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Orobanche cernua control experiments with different composting methods

Mehmet AYBEKE*

Trakya University, Faculty of Science, Department of Biology, Balkan Campus, Edirne, Turkey.
*Corresponding author: mehmetaybeke@yahoo.com

Abstract: Although composting is known as a successful method for orobanche struggle, there has not been detailed research conducted about it. To fill the deficiency, purpose of this study is to determine the contribution of different composting methods in successful *Orobanche cernua* (Orobanche, broomrape) struggle. Accordingly, in flower pot tests, using phenolic compound, straw, burnt cow manure, burnt sheep manure, fermented poultry manure, olive cake (prina), legume green manure, waste tea leaf, municipal solid waste (MSW), bran, oak shavings, mycorrhiza (in monadic form or multiple mixtures with each other) at varying rates, 81 different combinations of composting tests were made the trial garden of the Botanic section in 2012-2014 seasons (between May-August). After testing, orobanche infection on sunflower roots belonging to control and experimental groups were counted directly and the data were recorded and the data were compared with statistical analyses. According to the results, it was ascertained that some composting methods with Quercetin hydrate as phenolic, straw+burnt cow manure, MSW+waste tea leaf, bran, olive cake (prina) achieved success. Furthermore, the environment-friendly, sustainable and practical features of method were emphasized. Additionally, it was specified that it could be improved to provide regular plant development in arid lands which have an intense orobanche attacks.

Keywords: Sunflower, Orobanche, Broomrape, Compost, Straw, Olive manure, Poultry manure.

Introduction

Orobanche (*Orobanche cernua*) is a compulsory parasite plant which is seen on different herbs like sunflower, vetch, clover, tomato, potato and cotton. *Orobanche* and *Phelipanche* species (broomrapes) are holoparasites, acarpellous and rootless parasite plants which do not have chlorophyll, and their development depends completely on host plants (Joel et al., 2011). Broomrapes are adversely affecting agricultural productivity in about 16 million ha (approximately 1.2% of the world's arable land). They have spread especially on rapeseed-mustards (90%), sunflowers (51%), fava beans (35%), lentils (45%), tomatoes (75%) and decreased their yield (Anonymous, 2011). Planting sunflowers on about 10,000 ha in Shaanxi, Dingbian, spreading infection to 40-50% sunflowers and decreasing yield value evenly is an instance of economic loss dimension of parasites on plants (Chen, 2010). Different struggle methods such as classical breeding, soil fumigation, herbicides, crop rotation, quarantine, biological control, trap crops, solarization, sowing dates, genetic resistance and herbicides and herbicide-resistant crop sowing (Hershenhorn et al., 2009) were developed to fight against this parasitic plant, and composting with organic manures is another struggle method (Rathore et al., 2014). However, studies about this composting method have been limited with insufficient material. To fill this absence, the aim of this study is to determine potential positive contribution of different composting methods in *O. cernua* struggle.

Materials and Methods

In this study, a flower pot-No: K15-(14.5x23x11 cm dia. x height x base, 4 liter) was used. Several components such as phenolic compounds, straw (eddish), olive cake (prina), poultry manure (fermented, commercial), burnt cow or sheep manure, chopped green manure (*O. armena*) and clover (*Medicago sativa*), tea waste leaves (waste after brewing), municipal solid waste (MSW), bran, oak sawdust and mycorrhizal composting were tested in monadic form or by multiple mixing with each other as shown in Table 1. From these materials, phenolics and MSW were obtained from the chemistry department and municipal refining foundation, respectively. Oil cake (prina) and Möycorrhizal preperates were received from commercial companies. All manures (cow and sheep) and straw were collected from the fields. Legume manure (*O. armena* and *M. sativa*) and tea waste leaves were obtained from natural areas and household waste after use, respectively. The Orobanche seeds were collected from sunflower fields of Thrace Agricultural Research Institute and identified in the laboratory as *O. cernua* Loefl., then stored in a dry form at +4°C until used. In trials, 50 mg orobanche (*O. cernua* Loefl) seeds per kg soil, more or less 5000 viable seeds capable of germinating, a total of 0.2 g of orobanche seeds used in each experiment (Aybeke et al., 2014, 2015) were blended in the same container in quantity as given in the table and were filled in the pots. In each pot, three sunflowers seeds were added. After germinating, the sunflowers were reduced to one (Aybeke et al., 2015). All tests were executed in the trial garden of the Botanic section in 2012-2014 seasons (between May-August), and the seeds were watered with tap water (enough to grow a sunflower) every three days in May-August. In the control group, composting was not implemented and only sunflower and orobanche seeds (*O. cernua* Loefl) were planted, adding at the same rate to the pots as described above. At the end of 30-35 days, after the plants were removed from flower pots, orobanche infection on sunflower roots belonging to control and experimental groups were counted directly and the data were recorded. All values were means of three replicates (±SD).

The entire data were first subjected to an analysis of variance (ANOVA), followed by Dunnett's T3 test (Sokal and Rohlf, 1995). Groups were considered significantly different from each other, with $P<0.05$ and composting techniques bearing the lowest of broomrape infection were considered as best practices.

MSW's properties: pH: 7.46, EC (dSm^{-1}): 3.36, Organic carbon (%):22. 05±0.40, Water-soluble carbon (%):0.69±0.04, CEC (cmol kg^{-1}): 83.17±0.80, Total N (%):1.48±0.12 (≥0.5), Total P as P2O5: 3.12±0.21 (≥0.5), Total K as K2O: 19.40±2.1 (≥1.0). Olive cake; [moisture (%) 56,9, pH 6.45, electrical conductivity (dSm-1) 4.12, organic substance (g Kg^{-1}) 869,9, cellulose (g Kg^{-1}) 250,9, Total organic carbon (g Kg^{-1}) 524,9, total N (g Kg^{-1}) 12,3, C/N ratio 40,2, total fat (g Kg^{-1}) 92,8, soluble phenols (g Kg^{-1}) 20,8, P (g Kg^{-1}) 1,8, K (g Kg^{-1}) 15,8, Ca (g Kg^{-1}) 2,5, Mg (g Kg^{-1}) 0,8, Na (g Kg^{-1}) 2,3, Fe (g Kg^{-1}) 86, Cu (g Kg^{-1}) 15, Mn (g Kg^{-1}) 8,9, Zn (g Kg^{-1}) 15,3]. Chicken manure (total Organic substance: %45, total N: %3, Organic N: %1, total P205: 3, max. moisture: %20, pH: 7-9 (according to the package description), EC: 5-7 mmhos/cm). Mycorrhizal inoculant; commercial products were used so that the total viable fungal content reached 27.55% when dissolved in water. Its ingredients (as %): *Glomus intraradices* (25), *G. aggregatum* (24), *G. mosseage* (24), *G. clarum* (1), *G. monosporus* (1), *G. deserticola* (1), *G. brasilianum* (1), *G. etunicatum* (1), and *Gigaspora margarita* (1).

Results

According to the results of tests using phenolic materials and coffee waste powder, the only material which was able to decrease orobanche infection was Quercetin hydrate (Table 1). Among tests with legume green manure, No: 26g; MSW(2.9 gr)+legume green manure (=*Medicaga sativa*, 5.9 gr), No: 26e; MSW (2.9 gr)+legume green manure (*O. armena*, 2.9 gr), No: 26f; MSW (5.9 gr)+legume green manure (=*O. armena*, 2.9 gr) orobanche infection decreased fairly in comparison with control group (Figs. 2-3); but experiment 26h:MSW (5.9g)+legume green manure I (=*M. sativa*, 5.9 gr), No: 25c, MSW (2.9g)+legume green manureII (=*O. armena* 5.9g), No: 25d, MSW (5.9g)+(=*O. armena*, 5.9g) did not reduce Orobanche parasitism. In trials where only MSW was used (No: 14, 15, 32, 33, 34), orobanche infection on sunflower did not decrease. Binary mixture (No: 15a-b, 16, 17, 17a) that was composed of MSW+cow manure, (No: 23; 2 gr straw+3 gr burnt cow manure), and ternary mixture (No: 26, 2 gr straw+2 gr burnt cow manure+2g oak shavings) did not have a negative influence on *O. cernua* infection. However, on straw+cow manure and similar tests, only No: 18c; straw (22 gr)+cow manure (7.3 gr) and No: 24; straw (2 gr)+cow manure (2 gr)+bran (2 gr) could considerably reduce *O. cernua* infection among mixed ones. Orobanche infection amounts were relatively low on test No: 18b straw (10 gr)+cow manure (10 gr), but the plant developed to be too weak. Among tests with oak and bran powder (No: 18, 19), only bran powder (No: 19)

Table 1. Description of composting methods and theirs data.

Test No	Application	Mean	Standard deviation	Sig******
Control	0.2g orb*+ 3 s-seeds**	64.2	1.64	-
1	0.2g orb*+ 0.03g coffee waste (dry, powder)+3 s-seeds**	49.2	0.5	0.57
2	0.2g orb*+ 0.07g coffee waste (dry, powder)+3 s-seeds**	51.2	17.4	0.14
3	0.2g orb*+ 0.13g coffee waste (dry, powder)+3 s-seeds**	63.8	3	0.62
4	0.2g orb*+ phenol (%0.2 4 Hidroksi cinnamik acid)+3 s-seeds**	62.3	3.6	0.18
5	0.2g orb*+ phenol (% 0.2 Hidrokinon)+3 s-seeds**	-	-	-
6	0.2g orb*+ phenol (% 0.2 cafeic acid)+3 s-seeds**	82	1.5	0.6
7	0.2g orb*+ phenol (% 0.2 L-Dopa)+3 s-seeds**	81	2.7	0.61
8	0.2g orb*+ phenol (% 0.2 Benzoik Asit)+3 s-seeds**	52	5.3	0.42
9	0.2g orb*+ phenol (% 0.2 R. Hidrate)+3 s-seeds**	-	-	-
10	0.2g orb*+ phenol (% 0.2 Quercetin Hidrate)+3 s-seeds**	12	1.11	**0.001** s
11	0.2g orb*+ phenol (% 0.2 Gallic acid)+3 s-seeds**	49	2.4	0.964
12	0.2g orb*+ phenol (% 0.2 catechol)+3 s-seeds**	73	2.87	0.094
33	0.2g orb*+ legume green manureI***(3.5gr)+3 s-seeds**	58	2.19	0.47
34	0.2g orb*+ MSW***** (1gr)+legume green manureI*** (3.5 gr)+3 s-seeds**	63.5	1.24	0.6
26g	0.2g orb*+ MSW (2.9g)+legume green manureI***(5.9g)+3 s-seeds**	3	0.2	**0.001** s
26h	0.2g orb*+ MSW (5.9g)+legume green manure I*** (5.9g)+3 s-seeds**	43.9	4.5	0.52
25c	0.2g orb*+ MSW (2.9g)+legume green manureII****(5.9g)+3 s-seeds**	52.8	9.8	0.62
25d	0.2g orb*+ MSW (5.9g)+legume green manureII**** (5.9g)+3 s-seeds**	70.1	10.5	0.85
26e	0.2g orb*+ MSW (2.9g)+legume green manureII**** (2.9g)+3 s-seeds**	15.6	0.08	**0.001** s
26f	0.2g orb*+ MSW (5.9g)+legume green manureII**** (2.9g)+3 s-seeds**	5. 1	0.09	**0.002** s
34	0.2g orb*+ MSW (22gr) +3 s-seeds**	41.5	4.02	0.27
32	0.2g orb*+ MSW (7.3gr)+ 3 s-seeds**	29.7	6.2	0.83
33	0.2g orb*+ MSW (15.75gr)+3 s-seeds**	52	8.7	0.14
14	0.2g orb*+ MSW (2gr)+3 s-seeds**	91	3.1	0.14
15	0.2g orb*+ MSW (5gr)+3 s-seeds**	87	2.3	0.98
15a	0.2g orb*+ MSW (3.5g)+burnt cow manure (3.5g)+3 s-seeds**	62.1	5.9	0.51
15b	0.2g orb*+ MSW (7.35g)+burnt cow manure (7.35g)+3 s-seeds**	52.7	4.6	0.42
16	0.2g orb*+ MSW (2gr)+burnt cow manure (2 gr)+3 s-seeds**	56	2.3	0.63
17	0.2g orb*+ MSW (2gr)+burnt cow manure (3 gr)+3 s-seeds**	87	3.7	0.58
17a	0.2g orb*+ straw (7g)+burnt cow manure (8.4 g)+3 s-seeds**	63.5	9.8	0.17
18b	0.2g orb*+ straw (10g)+burnt cow manure (10 g)+3 s-seeds**	35.7	2.58	0.09
18c	0.2g orb*+ straw (22g)+burnt cow manure (7.3 g)+3 s-seeds**	3	0.001	**0.001** s
23	0.2g orb*+ straw (2gr)+burnt cow manure (3 g)+3 s-seeds**	67	3.2	0.82
24	0.2g orb*+ straw (2gr)+burnt cow manure (2 g)+bran (2gr)+3 s-seeds**	10	0.84	**0.001** s
26	0.2g orb*+ straw (2gr)+burnt cow manure (2gr)+oak shavings (2g)+3 s-seeds**	51	2.9	0.96
18	0.2g orb*+ oak sawdust (3gr)+3 s-seeds**	63	4.7	0.48
19	0.2g orb*+ bran (3gr)+3 s-seeds**	0	0.8	**0.001** s
21a	0.2g orb*+ MSW (7.87g)+tea waste (2.9g)+3 s-seeds**	30.4	3.8	0.62
21b	0.2g orb*+ MSW (7.8g)+tea waste (5.9g)+3 s-seeds**	58.7	5.8	0.96
21c	0.2g orb*+ MSW (14.87g)+tea waste (2.9g)+3 s-seeds**	7	0.81	**0.001** s

Table 1. To be continued.

Test No	Application	Mean	Standard deviation	Sig******
21d	0.2g orb*+ MSW (2.9g)+tea waste (5.9g)+3 s-seeds**	58.9	9.8	0.69
22a	0.2g orb*+ MSW (2.9g)+tea waste (2.9g)+3 s-seeds**	63.7	6.7	0.52
22b	0.2g orb*+ MSW (5.9g)+tea waste (2.9g) +3 s-seeds**	52.1	8.7	0.74
22c	0.2g orb*+ MSW (2.9g)+tea waste (5.9g)+3 s-seeds**	49.5	6.3	0.41
22d	0.2g orb*+ MSW (5.9g)+tea waste (5.9g)+3 s-seeds**	62.5	8.7	0.69
28	0.2g orb*+ MSW (2g)+tea waste (2gr)+3 s-seeds**	28	2.09	0.65
29	0.2g orb*+ MSW (4gr)+tea waste (2gr)+3 s-seeds**	63	2.08	0.41
19a	0.2g orb*+ straw (7.3g)+MSW (22g)+3 s-seeds**	43.2	3.21	0.87
19b	0.2g orb*+ Straw (22g)+MSW (7.3g)+3 s-seeds**	62.8	6.8	0.44
20d	0.2g orb*+ Straw (22g)+MSW (22g)+3 s-seeds**	-	-	-
30	0.2g orb*+ straw (2gr)+MSW (2gr) +tea waste (1gr)+3 s-seeds**	42	2.21	0.69
31	0.2g orb*+ straw (2gr)+MSW (3gr)+tea waste (2gr)+3 s-seeds**	49	2.09	0.85
23a	0.2g orb*+ Straw (7.3g)+MSW (7.3g)+tea waste (2.9g)+3 s-seeds**	37.9	5.7	0.09
23b	0.2g orb*+ Straw (14.87g)+MSW (7.3g)+tea waste (8.9g)+3 s-seeds**	-	-	-
24c	0.2g orb*+ Straw (14.87g)+MSW (22g)+tea waste (2.9g)+3 s-seeds**	72.3	9.8	0.85
24d	0.2g orb*+ Straw (14.87g)+MSW (22g)+tea waste (5.9g)+3 s-seeds**	5.6	5.6	**0.001** ^{s}
24e	0.2g orb*+ Straw (14.87g)+MSW (22g)+tea waste (8.9g)+3 s-seeds**	39.7	4.1	**0.002** ^{s}
24f	0.2g orb*+ Straw (14.87g)+MSW (29g)+tea waste (5.9g)+3 s-seeds**	3	0.05	**0.001** ^{s}
24g	0.2g orb*+ Straw (14.87g)+MSW (29g)+tea waste (8.9g)+3 s-seeds**	8	0.21	**0.001** ^{s}
27a	0.2g orb*+ fermented poultry manure (2.8gr)+3 s-seeds**	52.7	6.3	0.52
39a	0.2g orb*+ fermented poultry manure (5g)+3 s-seeds**	58.4	1.48	0.87
27b	0.2g orb*+ fermented poultry manure (5.7gr)+3 s-seeds**	40.9	5.3	0.14
27c	0.2g orb*+ fermented poultry manure (8.5gr)+3 s-seeds**	52.9	6.9	0.24
39b	0.2g orb*+ fermented poultry manure (10g)+3 s-seeds**	59.2	3.5	0.47
27d	0.2g orb*+ fermented poultry manure (11.5gr)+3 s-seeds**	53.6	8.2	0.08
27e	0.2g orb*+ fermented poultry manure (14.5gr)+3 s-seeds**	52.7	6.7	0.41
39c	0.2g orb*+ fermented poultry manure (15g)+3 s-seeds**	62.1	6.5	0.65
39d	0.2g orb*+ fermented poultry manure (20g)+3 s-seeds**	82	6.4	0.97
39e	0.2g orb*+ fermented poultry manure (25g)+3 s-seeds**	-	-	-
29a	0.2g orb*+ olive cake. prina (2.8g)+3 s-seeds**	3	1.03	**0.001** ^{s}
29b	0.2g orb*+ olive cake. prina (5.7g)+3 s-seeds**	4	0.06	**0.002** ^{s}
29c	0.2g orb*+ olive cake. prina (8.5g)+3 s-seeds**	3	0.01	**0.001** ^{s}
29e	0.2g orb*+ olive cake. prina (14.5gr)+3 s-seeds**	6	1.05	**0.001** ^{s}
40c	0.2g orb*+ olive cake. prina (15g)+3 s-seeds**	3	0.01	**0.001** ^{s}
40d	0.2g orb*+ olive cake. prina (20g)+3 s-seeds**	58.1	1.2	0.52
40e	0.2g orb*+ olive cake. prina (25g)+3 s-seeds**	56.7	5.6	0.4
31b	0.2g orb*+ mycorrhiza (0.5gr)+3 s-seeds**	51.5	9.7	0.71
41a	0.2g orb*+ mycorrhiza (0.05 gr)+3 s-seeds**	51.9	2.6	0.14
42a	0.2g orb*+ burnt sheep manure (5gr)+3 s-seeds**	61.8	3.2	0.35
42b	0.2g orb*+ burnt sheep manure (10gr)+3 s-seeds**	71.3	3.6	0.51

decreased rate of *O. cernua* in sunflower (Fig. 4).

In tests with MSW+tea waste leaf (No: 21a-d, 22a-d and No: 28-29), only the test No: 21c (14.87g+2.9g tea waste) could reduce orobanche infection. Binary mixture that was composed of straw+MSW (No: 19a, 19b, 20d) did not have an influence on reducing orobanche rate. However, among the tests with straw+MSW+tea waste (No: 30, 31, 23a, 23b, 24c, 24d, 24e, 24f, 24g), the ones

Figure 1-4. (1) A view of the test plot, (2) sunflowers removed from pots at the end of test, (3) close view of plants' roots in figure 2 and (4) roots of plants which were exposed to orobanche infection on another pot test; In figures 2, 3, 4 black arrows show intensity of orobanche infection in the control group, and the white arrows show roots of plants that composting was implemented on. They have little or no orobanche infection.

which could reduce the rate of orobanche were No: 24d, 24e, 24f, 24g. Regarding poultry manure (No: 27a-e, 39a-e), no reducing effect on orobanche rate was observed. With olive cake (prina; No: 29a-c and e, 40c-e) the ones that could reduce orobanche infection were No: 29a, 29b, 29c, 29e and 40c. Test with Mycorrhizal (No: 31b, 41a, 42a-b) and sheep manure (No: 42a-b) had no effect (positive/negative) on orobanche. In tests No: 5, 9, 20d, 23b and 39e, the sunflowers did not germinate.

Discussion

The aim of this study is to detect convenient composting methods which can be used in orobanche struggle. In the course of events, more or less negative effects of 81 different compost techniques including the control group, against sunflower orobanche infection were investigated in detail as given below.

The tests with phenolic substance Quercetin hydrate degraded more orobanche infection than others. Phenolic substances are secondary metabolites created against all kinds of biotic and abiotic stress (such as pathogen attack, wounding, radiation, high amounts of temperature change) by plants (Abu El-Soud et al., 2013; Al-Wakeel et al., 2013). Under these stressful conditions, the plants store different self-defense substances like simple phenylpropanoids, coumarins, benzoic acid derivatives, lignin and its precursors, flavonoids and tannins inside their organs (Wilfred and Nicholson, 2006) because phenolic compounds have roles as free radical scavengers and inhibitors of alterations in membrane structure and lipid peroxidation (Arora et al., 2000; Michalak, 2006; Verstraeten et al., 2003). Furthermore, phenolic compounds can be used for grass and pesticide management in a nature-friendly way (Zeng et al., 2008). For instance, it was determined that coumarin and allied phenols on the plants enhanced chlorogenic, ferulic and salicylic acid activities to accelerate defense reactions in phytopathogen attacks (Al-Wakeel et al., 2013). In a similar pot test, it was identified that quantity of *Orobanche cumana* on host plant was reduced with implementation of 60-ppm benzo (1,2,3) thiadiazole-7-carbothioic acid S-methyl ester (Sauerborn et al., 2002). Another study about sunflowers confirmed that some coumarins inhibited orobanche germination and development of haustorium (Serghini et al., 2001). Finally, thanks to acquired data, it was rigorously understood that every phenolic compound does not have an active role in phytopathogen stress and Quercetin hydrate has a decreasing effect on orobanche infection metabolism. From our point of view, quercetin hydrate increased the defense of host plant against parasites or affected the germinating metabolism of broomrape negatively. This way, orobanche infection rate considerably decreased. To confirm these new hypotheses, supplementary studies are required.

From binary compost tests with MSW and green manure (*M. sativa* and *O. armena*), it was determined that orobanche infection rate was relatively low at some composting doses, but high dose composting created adverse effects (No: 26h, 25d). Fundamentally, it was estimated that the decrease in infection rate is dependent on providing proper doses of N and P to sunflower. Because broomrapes are more active in arid lands, with nitrogen fertilization of more than 120 kh/ha, the broomrape infection is inhibited (Westwood and Foy, 1999; Yoneyama et al., 2001). It was estimated that reasons of reducing of parasite rate were probably lack of chemicals secreted from sunflowers' roots, which stimulate orobanche seed germination, degenerations related to nitrogen amounts in broomrape seeds/seedlings, or metabolic damages indexed to osmotic pressure between parasite and host plant (Abu-Irmaileh, 2008). Additionally, it was also speculated that using green manure including high doses of N in sunflower causes stress for plants and therefore increases sensitivity against orobanche. As in similar tests with apples where high doses of nitrogen affect fruit formation, fruit's high quality and balanced growth and yield of tree, it causes delays in fruit ripening, early fruit dropping and serious problems about transportation and storage (Kaçar and Katkat, 1999; Şeker et al., 2009). It was understood that the necessary dose for orobanche infection was 22 gr straw and 7.3g cow manure (No: 18c) in the mixture with straw and cow manure. It was observed that high or low amounts beyond No: 18c, did not reduce the orobanche infection rate and weakened the plant. Using bran in mixing with low dose straw-cow manure makes the manure meddle with soil more, very likely increasing the microbial activation because of its high carbohydrate content, and in the author's opinion, causing corruption of orobanche seeds. Thus, when the orobanche rate was reduced, the plant weakened in the test No:18b. Likewise, alternative studies specified that fertilization should be implemented depending upon requisitions of plants, features of soil and targeted outputs (Yolcu et al., 2010).

In tests where the only substance was MSW, there were no significant results about orobanche infection. MSW is a quite effective organic waste for quality of product and soil with its high organic substance, macronutrients and essential/trace element capacity (Papafilippaki et al., 2015) While it can sometimes be effective when used by itself, the rise in enzymatic, physicochemical and microbial activities of soil increases considerably when it is used with other organic wastes (Awasthi et al., 2015). In our studies, with this kind of co-composting implementations, high levels of orobanche biocontrol were achieved. For instance, in tests with MSW+Tea waste and trio compost implementations with straw+MSW+tea waste, notable success was achieved. A similar study indicated that using MSW and waste tea fairly enhanced physico-chemical and biological features of soil depending on the N, P, K macronutrient dose (Özdemir et al., 2009). The combination of straw and other various organic wastes had good results in alternative studies. For example, it was determined that the mulching method which consists of straw and other varied organic additives enhanced the soil quality, protected the plant against salinity and increased productivity (Chakraborty et al., 2010; Peng et al., 2016; Zhao et al., 2016).

Among the tests with oak and bran powder, especially when bran test was implemented by itself or with other waste components, a certain success was reached. In the author's opinion, bran could spread in soil more than oak shavings implementations because of having finer granular features, and accordingly could increase the disintegration and microbial activity. A similar study stated that implementations with woodchips showed more repressive effects on pre-emerging orobanches but they affected potato yield negatively (Haidar and Sidahmet, 2003). According to the author's opinion, executing compost implementation with bran before planting is more appropriate to prevent this negative outcome.

Based on tests with fermented poultry manure, there was no orobanche repressing effect at the highest dose (Table 1) application (No: 39e), where the sunflower did not even germinate. However, previous studies specified that poultry manure -by itself or with varied doses of elemental sulfur additives- substantially degraded the orobanche infection on eggplant and potato (Haidar and Sidahmed, 2006). It is estimated that the dissimilarities emerging from studies are probably related to fermentation features, N and P rates and alkalinity of manure. Because of low rate of N and alkali pH (7-9) are some of the sufficient conditions for orobanche germination (Haidar and Sidahmet, 2006).

In almost all tests with olive cake and prina, orobanche infection decreased fairly. A similar study showed that using olive cake did not affect yield value negatively on fava beans, peas and tomato, while substantially decreasing orobanche infection rates (Ghosheh et al., 1999, 2006).

None of the tests with mycorrhizal and sheep manure had an impact on decreasing orobanche infection. Similar studies emphasized that sheep manure was effective on pre-emerging-state orobanches but did not cause loss of weight on growing orobanche stems (Haidar and Sidahmet, 2003). Differences in results probably originated from the doses used and application site. While 10-20t/ha sheep manure was directly applied to fields, tests were implemented in pots in our studies. Additionally, rates used in our studies had to be approximately one 60th of those in the mentioned study and the higher dose pot application stopped plant development (no data given).

While mycorrhizal inoculation was highly protective for plants against abiotic stress (Çekiç et al., 2012), it did not prevent orobanche attack. These experiments indicated that mycorrhiza has no blocking function as a buffer between plant root and orobanche haustoriums. From our standpoint, success could be achieved with ectomycorrhizal tests, as endomycorrhizal fungi were used in the study.

Another remarkable result was that in the tests No: 5, 9, 20d, 23b and 39e, sunflowers did not germinate. It was speculated that doses of the substances (phenolic compounds) or manures used could have adversely affected these. In some studies, it was proven that various phenols had negative effects on seed germination (Rasmussen and Einhelling, 1977; Bhattacharyya et al., 1999). Otherwise, manure dose used in this study and its negative effects on orobanche generally coincided with other works (Haidar and Sidahmed, 2003, 2006; Ghosheh et al., 2006).

Generally, orobanche infection is seen more on arid lands. Wealthy organic and mineral content of soil considerably decreases infection rate and viability of orobanche seeds. For instance, organic additives that include too much N reduce orobanche parasitism. Therefore, not only soil quality increases but also orobanche risk is minimized as far as possible (Cooke, 2002; FAO, 2008). Another sample study confirmed that compost and heat factors on *Phelipanche aegyptiaca* seeds (a holoparasite taxon close to orobanche, Egyptian broomrape) substantially decreased seed viability, and farmers in Israel have been maintaining farm and organic manure composting methods traditionally on orobanche infection soil in a similar way (Yaacoby et al., 2015). Moreover, '*U.S. Environmental Protection Agency*' and the '*Canadian Environmental Quality Guidelines*' stated that temperatures >55°C for 15 days decreased the vitality of pathogens weed seeds in compost conditions (Larney and Olsen, 2006). Consequently, this alternative struggle method which is accepted as practical, sustainable and completely based on elimination of organic wastes and not causing natural diseases, has been gradually gaining importance in recent years (Haidar and Sidahmet, 2006). Especially the tests with phenolic compounds, straw+MSW+tea waste and bran combinations are new scientific contributions to recently mentioned studies. During some tests, it was also observed that sunflowers did not germinate or remained weak. However, with the help of such composting applications, plant growth may be regular and orobanche parasitism may be decreased to minimum level at the same time. Similar studies have been implemented in various stress conditions successfully. For example,, under natural salt stress conditions, the best composting mixture was straw (100 kg/decare)+MSW (75 g/2.5 m^2) in rice cultivation for protecting it from salt stress (Aybeke, 2016). Therefore, future efforts must improve these compost techniques in accordance with proper plant feeding methods for developments of sunflower or other orobanche parasitic host plants on especially arid lands. Present data form a basis for future studies.

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