3-3-3-2-1-2	38.66	4.43	21.90	114.67	12.00	2.00
43	SKC23824-422-3-3-3-2-1-3	36.73	2.36	20.26	103.33	16.00	2.00
44	SKC23824-422-3-3-3-2-1-4	31.90	3.06	21.40	97.00	14.00	2.00
45	SKC23824-422-3-3-3-2-1-5	31.83	4.15	22.06	120.67	8.00	2.00
46	98-Y-116	24.94	3.30	22.90	114.00	11.33	6.67
47	Sakha102	27.60	2.63	23.13	148.00	10.00	2.00
48	L204	26.23	3.36	23.56	127.00	13.00	7.00
49	Giza177	28.83	2.93	20.73	128.00	7.33	1.67
50	M202	25.70	3.20	21.40	120.00	15.67	8.00
L.S.D.		1.544	0.240	1.207	7.613	3.393	1.621

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الملخص

التحليل الوراثي وانتخاب سلالات مقاومة للفحه ناتجة من التهجين بين بعض أصناف الأرز الأمريكيه والمصريه

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التحليل الوراثي لعشائر الجيل الثاني والثالث في دراستنا يمكن أن يقسم بناءا على النسب الانعزال إلى مجموعتين.

المجموعة الأولى كانت النسب الانعزالية فيها 15 مقاوم إلى 1 مصاب وان النسب 15 مقاوم إلى 1 مصاب أوضحت وجود 2 زوجين من الجينات المقاومة للفحه الأوراق في هذه الهجن. هذا بالاضافه إلي أن نتائج الجيل الثالث أكدت ذلك أن هناك زوجين من جينات المقاومة تتحكم في مقاومة اللفحة في هذه الهجن.

كما وجد على الجانب الآخر أن النسب الانعزالية للعشائر في الجيل الثاني والثالث تنعزل إلى 3 مقاوم إلى 1 مصاب وهي الناتجة من الآباء المصرية (جيزة 177 وسخا 102) مع الأصناف الامريكيه (ال204 و ام 202) الحساسة للاصا به بلفحه الأوراق.

وبصفه موجزه فنسب الانعزال في المجموعة الأولى 15 مقاوم إلى 1 مصاب في الجيل الثاني والثالث توضح أن الصنف المصري سخا 102 يحمل زوجين من الجينات السائدة للمقاومة هما (A and B)

للفحه الأوراق بينما الصنف الأمريكي 116-واي-98 القابل للاصابه يحمل اليلين متنحيين.

بينما المجموعة الثانية والتي فيها نسبه الانعزال 3 مقاوم إلى 1 مصاب في الجيل الثاني والثالث فالنتائج توضح أن الصنف جيزة 177 يمكن أن يحمل جين واحد سائد (AAbb)

كما أوضح تحليل التباين وجود معنوية بين التراكيب الوراثية المختلفة لجميع الصفات وأن هناك مدى كبير للاختلافات.

ولقد تم الحصول على سلالات مبشره مقاومة للفحة و عاليه في المحصول وهذه الزيادة المحصول ترجع عموما إلى الزيادة في صفات السنبلة مثل وزن الآلف حبة ووزن السنبلة والتي كانت أعلى في القيم من الآباء وأيضا أعلى من قيم الأصناف المصرية. وعلى وجه العموم هذه السلالات المنتخبة يمكن استخدامها في برامج التهجين لنقل الصفات الجيدة لانتاج أصناف جديدة.