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RELATIVE TOLERANCE OF EGYPTIAN CLOVER GENOTYPES TO DODDER INFESTATION

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ABSTRACT

Egyptian clover or berseem (*Trifolium alexandrinum* L.) is the principle forage crop in Egypt. Unfortunately, the uncertified and uncontrolled local seeds are being contaminated with dodder (*Cuscuta* spp.) seeds, which affecting negatively both productivity and quality of produced forage. Three field experiments were carried out at Sakha Agricultural Research Station Farm, Kafer El-Sheikh Governorate, ARC, Egypt, during three successive winter seasons; 2008/09, 2009/10 and 2010/11, to investigate the performance of 100 berseem genotypes; 96 farmers seed lots and four commercial cultivars for its resistance/tolerance to dodder infestation. Highly significant differences were observed among the 100 genotypes under evaluation as well as the interaction between the sets and genotypes for all cuts and seasonal yield in the 1st season. The commercial cultivar; Helali (Genotype no.111) has high potential and high-yielding ability in comparison with other cultivars and landraces. It was bred for relatively high ability to rapid re-growth which may be associated with tolerance to biotic and abiotic stresses. In addition to, some landraces retained the least reduction percent of total chlorophyll. In general, the berseem genotypes under investigation manifested highly significant differences at all cuts and seasonal fresh and dry yield as well as chlorophyll content for reduction percent due to dodder infestation.

INTRODUCTION

Egyptian clover or berseem (*Trifolium alexandrinum* L.) is a winter annual legume widely grown in several countries for fresh fodder, hay and silage. In Egypt, the most limiting factor for animal wealth development is the lack of local feed due to the wide gap between the consumed and available local feed sources (ACSAD, 2008). Therefore, berseem is not only endogenous to Egypt but also the principal forage crop and occupying about 2.0–2.8 million Fadden (El-Nahrawy, 2009b). The animal wealth development is depending mainly on berseem in the winter season because most of the animal protein requirement is fulfilled with feeding on berseem (ACSAD, 2008). It is considered a principal source of animal feed for the most whole year specifically the smallholders due to its high yielding and quality potential. Moreover, it is the fertility foundation of agriculture in the Nile Delta and the valley and playing a vital role in sustaining the Egyptian agriculture (El-Nahrawy, 2009a). In addition, berseem still considered indispensable in rotation with cotton and other crops due to its high nitrogen fixation potential, so, it fixes more than 714 thousand tons of atmospheric N2 annually in Egypt (Kennedy & Mackie, 1925; Abd EL-Hady, 1993; Graves et al, 1996). Furthermore, berseem is one of the important sources for honey bees foraging. Nevertheless, berseem has not received much attention compared to cereal crops; i.e. wheat, rice and corn (The Strategy for Sustainable

Agricultural Development Towards; 2030). The remarkable increase in cereal productivity in the last two decades (from 8 million MT in 1980 to more than 22 million MT in 2009) is mainly due to developing high-yielding cultivars and making their certified seed available to growers. Unfortunately, this is not the case for berseem. Farmers have traditionally produced their own seed or purchased their requirements from the local markets. However, local seed is both uncertified and uncontrolled and the quality of such seed on local market is rather poor and most of it is contaminated with many weed seeds, especially, dodder seeds (*Cuscuta* spp.). Recently, an increasing number of farmers (85%) have been reporting troubles due to dodder infestation in berseem fields which affect both productivity and quality of produced forage (Abd El-Hamid & El-Khanagry, 2006). Dodder affects the growth and yield of infested plants and causes losses in crop. Infested berseem with dodder could lead to reduced protein content, fresh as well as dry forage yield and nutritive value. Therefore, dodder is considered a very big problem overall the world including Egypt and one of the main parasitic weed for crop plants not only berseem but also alfalfa, vegetables and fruits. Dodder can germinate alone if the weather is fit to germination, but, it cannot survive alone without attachment to a host. It must attach itself with a host plant by the suckers of the dodder. The hard seeds of dodder can remain in the soil for many years viable (Abd El–Wahed, 1996). Dodder species are distributed worldwide and continued to attack many different host plants. International trade, mainly with contaminated crop seeds, has led to the wide distribution of this parasite (Parker & Riches, 1993). It lives entirely on the host plant thus reducing the growth and yield of the host. Several herbicides have been successfully shown to selectively suppress attached dodder but complete control is rarely obtained. Dodder attached to genetically modified, herbicide resistant crops; have not been successfully killed by treatment with herbicide in all cases, indicating that, these crops will only be a partial solution to the problem. Dodder control will require an integrated approach conducted over a period of many years (Lanini & Kogan, 2005). Therefore, the main goals of this study were to assess the effect of dodder on growth and development of available berseem germplasm; commercial and high-yielding developed cultivars as well as farmers' seed lots. In addition to, estimate the losses occurred due to dodder infestation and to identify the most tolerant genotypes under artificial infestation.

MATERIALS AND METHODS

Three field experiments were carried out at Sakha Agricultural Research Station Farm, Kafer El-Sheikh-Governorate, Forage Crops Research Department (FCRD), Field Crops Research Institute (FCRI), Agricultural Research Center (ARC), Egypt, during three successive winter seasons; 2008/09, 2009/10 and 2010/11 to investigate the performance of some Egyptian clover genotypes for forage yield and its tolerance to dodder infestation (*Cuscuta planiflora*). One hundred genotypes were used in this investigation. Ninety six genotypes were chosen randomly from big collection of berseem farmers' seed lots (landraces) through survey overall most of the country issued by FCRD to capture most of the existing genetic variation and the rest four genotypes were commercial cultivars; Helali, Sakha-4, Sids-1 and Serw-1.

In the 1st season (2008/2009): Simultaneously, two adjacent as well as similar layouts were conducted. The recommended cultural practices for berseem such as preparing good seed bed, adding NPK fertilizers, cutting and irrigation were applied. The first layout accommodated the 100 genotypes which were divided into five sets and each set contained 20 genotypes. Genotypes were randomly distributed within each set and sets were randomly distributed within each replicate of the four replicates in complete block design without infestation of dodder seed. The second layout was carried out in a similar way to the first one but berseem seeds of each plot were mixed with dodder seeds in rate of 5% of berseem seeds, as it stated by Soliman (2002) to achieve the artificial infestation. The plot size was 1.2 x 2.0 m which contained four rows. The seeds of each genotype were seeded within the four rows according to the layout of the experiment. The space between the rows was 30cm and 1.50m between the plots. The sowing dates of the experiments were October 20, 15 and 18 for the three seasons, respectively. Four cuts were taken. Fresh forage yield/plot were weighted (Kg/plot) in the non-infested experiment and after separating dodder material from forage in the infested experiment. Percentage of reduction (R %) in forage yield due to dodder infestation was calculated according to Topps & Wain (1957) formula as following: $R\% = (A – B / A) \times 100$.

Where; A: Fresh forage weight on non-infested,

B: Fresh forage weight on infested.

At the end of 1st season, 25 genotypes were selected based on the least value of reduction in descending order of the fresh forage yield out of the 100 genotypes under evaluation. After the 4th cut, the selected 25 genotypes were left for open cross-pollination and the rest of genotypes were discarded to eliminate the possibility of producing pollen and providing good isolated area for the selected genotypes. Three hives of honey bees were provided during the flowering time to insure intercross pollination among the selected genotypes. Seeds of each genotype of the 25 selected genotypes were harvested, separately, after reaching maturity stage.

In the 2nd season (2009/2010): Seeds of the selected 25 genotypes along with two lots; genotypes no. 29 and 94, which were identified to be very sensitive to dodder infestation in the 1st season evaluated in a randomized complete block design (RCDB) with four replicates. The plot size, number of rows within the plot, the distance between plots and number of cuts were similar to that in the 1st season. At the end of 2nd season, selection was conducted for the genotypes that had the least percent of reduction in descending order. Six genotypes were selected based on the least value of reduction of the fresh and dry forage yield out of the 25 genotypes under evaluation. Seeds of each genotype of the six selected genotypes were harvested, separately. Reduction percentages for fresh and dry forage yield were estimated. Total chlorophyll content was determined from 10 fresh berseem plants mechanically by using chlorophyll meter content (spade value) for 10 genotypes which represent four degrees of dodder infestation tolerance; high, medium, low tolerance and sensitive. Also, percentage of reduction for total chlorophyll was estimated.

In the 3rd season (2010/2011): remnant seeds of the selected six genotypes which represent the parents as well as seeds of the same genotypes which selected in the 2nd season which represent the progenies of these parents and two check commercial varieties Giza-6 and Gemmiza-1 were evaluated on a RCDB with four replicates as stated in the 2nd season. The materials were left for seed production in isolated area and few honey bees' hives were provided during flowering time. Percentages of reduction for fresh as well as dry forage yield were estimated.

Analysis of variance for RCDB with four replications was carried out according to Sendecor & Cochran (1971) for each experiment (infested and non-infested). Moreover, the variance components were calculated according to Comstock & Robinson (1952).

RESULTS AND DISCUSSION

1st season (2008/2009)

Highly significant differences among the 100 genotypes under evaluation, the interaction between the sets and genotypes for all cuts and seasonal yield had been detected (Table 1). Means of fresh forage yield reduction percentages (FFY R %) due to infestation with dodder for the 100 genotypes at the four cuts and seasonal yield in the 1st season (2008/09) are shown (Table 2). FFY R % ranged from 4.75 for genotype no. 111 to about 54.0 for genotype no.108 at the 1st cut. Moreover, FFY R % ranged from 10.2 for genotype no.51 to 54.6 for genotype no.32 at the 2nd cut. In addition, FFY R % ranged from 8.93 for genotype no.51 to about 46.35 for genotype no.70 at the 3rd cut. While, FFY R % ranged from 14.03 for genotype no. 51 to 61.9 for genotype no.13 in the 4th cut. Regarding seasonal forage yield, R% value ranged from11.44 for genotype no.51 to 47.9 for genotype no.32. In general, genotype no.51 has the least reduction value (R %) among all the genotypes at all cuts and seasonal yield except at 1st cut, where, it is preceded by genotype no.111 which gave 4.75% for FFY then followed by genotype no.74, where, it gave 5.26%. Moreover, the average of FFY R % across the cuts increased in ascending order i.e. R % at 4th cut > 3rd cut > 2nd cut >1st cut. However, the highest FFY R % value was manifested by genotype no. 13, where, it gave 61.9 at 4th cut and genotype no. 94 where it gave 50.56 regarding the seasonal yield.

Table 1 : Mean squares of FFY R % for Egyptian clover genotypes infested by dodder at different cuts and seasonal yield in 1st season (2008/09).

S. O.V	d. f.	Mean squares				
		Cut1	Cut2	Cut3	Cut4	Seasonal yield
Sets (S)	4	104.118	333.257	847.456	1309.798	341.716
Reps/S	7	120.271	353.056	868.245	1331.266	353.217
Genotypes(G)	19	961.623**	388.440**	292.503**	864.297**	411.520**
S x G	76	538.991**	274.575**	252.966**	461.00**	283.900**
Error	258	8.485	10.870	10.877	3.920	4.768

****: Significant at the 0.01 level of probability.**

Table 2 : Means of FFY R % of Egyptian clover genotypes infested by dodder at different cuts and seasonal yield in 1st season (2008/2009).

Genotype	1st Cut	2nd Cut	3rd Cu3	4th Cut	Seasonal yield
1	44.725	34.900	32.675	44.425	38.328
2	33.00	26.375	13.475	28.750	24.745
4	37.700	37.625	32.150	41.975	37.238
6	43.625	40.100	33.450	30.450	36.338
7	48.325	45.750	39.275	49.725	27.477
8	27.425	24.900	23.875	33.725	27.477
9	44.625	36.700	34.325	52.500	42.198
10	47.525	46,625	43.350	50.075	46.725
11	35.975	39.775	36.275	59.850	43.840
12	16.750	14.925	16.625	27.525	19.160
13	40.025	40.625	28.100	61.900	42.945
14	8.103	29.900	18.100	18.950	20.253
15	15.100	19.100	15.875	14.875	16.395
16	6.450	27.400	21.625	17.975	20.055
17	39.200	29.900	26.45	43.250	34.047
18	26.575	33.325	26.975	32.125	30.563
19	34.450	41.125	35.800	32.975	35.477
20	29.225	28.775	30.350	27.200	28.920
21	9.200	30.975	16.275	36.325	25,023
22	24.675	37.325	32.625	39.700	34.885
23	30.850	31.550	23.600	29.625	28.717
24	25.350	37.000	25.200	33.300	31.040
25	12.725	26.650	21.275	21.825	21.695
26	25.150	29.450	27.150	29.100	28.037
29	46.300	49.025	38.900	43.325	44.245
31	31.125	39.400	40.400	34.800	37.212
32	50.200	54.550	45.075	42.125	47.900
33	29.875	40.675	39.000	47.175	40.420
34	39.325	43.800	36.350	38.725	39.682
35	9.050	20.050	17.475	22.250	17.827
36	28.350	39.800	37.800	40.875	37.792
37	11.775	29.100	22.700	22.575	22.800
38	16.000	25.875	15.225	19.950	21742
39	29.975	45.000	34.525	41.900	38.837
40	33.900	53.200	40.375	40.150	43.175
41	30.800	33.225	29.075	29.700	30.737
42	44.550	43.500	30.975	49.950	41.688
43	40.200	32.775	23.800	41.850	34.557
44	44.475	43.275	37.925	36.575	40.120
45	26.675	33.000	32.150	32.300	31.855
48	34.250	41.175	35.675	39.925	37.398
49	25.225	39.750	36.125	50.900	39.470
50	36.250	39.250	33.050	49.800	39.809
51	14.175	10.200	8.925	14.025	11.443
52	31.125	37.900	32.575	40.050	35.640
53	45.625	52.575	39.100	52.600	47.778
54	42.450	51.500	36.950	54.050	46.898
55	27.225	37.075	35.700	42.075	36.483
56	17.075	32.975	29.725	38.175	30.488
57	24.500	33.325	45.500	50.500	40.467
58	30.500	44.500	31.950	50.050	40.645
59	40.600	42.750	37.075	38.900	39.910

Cont. Table 2

60	36.225	36.825	32.075	38.150	35.633
61	21.150	47.000	40.675	51.075	42.627
62	13.800	24.200	18.850	21.050	20.160
64	40.025	47.275	41.725	54.525	46.388
65	18.250	27.125	26.550	18.425	23.400
67	43.225	36.500	34.525	40.050	37.970
68	33.500	35.200	36.475	44.475	37.592
69	35.650	36.325	38.200	46.050	39.443
70	40.375	40.050	46.350	36.850	38.093
72	15.025	35.975	35.825	42.625	34.647
73	12.075	14.700	21.050	23.675	18.573
74	5.260	25.025	20.025	22.975	19.935
75	38.450	47.650	41.650	55.625	46.583
76	42.500	46.375	42.650	52.350	46.332
77	30.000	45.000	38.125	52.050	37.930
78	29.825	38.775	36.825	48.450	39.490
79	23.800	40.425	39.375	53.100	41.250
80	39.500	38.775	36.600	54.100	42.455
82	22.450	38.150	38.450	52.650	39.970
83	23.250	36.825	34.525	35.750	33.908
84	26.925	44.650	39.275	60.000	45.200
85	26.675	37.900	38.900	50.025	39.733
86	33.575	36.350	37.525	49.075	39.778
87	27.200	44.925	43.000	16.825	37.015
88	27.375	32.575	35.675	44.875	30.642
90	39.500	39.200	40.100	49.950	42.495
93	20.050	33.825	30.225	29.850	29.807
94	43.325	47.700	46.575	61.750	50.562
95	19.800	33.650	29.200	25.975	28.088
96	33.525	39.000	36.900	52.425	41.540
97	18.200	32.950	36.950	51.750	37.533
98	33.500	40.900	39.750	52.175	42.642
99	28.675	32.700	18.575	30.425	27.638
100	34.850	44.550	41.825	58.075	46.407
101	42.975	34.600	35.100	56.725	41.920
103	34.775	36.325	37.725	47.150	39.023
104	38.750	38.025	36.125	45.125	39.557
105	35.800	38.150	35.725	40.000	37.338
106	16.300	34.600	36.950	43.125	34.500
107	10.600	31.050	26.000	28.550	25.582
108	53.975	42.300	37.325	41.525	42.887
109	45.725	47.925	40.525	48.150	46.297
110	33.275	42.775	42.525	53.550	43.997
111	4.750	12.577	10.500	22.625	13.530
112	10.600	31.750	29.075	27.950	26.852
113	23.825	29.950	33.750	38.725	32.210
115	10.675	25.425	21.025	38.875	25.688
116	39.550	41.075	37.250	52.925	43.308
F .test	**	**	**	**	**
LSD 0.05	4.054	4.589	2.053	5.462	3.039
LSD 0.01	5.341	6.046	2.705	7.196	4.004

**** Significant at the 0.01 level of probability.**

Similar results and conclusion were reached by AL-Menoufi & Hassan, 1977; AL-Menoufi *et al*. 1985; Lanini & Kogan, 2005; Abd El-Hamid & El-Khanagry, 2006; Goldwasser *et al*., 2001). These results may indicate that both genotypes no 51 and no. 111 had the least R % for most of the cuts and seasonal yield. Genotype no. 111 is commercial cultivar, Helali. Helali cv. has high potential and high-yielding ability in comparison with other cultivars. It was bred for relatively high ability to rapid re-growth which may be associated with good tolerance to biotic and abiotic stresses. Therefore, to be less affected due to dodder infestation it could be expected in comparison with other material under evaluation. Moreover, as it was reported by (Abd El-Hamid & El-Khanagry, 2006), about 85% of farmers' fields are infested with dodder. Existing of genotype no.51 among farmers' seed lots which retains some tolerance to dodder infestation is, also, expected due to co-evolution among parasite-host relationships.

2nd season (2009/10):

The mean squares of fresh as well as dry forage yield reduction percentages at different cuts and seasonal yield in the 2nd season (2009/10) are presented (Table 3).

Table 3 : Mean squares of fresh and dry forage yields reduction percent of Egyptian clover-genotypes infested by dodder at different cuts and seasonal yield in 2nd season (2009/2010).

S.O.V.	d. f.	Mean squares of reduction of fresh forage yield (FFY R %)				
		1st Cut	2nd Cut	3rd Cu3	4th Cut	Seasonal yield
Genotypes	26	216.47**	200.41**	581.65**	650.92**	269.5**
Error	78	2.88	2.23	2.03	3.50	0.776
		Mean squares of reduction of dry forage yield (DFY R %)				
Genotypes	26	277.81**	129.88**	608.31**	720.17**	365.91**
Error	78	11.92	12.99	17.73	15.88	4.47

****: Significant at the 0.01 levels of probability.**

Highly significant differences are shown (Table 3) among evaluated genotypes at all cuts and the seasonal yield for R% due to dodder infestation of both fresh and dry forage yields in 2nd season (2009/10). The means of FFY R% as well as DFY R% of 27 genotypes at different cuts and seasonal yield in 2nd season (2009/10) are presented (Table 4). It is shown from the recorded data that genotype no.29 had the highest FFY R% (44.0%) due to dodder infestation for the seasonal yield in 2nd season (2009/10). On the other hand, genotype no.111 had the least R% (10.1%) followed by genotype no.51 where R % = 10.3 for the same trait and it is shown to retain good tolerance to dodder infestation.

It is shown from the results that genotype no.29 had the highest DFY R% (50.90%). While genotype no.111had the least R% (14.5%) and it may be considered most tolerant genotype under the dodder infestation among the tested genotypes. Likewise, genotype no.111 was followed by genotype no.51 which had R% = 14.6% of DFY. In general, the berseem genotypes under investigation manifested highly significant differences at all cuts and seasonal dry yield for R% due to dodder infestation. These results are in agreement with similar investigations by AL-Menoufi & Hassan, 1977; AL-Menoufi *et al*. 1985; Lanini & Kogan, 2005; Abd El-Hamid & El-Khanagry, 2006; Goldwasser *et al*., 2001). Similarly, the DFY R % by dodder infestation was existed. Its grand mean increased from the 1st cut to 2nd cut then decreased in the 3rd cut and start to increase again in the 4th cut starting with R % = 20.1%, 41.5%,29.8%, and 31.1%, respectively, while, R % for seasonal yield are 32.4%.

Table 4 : Means of fresh and dry forage yield of Egyptian clover-genotypes infested by dodder at different cuts and seasonal yield in 2nd season (2009/10).

Genotypes	1st Cut		2nd Cut		3rd Cu3		4th Cut		Seasonal yield	
	FFY	DFY	FFY	DFY	FFY	DFY	FFY	DFY	FFY	DFY
2	29.70	39.55	20.20	44.35	34.20	28.90	32.50	30.22	29.50	37.00
8	7.60	14.82	21.90	44.45	37.80	37.47	42.10	44.15	29.90	39.10
12	7.20	11.75	7.80	33.40	18.60	27.22	22.50	23.72	15.10	28.02
14	14.40	24.80	25.60	47.10	17.60	23.07	21.90	24.75	20.10	28.94
15	8.10	14.35	10.30	36.32	25.40	23.65	27.90	28.55	19.20	28.41
16	14.90	18.12	23.10	47.42	19.70	23.55	34.00	37.87	23.80	30.66
21	12.10	21.90	20.80	42.24	36.10	36.85	26.70	26.42	25.30	34.66
23	16.10	23.70	21.50	45.15	41.90	43.18	38.90	36.87	31.40	38.66
25	13.30	19.40	21.80	43.37	31.80	38.25	35.50	38.62	26.40	36.02
26	25.60	32.47	24.40	46.45	29.00	26.57	43.10	48.37	30.90	39.49
29	23.60	29.00	34.80	52.70	55.90	50.95	51.90	51.87	44.00	50.92
35	7.70	8.82	10.00	33.82	15.80	27.02	24.20	23.20	15.10	24.24
37	8.60	16.35	16.80	40.67	20.50	21.12	23.60	22.05	18.20	25.19
38	6.10	16.57	12.60	36.35	26.80	26.42	27.50	28.72	20.10	25.70
51	3.30	3.25	12.40	33.20	17.90	12.17	5.20	5.50	10.30	14.61
56	25.90	30.50	21.90	42.87	35.40	16.22	46.80	47.47	33.60	39.81
62	5.00	10.62	11.60	32.85	30.80	44.50	22.60	21.27	19.10	31.59
65	9.40	18.17	8.70	35.87	19.20	13.50	26.90	24.95	17.20	30.21
73	15.30	17.02	16.90	40.40	19.20	17.10	11.40	9.17	15.80	17.77
74	8.00	17.80	14.20	40.45	25.40	37.80	22.20	24.95	18.30	31.17
93	21.60	27.80	32.90	53.25	62.20	62.62	65.60	65.82	36.40	56.41
95	18.20	24.35	22.70	43.20	35.30	35.42	31.40	32.72	27.90	35.53
99	19.10	28.80	18.50	42.05	33.10	32.77	28.90	33.12	26.10	35.87
107	17.90	23.52	22.10	44.02	39.80	41.37	43.60	44.62	32.40	42.28
111	3.00	7.47	8.50	33.25	10.80	10.75	15.50	12.25	10.10	14.54
112	10.10	17.97	16.00	39.62	18.40	24.65	22.70	24.47	17.70	26.30
115	18.90	25.80	25.10	45.57	22.10	21.42	27.90	30.52	23.70	30.82
F. test	**	**	**	**	**	**	**	**	**	**
LSD 0.05	2.39	4.86	2.11	5.07	2.01	5.93	2.64	5.61	29.50	37.00
LSD 0.01	3.17	6.45	2.79	6.73	2.66	7.86	3.49	7.44	29.90	39.10

****: Significant at the 0.01 levels of probability.**

Mean squares of R % of total chlorophyll content due to dodder infestation at different cuts and their mean in 2nd season (2009/010) and 3rd season (2010/2011) are presented (Table 5). It could be shown from the results that highly significant differences existed among the evaluated genotypes at all cuts and their mean for R % of total chlorophyll content in 2nd season (2009/10) and 3rd season (2010/2011).

Table 5 : Mean squares of total chlorophyll reduction percent (R %) of Egyptian clover-genotypes infested by dodder at different cuts and their means in 2nd season (2009/10) and 3rd season (2010/2011).

S. O. V.	d. f.	1st Cut	2nd Cut	3rd Cut	4th Cut	Mean
		2nd season (2009/10)				
Replications	3	0.539	2.650	1.139	0.593	0.793
Genotypes	26	65.80**	69.56**	111.56**	82.29**	65.12**
Error	78	4.91	6.22	5.07	6.99	1.43
		3rd season (2010/2011)				
Replications	3	0.548	2.340	1.138	0.459	0.835
Genotypes	26	13.07**	15.29**	27.62**	21.88**	9.77**
Error	78	1.731	1.631	1.009	1.553	0.164

****: Significant at the 0.01 levels of probability.**

Mean of R % for total chlorophyll content of 27 genotypes at different cuts and their mean in 2nd season (2009/010) are presented (Table 6).

Table 6: Mean of total chlorophyll R % at different cuts and seasonal yield of clover in 2nd season (2009/010).

G	Cut1	Cut2	Cut3	Cut4	mean
2	12.900	12.875	14.975	14.250	
8	19.650	13.325	12.425	8.425	13.4
12	9.675	7.450	12.800	9.425	13.6
14	11.605	11.450	9.125	12.775	9.9
15	7.425	6.175	10.925	11.550	11.3
16	12.325	10.100	11.800	15.650	9.1
21	13.900	17.00	16.350	14.700	12.6
23	10.200	14.500	10.725	13.575	15.6
25	10.900	12.700	12.750	15.725	12.3
26	10375	15.00	16.550	20.125	13.1
29	15.750	18.700	29.200	25.00	15.7
35	6.550	6.875	8.750	9.575	22.3
37	6.625	8.900	8.925	10.100	7.9
38	8.200	7.750	9.775	9.500	8.7
51	6.575	8.900	8.075	10.800	8.9
56	9.200	7.275	10.275	14.100	8.6
62	6.825	8.550	10.050	9.125	10.3
65	8.650	10.875	14.625	12.950	8.7
73	8.675	7.425	10.925	11.125	11.8
74	6.375	8.650	10.125	9.875	9.6
93	19.650	22.750	25.900	20.800	8.9
95	13.875	17.175	18.575	20.350	22.1
99	19.425	13.675	15.250	16.325	17.5
107	14.800	14.600	18.950	15.625	16.1
111	9.325	7.028	6.650	5.925	16.0
112	8.700	11.575	7.450	9.825	7.2
115	8.850	13.350	13.200	7.900	9.5
F. test	**	**	**	**	11.0
L.S.D0.05	3.12	3.511	3.17	3.723	**
0.01	4.138	4.6570	4.205	4.938	

**** Significant at the 0.01 level of probability, respectively.**

Significant differences among genotypes at all cuts concerning total chlorophyll R % was observed. Genotype no. 29 had the highest R% (22.3%) of total chlorophyll by dodder infestation while genotype no.111 had the lowest R % (7.2%) and it was followed by the genotype no.35 and 51, where they had 7.9% and 8.7% of reduction for the total chlorophyll content. The obtained results for total chlorophyll R % are in agreement with those obtained by Dinelli *et al*., 1993; Parker and Riches, 1993; Soliman, 2002; and Soliman & Abd El-Hamid, 2009.

3rd Season (2010/11):

Mean squares of fresh and dry forage yield R % due to dodder infestation in 3rd season (2010/11) are presented (Table 7). Highly significant differences among evaluated genotypes at all cuts and seasonal yield for fresh as well as dry forage yield R % due to dodder infestation in 3rd season (2010/11) are detected.

Table 7 : Mean squares of fresh and dry forage yield reduction (R %) of berseem genotypes infested by dodder at different cuts and seasonal yield in 3rd season (2010/11).

S. O.V.	d. f.	Reduction of Fresh Forage Yield (R %)				
		1st Cut	2nd Cut	3rd Cut	4th Cut	Seasonal yield
Replication	3	8.373	10.611	1.824	46.285	7.710
Genotypes	13	345.61**	301.32**	294.76**	547.40**	327.47**
Error	39	3.67	6.54	4.54	8.87	1.86
		Reduction of Dry Forage Yield (R %)				
Replication	3	17.70	23.68	5.70	53.42	7.59
Genotypes	13	327.81**	332.21**	317.85**	573.62**	355.90**
Error	39	5.32	7.11	5.62	8.87	2.40

****: significant at the 0.01 levels of probability.**

Mean of FFY R % at different cuts and seasonal yield due to dodder infestation in 3rd season (2010/11) are shown (Table 8). It is shown from the results that genotype (Giza 6) had the highest R% (43.3%) of the seasonal yield. On the other hand, the lowest R% (11.1%) recorded for genotype no.1110 (parent) then followed by genotype no. 111 (progeny) where it R % = 11.3% for FFY in 3rd season (2010/11). Similarly, mean of R % for dry forage yield due to dodder infestation at different cuts and their seasonal yield in 3rd season are presented in Table (8). It could be indicated from the data that genotype no. 51 had the lowest R% (11.9%) among the 14 genotypes under evaluation then followed by genotype no.111 where its R % = 12.4%. However, the highest R % (46.5%) was obtained by genotype Giza-6. Highly significant differences of R % among evaluated genotypes at all cuts and the seasonal yield in 3rd season (2010/11) were detected.

Table 8 : Mean of fresh (F) and dry (D) forage yields reduction (FY R %) of berseem genotypes infested by dodder at different cuts and seasonal yield in 3rd season (2010/11).

Genotypes	1st Cut		2nd Cut		3rd Cu3		4th Cut		Seasonal yield	
	FFY	DFY	FFY	DFY	FFY	DFY	FFY	DFY	FFY	DFY
120	14.3	18.8	15.90	17.5	10.7	23.5	18.00	28.7	14.9	23.0
350	6.9	12.4	16.10	16.2	14.5	21.2	19.2	24.9	15.2	20.1
510	7.1	12.9	15.20	16.6	9.8	13.7	13.5	22.5	11.8	17.3
730	10.3	12.4	8.90	9.4	10.8	11.2	31.3	37.1	16.1	19.9
740	9.3	11.3	14.50	17.3	18.4	21.9	15.8	22.5	15.0	19.6
1110	6.1	5.2	9.20	11.6	12.0	12.7	13.8	25.1	11.1	15.3
12	13.4	14.7	17.10	17.9	11.4	14.6	19.0	21.2	15.5	17.7
35	6.5	10.8	16.50	17.7	14.9	15.5	19.6	18.0	15.7	16.4
51	6.6	12.5	14.10	14.7	9.7	10.5	12.8	10.9	11.9	11.9
73	10.1	13.2	10.40	12.3	11.4	9.9	29.5	29.2	16.0	17.2
74	8.8	10.6	14.80	14.2	17.4	17.1	15.0	14.8	14.5	14.8
111	5.1	10.2	11.00	10.2	11.8	11.9	14.5	15.1	11.3	12.4
Gemmiza1	23.8	27.7	29.90	32.1	31.8	33.1	38.7	42.1	32.2	35.6
Giza 6	39.5	41.3	41.10	43.3	38.1	39.9	52.9	55.7	43.3	46.5
F .test	**	**	**	**	**	**	**	**	**	**
L .S. D 0.5	2.74	3.30	3.76	3.81	3.05	3.39	4.26	4.60		2.23
L .S. D 0.1	3.67	4.42	4.90	5.11	4.08	4.54	5.71	5.71		2.97

: significant at the 0.01 levels of probability.

Mean of total chlorophyll reduction (R %) due to dodder infestation at different cuts and their mean in 3rd season (2010/11) are presented in Table (9).

Table 9: Mean of total chlorophyll reduction (R %) of berseem genotypes infested by dodder at different cuts and their means in 3rd season (2010/11).

Genotypes	1st Cut	2nd Cut	3rd Cu3	4th Cut	Mean
120 p	7.8	6.4	7.2	6.4	6.9
350 p	9.2	8.7	9.9	7.5	8.8
510 p	5.9	5.7	5.8	4.4	5.5
730 p	6.9	4.8	7.6	2.3	5.5
740 p	8.7	7.9	10.2	6.1	8.2
1110 p	4.5	8.6	2.5	4.9	5.2
12 g	7.2	12.8	5.3	7.1	8.2
35 g	8.0	6.2	6.6	7.3	7.1
51 g	7.6	6.3	8.1	3.8	6.5
73 g	8.4	7.8	9.9	5.4	8.0
74 g	4.9	7.2	6.0	5.2	5.8
111 g	4.4	6.9	1.2	6.6	4.8
Gemmiza1 c	9.4	9.3	7.4	10.6	9.1
Giza 6 c	9.9	8.1	8.1	10.7	9.4
F .test	**	**	**	**	**
L .S. D 0.5	1.882	1.827	1.437	1.282	0.579
L .S. D 0.1	2.519	2.445	1.923	2.386	0.775

: significant at the 0.01 levels of probability. P: parent, g: progeny, c: check.

Highly significant differences among all the genotypes under evaluation at all the cuts and their mean are manifested. It is clear that Giza 6 had the highest (9.4) total chlorophyll R %, while, genotype no.111 had the least (4.8) total chlorophyll R % then followed by genotype no.1110 and genotype no.510 where R %, values were 5.2 and 5.5, respectively. The obtained results are in line with the following research findings by AL-Menoufi *et al*. 1985; Lanini & Kogan, 2005; Abd El-Hamid & El-Khanagry, 2006; Goldwasser *et al*., 2001.

CONCULUSION

Even though resistance/tolerance among and within crop plants to pests, especially for parasitic weed like dodder is difficult to obtain, highly significant differences among the evaluated berseem genotypes for fresh and dry forage yield reduction percentages due to dodder infestation in all cuts and seasonal yield during the study were detected

These differences are highly supported with obtaining less reduction percentages of fresh as well as dry forage yields for the tolerant berseem genotypes due to infestation with dodder. Indictor's traits which are highly associated i.e. total chlorophyll R%, CP R%, CF R%, and ash well performed for tolerant genotypes in comparison with the sensitive ones. The obtained results may be encouraging to use the tolerant genotypes, which had the least reduction percentages due to dodder infestation, for developing compost or synthetic cultivar(s) which retain tolerance to dodder infestation. This cultivar could be used by itself as a way of control of dodder in farmers' fields or integrated with the other factors of dodder control.

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التحمل النسبى لبعض التراكيب الوراثية للبرسيم المصرى للاصابة بالحامول

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ثلاث تجارب حقلية أجريت بمزرعة محطة البحوث الزراعية بسخا – كفر الشيخ خلال ثلاث مواسم شتوية متتالية هى : ٢٠٠٩/٢٠٠٨، ٢٠١٠/٢٠٠٩ و ٢٠١١/٢٠١٠م واشتملت هذه الدراسة على ١٠٠ تركيب وراثى من البرسيم المصرى ناتجة من تراكيب وراثية مأخوذة من (٩٦ عينة من المزارعيين و ٤ أصناف تجارية) وكان الهدف من الدراسة هو تقييم التراكيب الوراثية ودراسة تحملها للاصابة بالحامول .

- أظهرت النتائج أن هناك فروق معنوية عالية بين ال ١٠٠ تركيب وراثى الخاضعة للتقييم ف نسبة الفقد فى محصول العلف الأخضر والجاف وكذلك اختلافات معنوية عالية فى التفاعل بين المجاميع والتراكيب الوراثية لجميع الحشات والحشات الكلية الموسمية.
- أظهر الصنف هلالى (تركيب وراثى رقم ١١١) قدرة عالية لتحمل الاصابة بالحامول مقارنة بالتراكيب الوراثية الأخرى وذلك لقدرة التركيب الوراثى على سرعة اعادة النمو حيث سجل اقل نسبة فقد فى المحصول الأخضر و الجاف واقل نسبة نقص فى محتوى الكلوروفيل الكلى والبروتين والألياف مقارنة بالتراكيب الوراثية الأخرى التى تم اصابتها بالحامول.

من نتائج هذا البحث يمكن استخدام الصنف هلالى ضمن حزم المكافحة التكاملة للحامول حيث أنه تحمل الاصابة بالحامول مقارنة بغيره من التراكيب الوراثية الأخرى محل الدراسة.