Evaluation of the Cross Eskandarany x Whitaker for Powdery Mildew Resistance (PMR), Zucchini Yellow Mosaic Virus Resistance (ZYMR) and Some Yield Characters

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Introduction: Cucurbits play a significant role in human nutrition, especially in tropical countries where their consumption is high. Cucurbit crops constitute a major portion of vegetables and are grown in different regions of the Sudan. Squash is a promising export crop which can be readily produced at a low cost during the winter season of Sudan.

Zucchini yellow mosaic virus (ZYMV) and powdery mildew (PM) are major diseases in Sudan, causing significant yield losses (1,2). Summer production of squash resulted in low yield caused by failure of fruit development (5). The popular commercial cultivar of squash in Sudan is 'Eskandarany' which is susceptible to ZYMV and PM . The cultivar Whitaker is a summer squash released in 1998 at Cornell University (USA). Whitaker is resistant to four important diseases: ZYMV, papaya ring spot virus (PRSV), cucumber mosaic virus and PM (10).

Two aggressive isolates of ZYMV, Su19 and Su4, were reported in Sudan (4). The isolate Su19 is an aggressive isolate widely distributed in central Sudan where the field test was done. It incites typical yellow mosaic, deep foliar serration, blisters, deformation and plant stunting on the susceptible cv. Eskandarany. Powdery mildew caused by *Sphaerotheca fuliginea* (Schlecht. Ex Fr. Pol), race 0, 1 and 2 were reported (3), with seasonality of race prevalence. Resistance to PM was reported in wild *Cucurbita lundelliana* (12). This resistance was found to be conferred by a single dominant gene. Another wild squash, *C. martinezii,* was reported to be resistant to PM and this resistance was transferred to *C. pepo* (7). A single incompletely dominant gene *zym* plus some modifiers has been reported to confer resistance to ZYMV (8).

The objectives of this study were to determine (1) the inheritance of resistance to PM and ZYMV, and (2) the yield potential of the parents in cross combination.

Materials and Methods: Cultivar Eskandarany was selfed for four generations to ensure homozygosity. Six generations P_1 (Eskandarany), P_2(Whitaker), F_1, F_2, BCP_1, BCP_2 were generated at University of Gezira farm. The six generations were evaluated during the winter season of 2000/2001. The experimental design used was a randomized complete block design with three replicates . Evaluation of powdery mildew was done under natural conditions of infection. A scale of 1 to 9 was used (2), where 1 = stem: fungal growth with luxuriant sporulation; leaf: completely covered with fungal growth with luxuriant sporulation; 9 = stem and leaf free of fungal growth. Evaluation was done once at the end of the season and when the susceptible parent (P_1) was completely infected. Melon genotypes obtained from INRA, France were used to identify the PM causal agent (Table 1).

Evaluation for ZYMV was done under field conditions in season 1998/99 in Sudan. A scale of 1 to 9 was used, where 1=the plant is severely infected and is showing shoestringing symptoms, 9= no apparent symptoms of the virus. Mechanical inoculation with ZYMV-Su19 was done in the green house and ELISA testing at INRA, Montfavet, France. Three yield characters were measured:

1. number of days to flowering
2. ovary length at flowering (cm).
3. number of days from flowering to harvest (marketable size).

Table 1: Observed reaction of melon genotypes to powdery mildew.

Iran H	Nantais oblong	PMR 45	WMR 29	MR1	PMR5	PI 124112	PI 414723	Edisto
S	S	R	R	R	R	R	R	R

Table 2. Inheritance of powdery mildew resistance in cv. Whitaker (*Cucurbita pepo* L.).

Generation	No of plants	[z]R	S	Expected Ratio	X^2	P
P_1	35	0	35	0:1		
P_2	16	16	0	1:0		
F_1	38	38	0	1:0		
F_2	335	272	62	3:1	1.674>	99%
BCP_1	36	17	19	1:1	0.014>	99%
BCP_2	35	35	0	1:0		

[z]R: resistant, S: susceptible

Table 3. Generation means of ovary length, days to flowering and days to harvest marketable fruits.

Generation	Ovary length(cm)	Days to flowering	Days to harvest
[z]P_1	5.6±0.13	55.5±0.79	6.2±0.13
P_2	7.6±0.23	56.2±1.16	3.4±0.2
F_1	8.3±0.31	45.8±0.9	5.1±0.2
F_2	7.8±0.08	52.1±0.46	4.7±0.07
BCP_1	6.8±0.2	53±1.09	4.8±0.2
BCP_2	8.2±0.21	49.9±1.21	4.8±0.24

P_1: Eskandarany, P_2: Whitaker

For generation mean analysis, six parameter model (6) was used (m=mean, d=additive effect, h=dominance effect, i=additive x additive, j=additive x dominance, l= dominance x dominance). Narrow sense heritability (h^2_N) was estimated according to the partition of variance (11).

Results and Discussion: The Chi-square analysis revealed a good fit for a single completely dominant gene hypothesis for resistance to powdery mildew (Table 2) . According to the observed reaction of the differential genotypes race 1 of *Sphaerotheca fuliginea* is prevailing (Table 1). Nantais oblong is known to be resistant to *Erysiphe Cichoracearum* and race 0 of *S. fuliginea* whereas PMR45 is resistant to race 1 and susceptible to race 2 of *S. fuliginea*.

The cv. Whitaker displayed a high level of resistance to zucchini yellow mosaic virus (ZYMR=8) under natural infection conditions. Plants showed very light mosaic producing fruits with normal shape, size and color. The F_1 (Eskandarany x Whitaker) showed an intermediate level of resistance (ZYMR=5). The plants displayed a high level of mottling on leaves but they were vigorous and produced marketable fruits. Upon inoculation with the isolate Su 19 the cv. Whitaker displayed clear mosaic. The ELISA test confirmed the presence of the virus, but the virus

concentration is lower than that of the cv. Eskandarany. Hence, cv. Whitaker possesses a high tolerance to ZYMV-Su19. No source of immunity for summer squash to natural infection with ZYMV is reported (10).

The cv. Whitaker is not well adapted to Sudan conditions. But the F_1 Eskandarany x Whitaker showed a high level of tolerance to high temperature and it was vigorous and productive . Thus, the F_1 can be released as a summer F_1 hybrid. Since Whitaker derived its resistance to ZYMV from *C. ecuadorensis*, pyramiding genes with that of our breeding lines that derived their resistance to ZYMV from Nigerian Local is under way in an attempt to breed cultivars with a better level of resistance to ZYMV-Su19

Means of the three yield characters are shown in table 3. It is evident that the F_1 is showing heterotic effects in having a longer ovary and being earlier by about 10 days. The generation mean analysis based on the six parameter model indicates that additive and dominance gene effects were significant ($P>0.05$) for number of days to flowering with h^2_N =0.66. For ovary length additive and additive x additive effects were significant with h^2_N =0.65 while dominance and additive x dominance were significant for number of days to marketable size with h^2_N =0.2.

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