Original Research Article

Assessing of some summer forage crops to infection by common smut and downy mildew diseases for forage and silage production

ABSTRACT

The present study was carried out at Sakha Agricultural Research Station in the summer 2020 and 2021 seasons. Ten summer forage crops namely, Millet Saudia Arabia, Selection Millet1, Selection Millet2, Millet Shandawel 1, Sudangrass Giza1, Sudangrass Piper black ,Sorghum SX-17 were evaluated for downy mildew and common smut diseases and forage yield and some traits. Three cuts were taken from the seven fresh forage crops and only one cut for silage from maize (95 days), Teosinte and maize × teosinte (100days). Mean values of forage crops genotypes revealed significant to highly significant differences. Piper black had the highest fresh and dry forage yields at the three cuts and total over the two seasons which had (26.4,22.3,17.1 and 65.7kg/plot) for fresh and 5.3,2.8,2.5 and 10.59 for dry yield ,respectively . For combined data millet Shandawal 1 had 46.7 kg/plot, and 7.8 kg/plot ,while Saudia Arabia Millet gave 31.3 and 4.9 kg/plot, for total fresh and dry forage yields, respectively, so Shandawal 1 surpass Saudia Arabia by 49.2 and 59.2% for fresh and dry yield . Also, sorghum, piper black surpass SX-17 by 19.2 and 26.5 % for total fresh and dry yield, respectively. Maize SC168 x Teosinte Sakha was the highest for plant height (298 cm) ,stem diameter (2.9 cm) ,fresh/leaf stem percent(81%) and fresh forage yield (69 kg/plot) and exceed teosinte by 5.7,93.3,24.6 and 8.7% ,respectively . Meanwhile, exceed maize SC168 by 11.2, 16.0, 72.3 and 122.6%for plant height ,stem diameter ,fresh/leaf stem percent and fresh forage yield ,respectively. Saudia Arabia Millet and hybrid SX -17 were susceptible (s) to downy mildew disease on the other hand pearl millet 2,3,Giza 1 and piper black were resistance (R) to downy mildew disease at the three cuts in the two seasons . The local pearl millet1 , pearl millet2 , and pearl millet 3 (Shandawal 1) recorded the lowest percent of total infection by downy mildew disease1.666,0.000 and 1.333% respectively, also Giza 1 and piper black genotypes recorded the lowest percent of total infection by downy mildew disease which had 2.13 and 4.13% ,respectively. These tested local pearl millet and Giza 1 and piper black , were resistant(R) to downy mildew disease and can be used in breeding programs as sources of resistance to tested disease, In the revers , the imported pearl millet (Saudia Arabia pearl millet) and hybrid sorghum SX -17 were susceptible and recorded 20.33and 34.26, respectively. These results indicated dangerousness of importing susceptible materials. On the other hand, teosinte genotype was resistant to infection by downy mildew disease and the total infection percent was 0.000 in the first reading and 0.666% in the second , but maize was susceptible and recorded (16.70%) as total infection. Therefore the crossing between maize and teosinte resulted in moderate resistant (MR) whereas, 5.966% and 5.166% in the first and second reading. As common smut, teosinte was susceptible (s) but maize and maize x teosinte hybrid were moderate resistant (MR) for common smut infection disease. Finely, the local genotypes are better than the imported Saudi Arabia millet. Hybrid maize x teosinte was the best had more than twice maize silage yield (122.6%).

***Key words*:** forage crops; downy mildew; common smut; disease; hybrid Maize; Teosinte

1. INTRODUCTION

Egypt farmers are very high need to fresh forage to feed their livestock because it is essential especially during summer. The area devoted to the summer forage crops is very limited due to the big competition with the economical crops such as, rice, maize, cotton and grain sorghum. Studied the differences among fodder crops i.e. Sudan grass *cv.* Piper black, pearl millet, teosinte and local sorghum Sudan grass hybrid. The differences in the fresh and dry forage yield potentialities were the highest in the first cut and declined in the second cut and were the lowest in the third cut and indicated that total fresh and dry forage in the two reasons ranked as follow was in a descending order. Sorghum Sudan grass hybrid > Sudan grass> pearl millet> teosinte. Similar results were obtained for plant height and stem diameter . **Haggag [1] and Kumar Srivas and sing [2]** in a similar study found that dry forage yield to be significantly and positively associated with fodder yield , plant height and stem diameter Moreover, **Carpici and Celik [3]** concluded that the relationship between dry forage yield and each of the yield components except leaf/stem ratio were positive and significant .**Gheasemi et al [4]** compared fifteen genotypes of fodder summer and found significant differences among the genotypes in fodder and dry yield . **Maarouf and Moataz [5] and Gheasemi *et al* [6]** evaluated some newly developed sweet sorghum genotypes for some forage attributes. They found significant differences among the genotypes in green yield, dry matter yield, days to flowering, plant height and stem diameter. Summer forage like sorghum and pearl millet are considered the most important.

Fodder crops in Egypt :Such as sorghum and pearl millet are subject to attack downy mildew disease which decreases yield and nutritive value. Sorghum is count as downy mildew host and the pathogen could be transferable to maize and causes great in maize seed production. **Kumar Srivas and Singh [2]** stated that dry forage yield was significant and positive associated with fodder yield, plant height and stem diameter. Teosinte appears to have greater resistance against number of pathogens and pests than their cultivated counterpart. We therefore highlighted the need to study the teosinte in order to identify resistance traits that can be improved in maize, **[7].** Therefore, **Wang et al. [8] and Rich and Eteja [9]** found Mexican farmers occasionally use teosinte in maize crosses to improve their crop. Experimental crosses have been evaluated for pest resistance and indeed display increased resistance with respect to hybrid maize varieties to ear-infesting insects and various pathogens. Teosinte has also been evaluated for resistance in often aspects, Such as the parasitic weed striges, for which no resistance in maize is known. The aim of this study was to evaluate some summer forage crops to forage yield and ability of resistance the infection for downy mildew and common smut disease at Sakha area environmental.

We highlighted the need measures to protect teosinte as a precious resource for crop improvement, in particular resistance against downy mildew disease in maize. On the other hand, **Tolba [10]** who tested number of maize genotypes against u-maydis. He classified them as resistant (infection mature 10%), moderately resistant (11-20%), susceptible (up to 50% and highly susceptible) (≥50%). Maize (*Zea mays* L., ssp.mays) is one of the most important crop in the world cultivated preimainaly for use in animal feed and biofuel. Teosinte (*Z mays* ssp. Parviglumis Iltis × Doebley) and tripsacum are two crops wild relatives that have been extensively characterized as donors of economically important traits that could be used for improvement the maize **[11]**. Hand crosses of greenhouse grown maize and teosinte were performed. Maize plants were detangled and newly shedding teosinte male inflorescence were shaken over respective maize silks. The resulting seeds were resistance to insects and germinated in pots and grown to maturity in the greenhouse **[12].** Therefore, **Durham [13]** found that, crossing between teosinte or tripsa corn and maize is directed to the ability to confer root warms resistance, resistance to insects pests to disease, resistance to

disease drought tolerance and improved and improved stand ability to maize Via trips corn **[14].**

2. MATERIALS AND METHODS

The present study was carried out in the field of diseases at Sakha Agric. Res. St. (Northern Delta) A.R.C., Egypt, during 2020 and 2021 summer seasons, to evaluate the productivity of some summer forage crops and study the effects of imported crops on forage yield and its components as well as infection by common smut and downy mildew. The used materials in this investigation are presented in Table (1).

Table 1: The name and source of some summer forage crops

No.	Name	Source
1	Soudia Arabia Millet	Imported pearl millet from Soudia Arabia(Imported).
2	Local pearl millet 1 (Selection Millet 1)	Local pearl millet 1 selected through breeding program, Forage Crops Res. Dept., ARC, Egypt
3	Local pearl millet 2 (Selection Millet 2)	Local pearl millet 2 selected through breeding program, Forage Crops Res. Dept., ARC, Egypt
4	Local pearl millet 3 (Millet Shandawal 1)	Local Shandawal 1, selected through breeding program of millet.
5	Sorghum Giza1	Variety of Sorghum saccharatum, Forage Crops Res. Dept., ARC, Egypt
6	Sorghum Piper Black	Selected through breeding program of Sudan grass, Forage Crops Res. Dept., ARC, Egypt
7	Sorghum SX-17	Commercial hybrid sorghum(Imported)
8	Teosinte	Sakha genotype, Forage Crops Res. Dept.
9	Maize	Maize (SC168)
10	Maize*Teosinte	Maize (SC168)* Teosinte Sakha genotype

The ten summer forage crops were grown in a randomized complete blocks design (R.C.B.D.) with three replications. The plot size for each crop was 4.8 m^2 (two ridges, 60 cm width, and four meter long) {1.2x4=4.8 m^{2}}.

The seeding rates were 20 kg/fed for sorghum and millet, 30 kg/fed. for teosinte, while14 kg/fed for maize and, Maize x Teosinte hybrid and thinned to one plant in hill. Sowing date for first season was 15th Jun and fresh forage crops (7 genotypes) had cut after 50, 90 and 125 days from sowing date for first, second and third cut, respectively. While, silage forages had cut after 95 days from sowing for maize and 100 days for teosinte and their hybrid .Meanwhile, sowing date for second season was 17 th Jun and fresh forage crops (7 genotypes) had cut after 49,89 and 134 days from sowing date for first, second and third cut, respectively. While, Silage forages had cut after 96 for maize and 99 days for teosinte and their hybrid.

The seeds planting in hills in the top ridges and covered. The fertilizer rates were 200 kg/fed super phosphate (15.5% P_2O_5) added during land preparation. The nitrogen fertilizer rates were added at three equal doses (30 Kg/fed.). The first dose was added after about 21 days from sowing, the second and the third doses were added after the first and the second cuts, respectively. while, for silage forages (3 genotypes) were 250 Kg/ nitrogen /fed divided in to 125 kg N/fed after about 21 days from sowing and 125 kg N/fed after 30-35 days from the first dose .Disease assessment was recorded for downy mildew and expressed as infection percentage at two times the first 30 days after sowing and 30 after cut and ,for common smut after 60 days from sowing and after 20 days from the first one and expressed as percentage of diseased plants according to equation:

$$\text{Infection (\%)} = \frac{\text{No. of infected plants}}{\text{Total no. of plants (healthy + infected)}}$$

Common smut disease severity was classified into eight classes according to size of each gall and disease index (DI) adopted by **Tolba [10]** as follows:

$$DI = \frac{\sum(NPC \times CR)}{NIP \times MSC} \times 100$$

Where:
NPC = No. of plants in class rate.
CR = Class rate.
NIP = No. of inoculated plants.
MSC= Maximum severity class rate.
And modified disease class rate which was suggested later on as:
0 = No infection
1 = Galls less than 1 cm. in diameter
2 = Galls 1 to less than 2 cm.
3 = Galls 2 to less than 3 cm.
4 = Galls 3 to less than 4 cm.
5 = Galls 4 to less than 5 cm.
6 = Galls 5 to less than 6 cm.
7 = Galls 6 to less than 7 cm.
8 = Galls 7 cm. and more.

Appropriate agricultural practices were done during both growing seasons. The growth periods for all forage crops were ranged from 95 to 125 days. Data recorded as:
1-Fresh forage yield per cut (kg/ plot).
2-Dry forage yield per cut (kg/ plot).
3-Plant height (cm).
4-Stem diameter (cm).
5-Fresh leaf/ stem percent.
6- Total Fresh yield (Kg/plot).
7- Total dry yield (Kg/plot).

Statistical analysis:

Data were subjected to proper statistical analysis of RCBD design. Single and combined analysis of variance was done **[15]**. Means were compared at 0.05 levels of significant by the least significant differences (LSD) test, or treatment means were compared **[16]** and multiple range **[17].**

3. Results and dissection

Data presented in Table (2) showed that there are highly significant differences among the seven genotypes at the first and second seasons (2020/2021) and the combined for all studied traits i.e plant height , stem diameter , fresh yield , dry yield at the three cuts in the two seasons and their total fresh and dry yields **[18,19,20,21 and 22].**

Table 2: Analysis of variance of the two seasons and its combined data for seven forage crops at the three cuts.

S.O.V.	d.f	First season								
		PHC1	**PHC2**	**PHC3**	**SDC1**	**SDC2**	**SDC3**	**F/SPC1**	**F/SPC2**	**F/SPC3**
Rep.	2	1.86	1.29	4.00	0.01	0.004	0.004	0.57	0.76	0.43
Geno.	6	1108**	801.714**	733.714**	0.454**	0.314**	0.277**	109.714**	79.66**	92.85**
Error	12	36.02	32.79	27.50	0.03	0.02	0.02	4.57	7.26	9.60
Total	20	-	-	-	-	-	-	-	-	-
s.o.v.	d.f	FYC1	FYC2	FYC3	TFY	DYC1	DYC2	DYC3	TDY	-
Rep.	2	0.84	0.09	0.06	0.54	0.03	0.001	0.001	0.02	-
Geno.	6	75.907**	53.04**	31.214**	465.62**	3.036**	0.828**	0.65**	11.76**	-
Error	12	3.43	2.38	1.29	2.74	0.14	0.07	0.02	0.13	-
Total	20	-	-	-	-	-	-	-	-	-
S.O.V.	**d.f**	**Second season**								
		PHC1	**PHC2**	**PHC3**	**SDC1**	**SDC2**	**SDC3**	**F/SPC1**	**F/SPC2**	**F/SPC3**
Rep.	2	24.143	1.00	3.000	0.010	0.004	0.006	0.429	1.00	2.714
Geno.	6	1134.71**	796.714**	679.429**	0.467**	0.357**	0.264**	112.429**	71.429**	94.714**
Error	12	25.476	34.5	27.667	0.018	0.021	0.011	5.929	5.00	7.714
Total	20	-	-	-	-	-	-	-	-	-
s.o.v.	d.f	FYC1	FYC2	FYC3	TFY	DYC1	DYC2	DYC3	TDY	-
Rep.	2	0.13	0.053	0.03	0.023	0.005	0.0001	0.0001	0.002	-
Geno.	6	53.084**	42.25**	25.404**	354.367**	2.123**	0.722**	0.584**	9.178**	-
Error	12	2.67	1.723	1.083	0.288	0.107	0.021	0.039	0.021	-
Total	20	-	-	-	-	-	-	-	-	-
S.O.V.	**d.f**	**Combined data**								
		PHC1	**PHC2**	**PHC3**	**SDC1**	**SDC2**	**SDC3**	**F/SPC1**	**F/SPC2**	**F/SPC3**
years	1	192.9*	94.5**	61.9*	0.1 *	0.03 *	0.02 Ns	21.4**	22.88**	13.7*
error	4	13	1.1	3.5	0.008	0.004	0.01	0.5	0.88	1.57
Geno.	6	2240.4**	1596.9**	1411.7**	0.900**	0.67**	0.53**	221.7**	149.55**	186.85**
Y * G	6	2.4 Ns	1.5 Ns	1.4 Ns	0.007 Ns	0.004 Ns	0.01 Ns	0.42 Ns	1.54 Ns	0.71 Ns
error	24	30.8	33.6	27.6	0.03	0.02	0.02	5.3	6.13	8.65
Total	41	-	-	-	-	-	-	-	-	-
S.O.V.	**d.f**	**FYC1**	**FYC2**	**FYC3**	**TFY**	**DYC1**	**DYC2**	**DYC3**	**TDY**	**-**
years	1	62.7**	23.6**	1.8**	199.8**	2.5**	0.30**	0.02**	5.4**	-
error	4	0.5	0.1	0.2	0.3	0.1	0.001	0.001	0.01	-
Geno.	6	127.8**	94.9**	338.3**	815.3**	5.1**	1.5**	1.2 **	20.8**	-
Y * G	6	1.2 Ns	0.4 Ns	1.5 Ns	4.7*	0.1 Ns	0.006 Ns	0.005 Ns	0.1 Ns	-
error	24	3.1	2.0	28.5	1.5	0.1	0.04	0.03	0.07	-
Total	41	-	-	-	-	-	-	-	-	-

C: Cut; **PH**: Plant height; **FY**: Fresh yield; **SD**: Stem diameter; **TFY**: Total fresh yield; **F.L/SP**: Fresh leaf stem percent; **DY**: Dry yield; **D.L/S.P**: Dry leaf stem percent and **TDY**: Total dry yield.

Data in Table (3) revealed that piper black was superior for plant height in the two seasons and its combined but Soudia Arabia millet had the shortest plants. Hybrid SX-17 had the highest stem diameter in the two seasons and at its combined, however, Soudia Arabia millet gave the lowest stem diameter plants. Local pearl millet3 had highest fresh leaf/stem

ratio at the three cuts in the two seasons nearly. But hybrid SX-17 had the lowest fresh leaf/stem ratio values **[2, 3 and 5].**

Table 3: Mean performance of morphological characters of seven fresh forage crops at three cuts in the first, second season and their combined data

Genotypes		First season								
		plant height cm			stem diameter			fresh leaf /stem%		
		Cut 1	Cut 2	Cut 3	Cut 1	Cut 2	Cut 3	Cut 1	Cut 2	Cut 3
1	Soudia Arabia Millet	120.0	116.0	112.0	0.80	0.70	0.60	38.0	44.0	47.0
2	Local pearl millet 1 (Selection Millet 1)	148.0	138.0	130.0	0.90	0.80	0.70	48.0	52.0	56.0
3	Local pearl millet 2 (Selection Millet 2)	152.0	142.0	132.0	1.10	0.90	0.70	50.0	55.0	60.0
4	Local pearl millet 3 Millet Shandawal 1	158.0	148.0	138.0	1.20	1.00	0.80	51.0	54.0	58.0
5	S. Giza1	170.0	156.0	150.0	1.70	1.30	1.20	45.0	50.0	55.0
6	S. Piper B	180.0	168.0	160.0	1.50	1.30	1.10	43.0	49.3	53.0
7	S. SX-17	164.0	152.0	146.0	1.80	1.60	1.40	35.0	41.0	45.0
	F test	**	**	**	**	**	**	**	**	**
	L.S.D	10.68	10.19	9.329	0.31	0.26	0.26	3.803	4.794	5.11
Genotypes		Second season								
		plant height cm			stem diameter			fresh leaf/ stem%		
		Cut 1	Cut 2	Cut 3	Cut 1	Cut 2	Cut 3	Cut 1	Cut 2	Cut 3
1	Soudia Arabia Millet	114.0	112.0	111.0	0.70	0.60	0.50	36.0	43.0	46.0
2	Local pearl millet 1 (Selection Millet 1)	144.0	136.0	128.0	0.80	0.70	0.60	47.0	50.0	55.0
3	Local pearl millet 2 (Selection Millet 2)	149.0	140.0	130.0	0.90	0.80	0.70	48.0	54.0	60.0
4	Local pearl millet 3 Millet Shandawal 1	155.0	145.0	135.0	1.10	1.00	0.90	50.0	51.0	56.0
5	S. Giza1	166.0	152.0	146.0	1.50	1.30	1.10	44.0	50.0	53.0
6	S. Piper B	174.0	164.0	158.0	1.50	1.30	1.10	41.0	47.0	52.0
7	S. SX-17	160.0	150.0	143.0	1.70	1.50	1.30	34.0	40.0	44.0
	F test	**	**	**	**	**	**	**	**	**
	L.S.D	8.979	10.45	9.357	0.24	0.26	0.19	4.33	3.98	4.94
Genotypes		Combined data								
		plant height cm			stem diameter			fresh leaf /stem%		
		Cut 1	Cut 2	Cut 3	Cut 1	Cut 2	Cut 3	Cut 1	Cut 2	Cut 3
1	Soudia Arabia Millet	117.0	114.0	111.5	0.80	0.70	0.60	37.0	43.5	46.5
2	Local pearl millet 1 (Selection Millet 1)	146.0	137.0	129.0	0.90	0.80	0.70	47.5	51.0	55.5
3	Local pearl millet 2 (Selection Millet 2)	150.5	141.0	131.0	1.00	0.90	0.70	49.0	54.5	60.0
4	Local pearl millet 3 Millet Shandawal 1	156.5	146.5	136.5	1.20	1.00	0.90	50.5	52.5	57.0
5	S. Giza1	168.0	154.0	148.0	1.60	1.30	1.20	44.5	50.0	54.0
6	S. Piper B	177.0	166.0	159.0	1.50	1.30	1.10	42.0	48.2	52.5
7	S. SX-17	162.0	151.0	144.5	1.80	1.55	1.40	34.5	40.5	44.5
	F test	**	**	**	**	**	**	**	**	**
	L.S.D	6.6	6.9	6.3	0.20	0.20	0.20	2.7	3.0	3.5

Data in Table (4) showed that piper black had the highest fresh and dry forage yield at the three cuts in the two seasons and it's combined. Piper black had the highest fresh and dry forage yield at the three cuts in the two seasons and its combined which had (26.4,22.3,17.1 and 65.7kg/plot) for fresh yield for combined data, while had 5.3,2.8,2.5 and 10.59 for dry yield ,respectively **[6,23,24 and 25].** For combined data of total yield millet Shandawal 1 were 46.7 kg/plot, and 7.8 kg/plot ,while Saudia Arabia Millet gave 31.3 and 4.9 kg/plot, for total fresh and dry forage yields, respectively, it mean that Shandawal 1 surpass Saudia Arabia by 49.2 and 59.2% for fresh and dry yield, where Saudia Arabia Millet had 12.8 , 10.5, 80 and 31.3 kg/plot for fresh yield in first ,second, third and total yield ,respectively **[26]**. While for sorghum, piper black surpass SX-17 by 19.2 and 26.5 % for total fresh and dry yield ,respectively. Saudia Arabia Millet and hybrid SX -17 were susceptible (s) to downy mildew disease on the other hand pearl millet 2,3, Giza 1 and piper black were

resistance (R) to downy mildew disease at the three cuts in the two seasons but Saudia Arabia Millet gave the lowest fresh and dry forage yields at the three cuts in the two seasons and its combined. Saudia Arabia Millet and hybrid SX -17 were susceptible (s) to downy mildew disease on the other hand pearl millet 2,3,Giza 1 and piper black were resistance (R) to downy mildew disease at the three cuts in the two seasons **[27,28,29 and 30] .**

Table 4: Fresh and dry forage yield (kg/plot)of studied seven forage crops to downy mildew disease under field disease nursly at three cuts and their total in both seasons ,combined analysis and Disease reaction.

	Genotypes	First season								
		Fresh forage yield (kg/plot)				Dry forage yield (kg/plot)				Disease reaction
		cut 1	cut2	cut3	Total	cut1	cut2	cut3	Total	
1	Soudia Arabia Millet	13.5	11.0	8.0	32.5	2.70	1.32	1.10	5.14	Susceptible(S)
2	Local pearl millet 1 (Selection Millet 1)	18.0	15.0	11.0	44.0	3.60	1.95	1.64	7.20	Resistant(R}
3	Local pearl millet 2 (Selection Millet 2)	19.0	15.8	11.6	46.4	3.80	2.13	1.83	7.76	R
4	Local pearl millet 3 Millet Shandawal 1	20.0	16.5	12.5	49.0	4.00	2.18	1.95	8.13	R
5	S. Giza1	25.0	21.2	15.8	62.6	5.12	2.71	2.34	10.18	R
6	S. Piper B	28.4	23.5	17.6	69.5	5.68	2.94	2.55	11.17	R
7	S. SX-17	23.4	19.5	14.5	57.4	4.60	2.24	1.88	8.80	S
	F test	**	**	**	**	**	**	**	**	-
	L.S.D	3.296	2.742	2.021	2.945	0.66	0.47	0.27	0.64	-
	Genotypes	Second season								
		Fresh forage yield (kg/plot)				Dry forage yield (kg/plot)				Disease reaction
		cut1	cut2	cut3	Total	cut1	cut2	cut3	Total	
1	Soudia Arabia Millet	12.0	10.0	8.0	30.0	2.40	1.15	1.08	4.65	Susceptible(S)
2	Local pearl millet 1 (Selection Millet 1)	16.5	14.0	11.0	41.5	3.30	1.88	1.69	6.88	Resistant(R}
3	Local pearl millet 2 (Selection Millet 2)	17.0	14.5	11.4	42.9	3.40	1.98	1.82	7.20	R
4	Local pearl millet 3 Millet Shandawal 1	17.5	15.0	11.8	44.3	3.50	2.00	1.87	7.37	R
5	S. Giza1	22.6	19.5	15.4	57.5	4.50	2.50	2.30	9.33	R
6	S. Piper B	24.4	21.0	16.5	61.9	4.88	2.68	2.44	10.01	R
7	S. SX-17	20.8	18.0	14.0	52.8	4.16	2.02	1.77	7.94	S
	F test	**	**	**	**	**	**	**	**	-
	L.S.D	2.907	2.335	1.851	0.955	0.58	0.26	0.35	0.26	-
	Genotypes	Combined data								
		Fresh forage yield (kg/plot)				Dry forage yield (kg/plot)				Disease reaction
		cut1	cut2	cut3	Total	cut1	cut2	cut3	Total	
1	Soudia Arabia Millet	12.8	10.5	8.0	31.3	2.60	1.20	1.10	4.90	Susceptible(S)
2	Local pearl millet 1 (Selection Millet 1)	17.3	14.5	11.0	42.8	3.50	1.90	1.70	7.04	Resistant(R}
3	Local pearl millet 2 (Selection Millet 2)	18.0	15.2	11.5	44.7	3.60	2.10	1.80	7.50	R
4	Local pearl millet 3 Millet Shandawal 1	18.8	15.8	12.2	46.7	3.80	2.10	1.90	7.80	R
5	S. Giza1	24.1	20.4	15.6	60.1	4.80	2.60	2.30	9.75	R
6	S. Piper B	26.4	22.3	17.1	65.7	5.30	2.80	2.50	10.59	R
7	S. SX-17	22.1	18.8	14.3	55.1	4.40	2.10	1.80	8.37	S
	F test	**	**	**	**	**	**	**	**	-
	L.S.D	2.1	1.7	1.3	1.5	0.40	0.30	0.20	0.32	-

Data presented in Table 5, showed that, the local pearl millet 1, pearl millet 2 and pearl millet 3 recorded the lowest percent of total infection by downy mildew disease, it was recorded 1.666, 0.000 and 1.333 % respectively, therefor, these tested local peal millet were resistant (R) to downy mildew disease and can be using them in breeding program as sources of resistance to the tested disease. Giza1 and piper black cultivars were also recorded low percentage of total infection by the disease; they recorded 2.132 and 4.132 % respectively, and also can use them as sources of resistance to the tested disease in breeding program. In the revers, the imported pearl millet (Soudia pearl millet) and SX-17 cultivars were

susceptible (S) and recorded the highest total infection percent; they recorded 20.333 and 34.266 % respectively. These results indicated the dangerousness of importing the susceptible materials and transferring it inside the country. On the other hand, during 2021 growing season, the presented data in table 6 were in the same line with which reported during 2020 growing season. The local pearl millet 1 , pearl millet 2, pearl millet 3, Giza1and piper black recorded low percentage of total infect disease in second season i.e 0.666 , 0.000 , 1.332 , 2.033 and 3.266 respectively, therefore these tested genotypes were resistance(R) to downy mildew disease and can be using them in breeding program as sources of resistance to the tested disease. In the revers the impotent pearl millet, Soudia pearl millet and SX-17 hybrid were susceptibility (s) and recorded the highest total infect to downy mildew disease. On the other hand ,the combination between two tested two season injected the same trend, therefore, the local pearl millet 1 ,2 ,3 , S.Giza 1 and S.Piper Black recorded low percentage of total infection percentage of disease i.e. 1.166 , 0.000 , 1.332 , 2.083 and 3.699% ,respectively .While the revers was tree in case of important pearl millet (Soudia Arabia Millet) and Sx-17 were susceptible.

Table 5: Reaction of seven genotypes to downy mildew disease under field disease nursly during two growing season.

Genotypes	First season			
	Local infection %	Systemic infection%	Total infection %	Disease reaction
Soudia Arabia Millet	11.000b	9.333b	20.333b	Susceptible (S)
Local pearl millet 1 (Selection Millet 1)	1.000 d	0.666 c	1.666 d	Resistant (R}
Local pearl millet 2 (Selection Millet 2)	0.000 d	0.000 c	0.000 d	R
Local pearl millet 3 (Millet Shandawal 1)	1.000 d	0.333 c	1.333 d	R
S. Giza1	1.066 d	1.066 c	2.132 cd	R
S. Piper B	3.066c	1.066 c	4.132 c	R
S. SX-17	22.200 a	12.066 a	34.266 a	S
Significant	**	**	**	-
L.S.D 0.05	1.982	1.614	2.2	-
Genotypes	**Second season**			
	Local infection %	**Systemic infection%**	**Total infection %**	**Disease reaction**
Soudia Arabia Millet	12.333 b	11.333b	23.666 b	Susceptible (S)
Local pearl millet 1 (Selection Millet 1)	0.333 c	0.333 de	0.666 c	Resistant (R}
Local pearl millet 2 (Selection Millet 2)	0.000 c	0.000 e	0.000 c	R
Local pearl millet 3 Millet Shandawal 1	0.666 c	0.666 cd	1.332c	R
S. Giza1	1.400 c	0.633 cd	2.033 c	R
S. Piper B	2.066c	1.200 c	3.266 c	R
S. SX-17	25.200 a	14.333 a	39.533 a	S
Significant	**	**	**	-
L.S.D 0.05	3.492	0.584	3.648	-
Genotypes	**Combined**			
	Local infection %	**Systemic infection%**	**Total infection %**	**Disease reaction**
Soudia Arabia Millet	11.6665b	10.333b	22b	Susceptible (S)
Local pearl millet 1 (Selection Millet 1)	0.6665c	0.500d	1.166c	Resistant (R)
Local pearl millet 2 (Selection Millet 2)	0.000c	0.000d	0.000c	R
Local pearl millet 3 Millet Shandawal 1	0.833c	0.4995d	1.3325c	R
S. Giza1	1.233c	0.850cd	2.083c	R
S. Piper B	2.566c	1.133c	3.699c	R
S. SX-17	23.7a	13.1995a	36.8995a	S
Significant	**	**	**	-
L.S.D 0.05	2.737	1.099	2.924	-

Data presented in **Table (6)** and figures 1, 2, 3 and 4 found that, the oospores of prenosclerospora sorghi were highly significantly (+++) founded in the soil around all tested genotypes, during the two tested seasons. While, it was not found in plant tissues of pearl millet 1(Selection Millet 1) and pearl millet 2 (Selection Millet 2) (-) during two tested seasons. Moreover it were low found in plant tissues (+) in pearl millets 3(Millet Shandawal 1) and piper black during two tested season , while in case of Giza 1 the oospores of the tested pathogen found in low during the first season only (season 2020). On the other hand, the oospores of tested pathogen were highly significantly founded (+++) in tissues of imported pearl millet (Suodia pearl millet) and SX-17 genotypes during two tested season. The same trend was obtained in case of combined between two tested season.

Table 6: Residual oospores of Prenosclerospora sorghi after harvest in soil and plant tissues in two seasons.

Genotypes	First season		Second season		combined	
	In plant tissues	In the soil	In plant tissues	In the soil	In plant tissues	In the soil
Soudia Arabia Millet	+++	+++	+++	+++	+++	+++
Local pearl millet 1 (Selection Millet 1)	-	+++	-	+++	-	+++
Local pearl millet 2 (Selection Millet 2)	-	+++	-	+++	-	+++
Local pearl millet 3 (Millet Shandawal 1)	+	+++	+	+++	+	+++
S. Giza1	+	+++	-	+++	-	+++
S. Piper B	+	+++	+	+++	+	+++
S. SX-17	+++	+++	+++	+++	+++	+++

The microscopic investigation was 40×10 magnification (**Otika digital camera, b-193, Germany)**

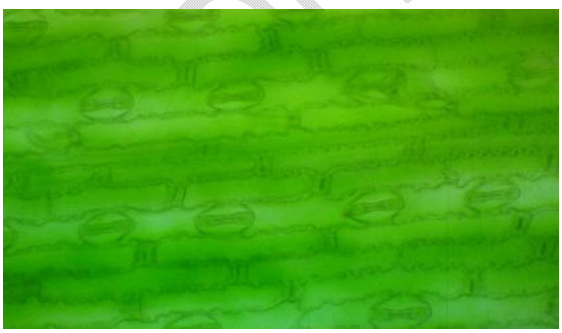

Figure 1: No oospores founded(-)

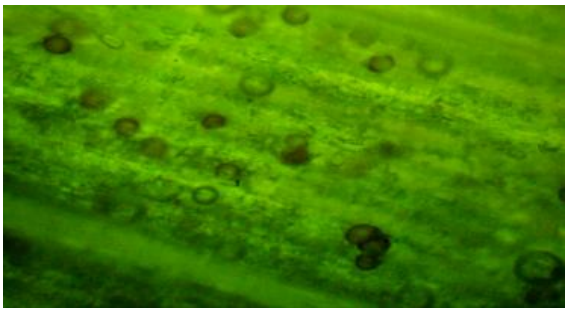

Figure 3: oospores up to 10 spores In the microscopic field at 40×10 = 400x(++)

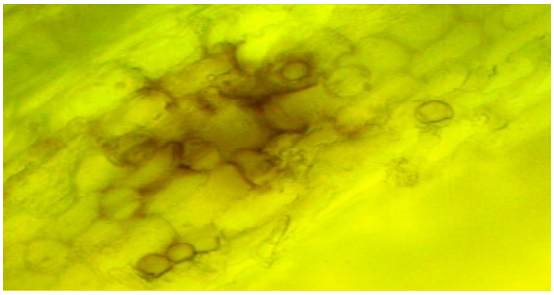

Figure 2: oospores less than 10 spores In microscopic field (+)at 40× 10 =400 x

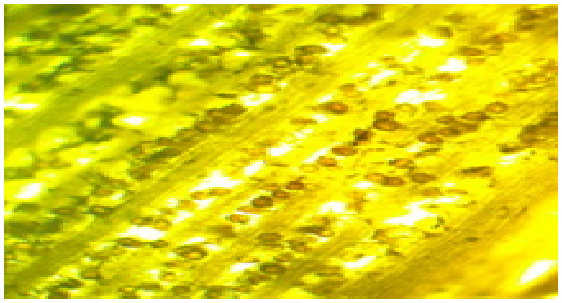

Figure 4: heavy oospores in adult leaves in final(+++)

Data in **Table (7)** mentioned that these are highly significant differences among the three crops for silage fresh, dry yield and its components in the two seasons and it's combined. Mean performance morphological characters ,fresh and dry forage yield (kg/plot) of three forage crops for silage in first, second season and combined data for reaction to common smut disease under natural infection are presented in **Table (8).** Hybrid maize x teosinte had the highest values of plant height, stem diameter fresh leaf/stem percent, fresh and dry forage yields in the two seasons and its combined data, while maize gave the lowest values **[7, 8 and 9].**Teosinte is susceptible(s) while maize and hybrid maize x teosinte were moderate susceptible (MR) in the two seasons and its combined to common sumt disease infection **[10].**

Maize SC168 x Teosinte Sakha was the highest for plant height (298 cm) ,stem diameter (2.9 cm), fresh/leaf stem percent(81%) and fresh forage yield (69 kg/plot) and exceed teosinte by 5.7,93.3,24.6 and 8.7%.Meanwhile,exceed maize SC168 by 11.2,16.0,72.3 and 122.6%for plant height ,stem diameter ,fresh/leaf stem percent and fresh forage yield ,respectively **[31]**. It can be concluded that hybrid maize x teosinte was the best silage fresh yield ,where it had more than twice maize silage (122.6%),while maize can be used in breeding program to transfer common smut disease to teosinte and hybrids **[32 and 33].**

Table 7: Analysis of variance of two seasons and combined data for three forage crops for silage

S.O.V.	d.f	First season				
		PH	SD	F/SP	FY	DY
Rep.	2	34.3	0.003	2.33	2.7	0.312
Geno.	2	916**	1.56**	925**	1204**	102.74**
Error	4	30.8	0.053	14.33	25.2	2.98
Total	8	-	-	-	-	-
S.O.V.	d.f	Second season				
		PH	SD	F/SP	FY	DY
Rep.	2	0.33	0.003	1.33	2.73	0.227
Geno.	2	532**	1.63**	769**	1339**	124.067**
Error	4	46.33	0.083	11.33	15.58	1.003
Total	8	-	-	-	-	-
S.O.V.	d.f	Combined data				
		PH	SD	F/SP	FY	DY
years	1	72	0.08	45.5	0.5	0.151
error	4	17.3	0.003	1.833	2.7	0.269
Geno.	2	1352**	3.185**	1684.5**	2530.5**	223.686**

Y * G	2	96 Ns	0.005 Ns	9.5 Ns	12.5 Ns	3.123 Ns
error	8	38.58	0.068	12.833	20.38	1.992
Total	17	-	-	-	-	-

Table 8: Mean performance of fresh and dry forage yields (kg/plot) of three forage crops for silage in first, second season and their combined data and reaction to common smut disease under natural infection.

		First season					
	Genotypes	**plant height cm**	**Stem diameter**	**Fresh leaf stem%**	**Fresh forage yield (kg/plot)**	**Dry forage yield (kg/plot)**	**Disease reaction**
1	**Teosinte**	276	1.4	65	62	17.4	S
2	**Maize**	266	2.4	45	32	7.7	MR
3	**Maize × Teosinte (H.)**	300	2.8	80	70	18.2	MR
	F test	**	**	**	**	**	-
	L.S.D	12.6	0.5	8.6	11.4	3.9	-
		Second season					
	Genotypes	**plant height cm**	**Stem diameter**	**Fresh leaf stem%**	**Fresh forage yield (kg/plot)**	**Dry forage yield (kg/plot)**	**Disease reaction**
1	**Teosinte**	288	1.5	65	65	18.8	S
2	**Maize**	270	2.6	50	30	6.9	MR
3	**Maize × Teosinte (H.)**	296	2.9	82	68	17	MR
	F test	**	**	**	**	**	-
	L.S.D	15.43	0.653	7.632	8.9	2.3	-
		Combined data					
	Genotypes	**plant height cm**	**Stem diameter**	**Fresh leaf stem%**	**Fresh forage yield (kg/plot)**	**Dry forage yield (kg/plot)**	**Disease reaction**
1	**Teosinte**	282	1.5	65	63.5	18.1	S
2	**Maize**	268	2.5	47	31	7.3	MR
3	**Maize × Teosinte (H.)**	298	2.9	81	69	17.6	MR
	F test	**	**	**	**	**	-
	L.S.D	8.27	0.347	4.769	6.01	1.88	-
	percent of increase % from teosinte	5.7	93.3	24.6	8.7	-	-
	percent of increase % from maize	11.2	16.0	72.3	122.6	-	-

Data presented in **Table (9**) found that, teosinte genotype was resistant to infection by downy mildew disease, here, the total infection percent was 0.000 in the first reading and 0.666 % in the second reading. On the other hand, the maize cultivar was susceptible and had the highest total infection percentage (16.700 and 15.46 %) by the disease at the first and second reading, respectively. Therefore, the crossing between maize 1 and teosinte resulted in moderate resistant (MR) hybrid (maize 1 × teosinte) in the reading1 (the total infection by the disease was5.166 % in the reading 1 , and also 5.966 % in the reading 2 , respectively **[8]**.

These results indicated that, the resistance to downy mildew disease can be transferring from teosinte to the hybrid which resulted from crossing between maize and teosinte. **Elvira *et al* [7]**, which showed that, teosinte appear to have greater resistance against a number of pathogens and pests than their cultivated counterpart. We therefore highlight the need to study the teosinte in order to identify resistance traits that can be improved in maize.

Table 9: Reaction teosinte, maize, maize × Teosinte (hybrid) to downy mildew disease under field disease nursly during two growing season.

Genotypes	First season							
	Reading 1				Reading 2			
	Local infection	Systemic infection	Total infection	Disease reaction	Local infection	Systemic infection	Total infection	Disease reaction
Teosinte	0.000 c	0.000 c	0.000 c	R	0.666 c	0.000 c	0.666 c	R
Maize	10.300 a	6.400 a	16.700 a	S	10.300 a	6.400 a	16.700 a	S
maize × Teosinte	2.333 b	2.833 b	5.166 b	MR	4.166 b	1.800 b	5.966 b	MR
Significant	**	**	**	-	**	**	**	-
L.S.D 0.05	1.398	1.702	1.385	-	0.604	0.809	0.923	-
Genotypes	**Second season**							
	Reading 1				Reading 2			
	Local infection	Systemic infection	Total infection	Disease reaction	Local infection	Systemic infection	Total infection	Disease reaction
Teosinte	0.000 c	0.333 b	0.333 c	R	0.000 c	0.000 b	0.000 c	R
Maize	11.633 a	3.833 a	15.466 a	S	11.633 a	3.833 a	15.466 a	S
maize × Teosinte	3.366 b	1.300 b	4.66 b	R	3.966 b	2.966 a	6.932 b	MR
Significant	**	**	**	-	**	**	**	-
L.S.D 0.05	1.721	1.328	1.378	-	0.735	1.306	1.933	-
Genotypes	**Combined**							
	Reading 1				Reading 2			
	Local infection	Systemic infection	Total infection	Disease reaction	Local infection	Systemic infection	Total infection	Disease reaction
Teosinte	0.000 c	0.167c	0.167c	R	0.333c	0.000c	0.333c	R
Maize	10.967a	5.117a	16.083a	S	10.967a	5.117a	16.083a	S
maize × Teosinte	2.850b	2.067b	4.913b	MR	4.066b	2.383b	6.449b	MR
Significant	**	**	**	-	**	**	**	-
L.S.D 0.05	1.560	1.515	1.382	-	0.670	1.058	1.428	-

Data presented in Table (10) showed that ,the teosinte genotype was susceptible to smut disease and had the highest disease index (58.053) and infection % were 30.033% in the first reading ,and also was highest in second reading (disease index was 28.033 and infection % was 21.933%).While, the maize was moderately resistant ,the disease index and infection % were 17.466 and 11.166%respectively .Moreover, the crossing between teosinte and maize resulted in moderately resistant hybrid maize × Teosinte, the disease index was 15.500 and 9.766 while, the infection %was 11.5333 % and 10.500% in first and second reading, respectively. Tolba [10] found same results who tested number of maize genotypes against uomydis, who classified them as resistant (infection not more than10%),moderately resistant(11.200%) susceptible (up to 50%) and highly susceptible (≥ 50%).Moreover ,the results obtained in second season and the combined between two tested seasons were in the same trend in first season [34 and 35].

Table 10: Reaction of teosinte, maize and teosinte × maize 1 (hybrid) to common smut disease under natural infection during two growing season.

Genotypes	First season					
	Reading 1			Reading 2		
	Disease index	Infection%	Disease reaction	Disease index	Infection%	Disease reaction
Teosinte	58.033 a	30.433 a	S	28.033 a	21.933 a	S
Maize	17.466 b	11.166 b	MR	17.466 b	11.166 b	MR
Teosinte × maize1	15.500 b	11.533 b	MR	9.766 b	10.500 b	MR
Significant	**	**	-	**	**	-
L.S.D 0.05	8.677	1.328	-	6.056	1.623	-
Genotypes	**Second season**					
	Reading 1			Reading 2		
	Disease index	Infection%	Disease reaction	Disease index	Infection%	Disease reaction
Teosinte	49.466 a	24.733 a	S	26.600 a	21.366 a	S
Maize	14.066 b	10.633 b	MR	14.066 b	10.633 b	MR
Teosinte × maize1	15.133 b	11.866 b	MR	9.533 b	10.966 b	MR
Significant	**	**	-	**	**	-
L.S.D 0.05	5.636	4.243	-	1.451	3.257	-
Genotypes	**Combined**					
	Reading 1			Reading 2		
	Disease index	Infection%	Disease reaction	Disease index	Infection%	Disease reaction
Teosinte	53.75a	27.58a	S	27.32a	21.65a	S
Maize	15.77b	10.90b	MR	15.77b	10.90b	MR
Teosinte × maize1	15.32b	11.70b	MR	9.65c	10.73b	MR
Significant	**	**	-	**	**	-
L.S.D 0.05	7.16	2.79	-	3.75	2.44	-

4. CONCLUSION

The local genotypes are better than the imported ones, as the imported Saudi millet was more susceptible to downy mildew than the other local ones. The cross between maize and teosinte produced a hybrid resistant to smut as it took the resistance characteristic of maize, resistant to downy mildew as it took the resistance characteristic of teosinte, It can be concluded that hybrid maize x teosinte was the best silage fresh yield, where it had more than twice maize silage (122.6%), while maize can be used in breeding program to transfer common smut disease to teosinte and hybrids.

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