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Infection Severity of Semi Parasite Species on Hosts in East Mediterranean Region of Turkey

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Abstract: *The semi parasitic plants causes the most serious and economically important diseases of forest trees in Turkey. So infection severity of mistletoe species were calculated according to hosts in Eastern Mediterranean Region. This study was carried out to determine the hosts and severity infection of Viscum, Arceuthobium and Loranthus species which cause problems on the forest and fruit trees. According to these surveys, the ratio of infection severity of Viscum album subsp. abietis was determined moderate to severe (9.73%) on Abies cilicica subsp cilicica, while it was found less severe (2.40%) on Cedrus libanii. Similarly, V. album subsp. austriacum was found moderate to severe (15.25%) on Pinus nigra subsp. pallasiana. Another semi parasite plant, the ratio of infection severity of Arceuthobium oxycedri on the host were determined moderate to severe (10.82%) for Juniperus oxycedrus subsp. oxycedrus. Besides it was less severe (8.57%) for Juniperus excelsa and (7.78%) for Juniperus drupacea. Also infection severity of Loranthus europaeus was found less severe (8.69%) on Quercus cerris and (7.97%) on Quercus infectoria. The mistletoe species are caused swelling branches and drying on shoot tips of hosts in Kahramanmaras region*

Keywords: *Semi parasites, mistletoe species, host, pine, oaks and severity infection*

I. Introduction

Conifer trees and fruit production have an important agro forestry activities in Turkey. Many external factors affect yield and quality of the production of timber and one of the important components of these semi parasite plants. The term mistletoe was first used as Viscum album in the seventeenth and eighteenth centuries when new species were described all over the world of Viscum species of Loranthaceae. It has 3 subspecies belonging to the species of *Viscum album* in Turkey. These subspecies are *Viscum album* ssp. *album*, *Viscum album* ssp. *abietis* and *Viscum album* ssp. *austriacum* (Miller1982).Three widely distributed subspecies of *V. album* that differ in host specificity have been recognized as *V. album* subsp. *album* on dicotyledonous trees, *V. album* subsp. *abietis* on *Abies* spp., *V. album* subsp. *austriacum* on *Pinus* spp. and rarely *Larix* spp. and *Picea* spp. in Europe (Ball 1993). Since the mistletoe species have chlorophyll, it can make photosynthesis. However it does not has a root system like the other plants. Haustorium of the mistletoe penetrates to xylem of host and so it can be nourished. The mistletoe have flowers and seeds.The external surfaces of their seeds are sticky,so they can easily stick on tree branches and they are capable of germinate over on hosts (Hawksworth and Scharpf 1986., Hawskworth and Wiens 1996). Viscum species weaken host's development basically by feeding xylem with water and solved materials in water and also by plugging haustorium's feeding canals (Calder and Bernhardt 1983., Wahid *et al.* 2015). *Arceuthobium oxycedri* is wide spread in Turkey and it usually found on *J. oxycedrus* and *J. drupacea* trees in Turkey (Miller 1982), Hawksworth and Wiens 1996). The mistletoe infestation and tree mortality and concluded that mistletoe is the most important biotic factor of tree decline and mortality (Tsopelas *et al.* 2004). Mistletoe infestation is also high on *Pinus sylvestris* in Switzerland (Dobbertin *et al.* 2005, Dobbertin and Rigling 2006., Rigling *et al.* 2010). *Viscum album* L. was infected 22.5% rate of deciduous trees (Baltazar *et al.* 2013). Differences in defoliation among infestation classes were always significant in Greece (Raftoyannis *et al.* 2015). According to these surveys, the ratio of existence of Arceuthobium oxycedri on the host were determined as high dense and it was 16.990 number/host for *Juniperus oxycedrus* subsp. *oxycedrus*, 15.331 for *Juniperus excelsa* and 14.388 for *Juniperus drupacea*. Also *Loranthus europaeus* was found dense 3.327 on *Quercus cerris* and 2.741 on *Q. infectoria*. Another semi-parasite plant, *Viscum album* subsp. *abietis* was determined as dense 9.922 number/host on *Abies cilicica* subsp *cilicica*, while it was mid dense 0.449 on Cedrus libanii. Besdies, V. album subsp. austriacum was found as high dense 14.535 on *Pinus nigra* subsp. *pallasiana*. Whereas, *Viscum album* ssp. *album* was not found on any host in Kahramanmaras region of Turkey (Ustuner, 2016).

This research with infection severity of mistletoe species will be determined on the forest trees. No research has been carried out in Kahramanmaras region as regards this topic so far.

II. Materials and Methods

The mistletoe species were obtained from the fruit and forest trees in Kahramanmaras region of Turkey

This work was supported by The regional directorate of forestry of Kahramanmaras in 2012-2015. The study was carried out in the forest district and it is located between 480 and 1800 m above the sea level. Kahramanmaras region is located in the in Mediterranean Region that is situated between 27°11' and 38° 36' north latitude with 36° 15' and 37° 42' east longitude.

Surveys were applied in Kahramanmaras subregion (Center, Afsin, Andırın, Caglayancerit, Ekinozu, Elbistan, Göksun, Nurhak, Pazarcık and Türkoglu). This study was carried out by taking random samples from10% of total area. They have been given forest area in Table 1. Branch was dried and swelled by mistletoe on the hosts was counted with the help of field glass.

Table (1): Area of forest trees according to subregions of Kahramanmaras (Anonymous 2012)

Sub-region	Forest trees (hosts)	Area (ha)
Center	Syrian junıper (*Juniperus drupacea* Labill.)	8559
	Crimean juniper (*Juniperus excelsa* Bieb.)	3132
	Small fruited pine (*J. oxycedrus* L. subsp. *oxycedrus*)	3284
	Taurus fir *(Abies cilicica subsp cilicica* Carr)	3521
	Taurus cedar (*Cedrus libanii*)	9852
	Crimean pine [*Pinus nigra* Subsp. *pallasiana* Holmboe.]	14375
	Turkey oak (*Quercus cerris*)	2854
	Aleppo oak (*Quercus infectoria*)	1895
Afsin	Syrian junıper (*Juniperus drupacea* Labill.)	2795
	Crimean juniper (*Juniperus excelsa* Bieb.)	2550
	Small fruited pine (*J. oxycedrus* L. subsp. *oxycedrus*)	3400
	Taurus fir *(Abies cilicica subsp cilicica* Carr)	435
	Taurus cedar (*Cedrus libanii*)	87
	Crimean pine [*Pinus nigra* Subsp. *pallasiana* Holmboe.]	2551
	Turkey oak (*Quercus cerris*)	4500
	Aleppo oak (*Quercus infectoria*)	3050
Andırın	Syrian junıper (*Juniperus drupacea* Labill.)	1045
	Crimean juniper (*Juniperus excelsa* Bieb.)	1400
	Small fruited pine (*J. oxycedrus* L. subsp. *oxycedrus*)	1100
	Taurus fir *(Abies cilicica subsp cilicica* Carr)	2161
	Taurus cedar (*Cedrus libanii*)	992
	Crimean pine [*Pinus nigra* Subsp. *pallasiana* Holmboe.]	8396
	Turkey oak (*Quercus cerris*)	4000
	Aleppo oak (*Quercus infectoria*)	2224
Caglayancerit	Syrian junıper (*Juniperus drupacea* Labill.)	1286
	Crimean juniper (*Juniperus excelsa* Bieb.)	1570
	Small fruited pine (*J. oxycedrus* L. subsp. *oxycedrus*)	1230
	Taurus fir *(Abies cilicica subsp cilicica* Carr)	0
	Taurus cedar (*Cedrus libanii*)	3697
	Crimean pine [*Pinus nigra* Subsp. *pallasiana* Holmboe.]	10
	Turkey oak (*Quercus cerris*)	1350
	Aleppo oak (*Quercus infectoria*)	1210
Ekinozu	Syrian junıper (*Juniperus drupacea* Labill.)	1100
	Crimean juniper (*Juniperus excelsa* Bieb.)	3158
	Small fruited pine (*J. oxycedrus* L. subsp. *oxycedrus*)	2256
	Taurus fir *(Abies cilicica subsp cilicica* Carr)	0
	Taurus cedar (*Cedrus libanii*)	1365
	Crimean pine [*Pinus nigra* Subsp. *pallasiana* Holmboe.]	3886
	Turkey oak (*Quercus cerris*)	198
	Aleppo oak (*Quercus infectoria*)	100.3
Elbistan	Syrian junıper (*Juniperus drupacea* Labill.)	100
	Crimean juniper (*Juniperus excelsa* Bieb.)	110
	Small fruited pine (*J. oxycedrus* L. subsp. *oxycedrus*)	140
	Taurus fir *(Abies cilicica subsp cilicica* Carr)	0
	Taurus cedar (*Cedrus libanii*)	0
	Crimean pine [*Pinus nigra* Subsp. *pallasiana* Holmboe.]	0
	Turkey oak (*Quercus cerris*)	158
	Aleppo oak (*Quercus infectoria*)	120
Göksun	Syrian junıper (*Juniperus drupacea* Labill.)	2500
	Crimean juniper (*Juniperus excelsa* Bieb.)	5520
	Small fruited pine (*J. oxycedrus* L. subsp. *oxycedrus*)	2700
	Taurus fir *(Abies cilicica subsp cilicica* Carr)	2158
	Taurus cedar (*Cedrus libanii*)	2379
	Crimean pine [*Pinus nigra* Subsp. *pallasiana* Holmboe.]	3353
	Turkey oak (*Quercus cerris*)	450
	Aleppo oak (*Quercus infectoria*)	279
Nurhak	Syrian junıper (*Juniperus drupacea* Labill.)	8112
	Crimean juniper (*Juniperus excelsa* Bieb.)	4321

	Small fruited pine (*J. oxycedrus* L. subsp. *oxycedrus*)	3832
	Taurus fir *(Abies cilicica subsp cilicica* Carr)	0
	Taurus cedar (*Cedrus libanii*)	0
	Crimean pine [*Pinus nigra* Subsp. *pallasiana* Holmboe.]	0
	Turkey oak (*Quercus cerris*)	5229
	Aleppo oak (*Quercus infectoria*)	2000
Pazarcık	Syrian junıper (*Juniperus drupacea* Labill.)	12
	Crimean juniper (*Juniperus excelsa* Bieb.)	10
	Small fruited pine (*J. oxycedrus* L. subsp. *oxycedrus*)	15
	Taurus fir *(Abies cilicica subsp cilicica* Carr)	0
	Taurus cedar (*Cedrus libanii*)	882
	Crimean pine [*Pinus nigra* Subsp. *pallasiana* Holmboe.]	10
	Turkey oak (*Quercus cerris*)	950
	Aleppo oak (*Quercus infectoria*)	828
Türkoglu	Syrian junıper (*Juniperus drupacea* Labill.)	0
	Crimean juniper (*Juniperus excelsa* Bieb.)	0
	Small fruited pine (*Juniperus oxycedrus* L. subsp. *oxycedrus*)	0
	Taurus fir *(Abies cilicica subsp cilicica* Carr)	85
	Taurus cedar (*Cedrus libanii*)	0
	Crimean pine [*Pinus nigra* Subsp. *pallasiana* Holmboe.]	735
	Turkey oak (*Quercus cerris*)	6000
	Aleppo oak (*Quercus infectoria*)	4052

Special coverage was calculated with formula proposed by Odum (1971),
where SC= Total % coverage of each species/ measuring the count of each species found……(1)
Infection severity of the semi parasites was calculated with formula proposed by Üstüner and Kitiş (2015) with the following equations;
Infection severity (%) = (a*Co) + (b*Dried Branches Rate) + (c*T.A) + (d*S.R.)……(2)
where Co= Coverage, a=1. Coefficient value, D.B.R.= Dried branches rate, b=2. Coefficient value, TA=Tree age., c= 3. Coefficient value, Swelling rate= S.R. d= 4. Coefficient value. The presentation of the scale of infection severity was given in Table 2 and 3.

Table (2): Scale of infection severity of mistletoe species on hosts

Scale value	Infection rate	Scale of infection
1	0-10	Less severe
2	10-40	Moderate to severe
3	40-70	Severe
4	70-100	Very severe

Table (3): Rate of infection severity of semi parasites on hosts

Mistletoe Coverage (%)	**Scale value**	**a**	**Dried branches rate (%)**	**Scale value**	**b**	**Tree age**	**Scale value**	**c**	**Swelling rate (%)**	**Scale value**	**d**
0-20	1	0.8	0-20	1	0.6	<4	1	0.2	0-20	1	0.4
21-40	2	0.8	21-40	2	0.6	4-6	2	0.2	21-40	2	0.4
41-60	3	0.8	41-60	3	0.6	7-9	3	0.2	41-60	3	0.4
61-80	4	0.8	61-80	4	0.6	10-15	4	0.2	61-80	4	0.4
81-100	5	0.8	81-100	5	0.6	>15	5	0.2	81-100	5	0.4

III. Results and Discussion

The mistletoes cause the most serious and economically important diseases of conifers in Turkey. So infection severity of Viscum, Arceuthobium and Loranthus species were calculated according to hosts in Kahramanmaras subregions. Infection severity of *Viscum album* subsp. *abietis* was determined moderate to severe (9.73%) on *Abies cilicica* subsp *cilicica*, while it was found less severe 2.40% on *Cedrus libanii*. However, *V. album* subsp. *austriacum* was found moderate to severe15.25% on *Pinus nigra* subsp. *pallasiana*. Whereas, *Viscum album* ssp. *a lbum* was not found on any host in the region. Arceuthobium and Viscum species were not seen on any fruit and landscape trees in Kahramanmaras subregions. Infection severity of *Arceuthobium oxycedri* was determined moderate to severe and it was (10.82%) for *Juniperus oxycedrus* subsp. *oxycedrus*. At the same time it was calculated less severe as (8.57%) for *Juniperus excelsa* and (7.78%) for *Juniperus drupacea* in Kahramanmaras region. Also, infection severity of *L. europaeus* was found less severe (8.69%) on *Q. cerris* and (7.97%) on *Q. infectoria*. The mistletoe species are being caused swelling branches and drying on shoot tips of hosts in Kahramanmaras region. The infection severity of Viscum, Arceuthobium and Loranthus species were determined respect to Kahramanmaras subregions as follows;

3.1. Center Subregion

In this subregion, infection severity of *V. album* ssp. *abietis* was found less severe 9.26% on *A. cilicica* subsp. *cilicica* but it was not seen on *C. libanii* (Table 4). Infection severity of *V. album* ssp. *austriacum* was found moderate to severe11.74% on *P. nigra* subsp. *pallasiana*. *A. oxycedri* was found less severe (7.86%) on *J. oxycedrus* subsp. *oxycedrus*, (4.60%) on *J. excelsa* and (4.12%) on *J. drupacea*. But *L. europaeus* was not seen on hosts.

Table (4): Rate of infection severity of mistletoe species on hosts

Semi Parasites	*Viscum album* ssp. *abietis*				
Hosts	Coverage	Dried branches Rate	Tree age	Swelling rate	Infection severity (%)
A. cilicica subsp.*cilicica*	2.85	1.93	28	0.56	9.26
Cedrus libanii	-	-	-	-	-
	Viscum album ssp. *austriacum*				
P. n. subsp. *pallasiana*	4.59	2.34	30	0.83	11.74
	Arceuthobium oxycedri				
*J. o.*subsp.*oxycedrus*	2.83	3.20	17	0.35	7.86
J. excelsa	1.76	-	16	-	4.60
J. drupacea	1.65	-	14	-	4.12

3.2.Afsin subregion

In Afsın subregion, the ratio of infection severity of *V. album* ssp. *abietis* was found less severe (9.43%) on *A. cilicica* subsp. *cilicica* however it was not any seen on *C. libanii.* Infection severity of *V. album* ssp. *austriacum* was found moderate to severe (16.93%) on *P. nigra* subsp. *pallasiana* (Table 5). *A. oxycedri* was found moderate to severe (12.02%) on *J. oxycedrus* subsp. *oxycedrus* while it was calculated less severe *J. excelsa* and *J. drupacea*. The ratio of infection severity were 9.61% and 9.56%, respectively. Also infection severity of *L. europaeus* was calculated less severe (9.50%) on *Q. cerris* and (8.77%) on *Q. infectoria.*

Table (5): Rate of infection severity of mistletoe species on hosts

Semi Parasites	***Viscum album* ssp. *abietis***				
Hosts	**Coverage**	**Dried branches rate**	**Tree age**	**Swelling rate**	**Infection severity (%)**
A. cilicica subsp.*cilicica*	3.20	2.63	25	0.74	9.43
Cedrus libanii	-	-	-	-	-
	Viscum album ssp. *austriacum*				
P. n. subsp. *pallasiana*	9.72	5.65	28	0.43	16.93
	Arceuthobium oxycedri				
*J. o.*subsp.*oxycedrus*	7.64	2.18	23	-	12.02
J. excelsa	6.52	-	22	-	9.61
J. drupacea	5.45	-	26	-	9.56
	Loranthus europaeus				
Quercus cerris	4.13	3.42	19	0.86	9.50
Quercus infectoria	3.75	3.10	18	0.79	8.77

3.3. And □r □nSubregion

In Andırın's forest, the ratio of infection severity of *V. album* ssp. *abietis* was found severe (44.16%) on *A. cilicica* subsp. *cilicica* while it was found less severe (8.39%) on *C. libanii.* Infection severity of *V. album* ssp. *austriacum* was found severe (40.06%) on *P. nigra* subsp. *pallasiana. A. oxycedri* was found moderate to severe on *J. oxycedrus* subsp. *oxycedrus*, *J. excelsa* and *J. drupacea* and the ratio of infection severity 24.04%, 17.41% and 14.66 % respectively (Table 6). Besides infection severity of *L. europaeus* was calculated moderate to severe (10.76%) on *Q. cerris* and (10.12%) on *Q. infectoria.*

Table (6): The ratio of infection severity of mistletoe species on hosts

Semi Parasites	*Viscum album* ssp. *abietis*				
Hosts	Coverage	Dried branches rate	Tree age	Swelling rate	Infection severity (%)
A. cilicica subsp.*cilicica*	25.79	20.92	30	12.45	44.16
Cedrus libanii	1.68	0.42	34	-	8.39
	Viscum album ssp. *austriacum*				
P. n. subsp. *pallasiana*	22.96	19.58	29	10.36	40.06
	Arceuthobium oxycedri				
*J. o.*subsp.*oxycedrus*	12.84	13.80	22	2.74	24.04
J. excelsa	10.73	5.62	27	0.15	17.41
J. drupacea	9.25	1.1	33	-	14.66
	Loranthus europaeus				
Quercus cerris	4.10	4.65	21	1.23	10.76
Quercus infectoria	3.95	4.10	20	1.37	10.12

3.4. Caglayancerit subregion

In this subregion, Disease of *V. album* ssp. *abietis* was not seen on hosts. Infection severity of *V. album* ssp. *austriacum* was found moderate to severe on *P. nigra* subsp. *pallasiana, A. oxycedri* was found moderate to severe on *J. oxycedrus* subsp. *oxycedrus*, *J. excelsa* and *J. drupacea* (Table 7). The ratio of infection severity 19.44%,13.74%, 11.60% and 11.38% respectively. At the same time, infection severity of *L. europaeus* was found moderate to severe (11.98%) on *Q. cerris* and (10.53%) on *Q. infectoria.*

Table (7): Infection severity of mistletoe species on hosts

Semi Parasites	*Viscum album* ssp. *abietis*				
Hosts	Coverage	Dried branches rate	Tree age	Swelling rate	Infection severity (%)
A. cilicica subsp.*cilicica*	-	-	-	-	-
Cedrus libanii	-	-	-	-	-
	Viscum album ssp. *austriacum*				
P. n. subsp. *pallasiana*	9.83	6.14	30	4.75	19.44
	Arceuthobium oxycedri				
*J. o.*subsp.*oxycedrus*	8.50	2.45	26	0.68	13.74
J. excelsa	7.75	-	27	-	11.60
J. drupacea	6.90	0.10	29	-	11.38
	Loranthus europaeus				
Quercus cerris	4.53	5.86	20	2.14	11.98
Quercus infectoria	4.32	3.82	19	2.48	10.53

3.5. Ekinozu subregion

In Ekinozu's forest area, the ratio of infection severity of *V. album* ssp. *abietis* was found less severe (5.6%) on *C. libanii*. But infection severity of *V. album* ssp. *austriacum*, *A. oxycedri* and *L. europaeus* was found moderate to severe on hosts respectively (Table 8). The ratio of infection severity 20.29% for *P. nigra* subsp. *pallasiana*,14.95% for *J. oxycedrus* subsp. *oxycedrus*, 12.35% for *J. excelsa,* 11.75% for *J. drupacea*, 17.50% for *Q. cerris* and 17.06% for *Q. infectoria.*

Table (8): Infection severity of mistletoe species on hosts

Semi Parasites	*Viscum album* ssp. *abietis*				
Hosts	Coverage	Dried branches rate	Tree age	Swelling rate	Infection severity (%)
A. cilicica subsp.*cilicica*	-	-	-	-	-
Cedrus libanii	1.01	-	24	-	5.60
	Viscum album ssp. *austriacum*				
P. n. subsp. *pallasiana*	9.90	6.71	32	4.86	20.29
	Arceuthobium oxycedri				
*J. o.*subsp.*oxycedrus*	9.50	3.45	25	0.72	14.95
J. excelsa	8.94	-	26	-	12.35
J. drupacea	7.10	0.12	30	-	11.75
	Loranthus europaeus				
Quercus cerris	7.83	8.35	22	4.69	17.50
Quercus infectoria	7.14	8.20	23	4.58	17.06

3.6. Elbistan subregion

In this subregion, Disease of *V. album* ssp. *abietis* and *V. album* ssp. *austriacum* were not found on hosts (Table 9). In addition, *A. oxycedri* was found less severe on *J. excelsa, J. oxycedrus* subsp. *oxycedrus* and *J. drupacea*, the ratio of infection severity 5.76%, 5.37% and 4.83% respectively. Also infection severity of *L. europaeus* was found moderate to severe 10.45%) on *Q. cerris* and 10.30% on *Q. infectoria.*

Table (9): Infection severity of mistletoe species on hosts

Semi Parasites	*Viscum album* ssp. *abietis*				
Hosts	Coverage	Dried branches rate	Tree age	Swelling rate	Infection severity (%)
A. cilicica subsp.*cilicica*	-	-	-	-	-
Cedrus libanii	-	-	-	-	-
	Viscum album ssp. *austriacum*				
P. n. subsp. *pallasiana*	-	-	--	-	-
	Arceuthobium oxycedri				
*J. o.*subsp.*oxycedrus*	0.72	-	24	-	5.37
J. excelsa	0.96	-	25	-	5.76
J. drupacea	0.54	-	22	-	4.83
	Loranthus europaeus				
Quercus cerris	4.16	4.73	19	1.25	10.45
Quercus infectoria	4.00	4.31	20	1.32	10.30

3.7. Göksun Subregion

In Göksun's forest area, the ratio of infection severity of *V. album* ssp. *abietis, V. album* ssp. *austriacum, A. oxycedri* and *L. europaeus* was found moderate to severe on hosts respectively (Table 10). 34.51% for *A. cilicica* subsp.*cilicica,* 10.06% for *C. libanii,* 39.43% for *P. nigra* subsp. *pallasiana,* 17.34% for *J. oxycedrus* subsp. *oxycedrus,* 13.70 % for *J. excelsa,* 11.39% for *J. drupacea,* 12.25% for *Q. cerris* and 11.05% for *Q. infectoria*.

Table (10): Infection severity of mistletoe species on hosts

Semi Parasites	*Viscum album* ssp. *abietis*				
Hosts	Coverage	Dried branches rate	Tree age	Swelling rate	Infection severity (%)
A. cilicica subsp.*cilicica*	21.45	10.83	35	9.64	34.51
Cedrus libanii	3.58	-	36	-	10.06
	Viscum album ssp. *austriacum*				
P. n. subsp. *pallasiana*	23.86	14.90	34	11.54	39.43
	Arceuthobium oxycedri				
*J. o.*subsp.*oxycedrus*	8.15	7.34	30	1.05	17.34
J. excelsa	7.73	3.20	28	-	13.70
J. drupacea	6.49	-	31	-	11.39
	Loranthus europaeus				
Quercus cerris	5.02	5.20	21	1.94	12.25
Quercus infectoria	4.83	4.05	20	1.90	11.05

3.8. Nurhak subregion

In this subregion, *V. album* ssp. *abietis* and *V. album* ssp. *austriacum* were not seen on hosts respectively (Table 11). However *A. oxycedri* and *L. europaeus* were found moderate to severe on hosts. 12.96% for *J. oxycedrus* subsp. *oxycedrus*, 10.68% for *J. excelsa*, 10.15% for *J. drupacea*, 14.54% for *Q. cerris* and 11.96% for *Q. infectoria.*

Table (11): Infection severity of mistletoe species on hosts

Semi Parasites	*Viscum album* ssp. *abietis*				
Hosts	Coverage	Dried Branches Rate	Tree age	Swelling rate	Infection severity (%)
A. cilicica subsp.*cilicica*	-	-	-	-	-
Cedrus libanii	-	-	-	-	-
	Viscum album ssp. *austriacum*				
P. n. subsp. *pallasiana*	-	-	-	-	-
	Arceuthobium oxycedri				
*J. o.*subsp.*oxycedrus*	8.20	2.05	25	0.43	12.96
J. excelsa	7.36	-	24	-	10.68
J. drupacea	7.19	-	22	-	10.15
	Loranthus europaeus				
Quercus cerris	6.24	7.15	20	3.17	14.54
Quercus infectoria	5.10	5.40	18	2.60	11.96

3.9. Pazarc k subregion

In this subregion, disease of *V. album* ssp. *abietis, A. oxycedri and L. europaeus* was not seen on hosts (Table 12). Infection severity of *V. album* ssp. *austriacum* was calculated less severe (2.48%) on *P. nigra* subsp. *pallasiana.*

Table (12): Infection severity of mistletoe species on hosts

Semi Parasites	*Viscum album* ssp. *abietis*				
Hosts	Coverage	Dried branches rate	Tree age	Swelling rate	Infection severity (%)
A. cilicica subsp.*cilicica*	-	-	-	-	-
Cedrus libanii	-	-	-	-	-
	Viscum album ssp. *austriacum*				
P. n. subsp. *pallasiana*	0.11	-	12	-	2.48
	Arceuthobium oxycedri				
*J. o.*subsp.*oxycedrus*	-	-	-	-	-
J. excelsa	-	-	-	-	-
J. drupacea	-	-	-	-	-

3.10. Türkoglu Subregion

In this region, *V. album* ssp. *abietis, A. oxycedri* and *L. europaeus* were not seen on hosts (Table 12). Infection severity of *V. album* ssp. *austriacum* was found less severe (2.2%) on *P. nigra* subsp. *pallasiana* (Table 13).

Table (13): Infection severity of mistletoe species on hosts

Semi Parasites	*Viscum album* ssp. *abietis*				
Hosts	Coverage	Dried branches rate	Tree age	Swelling rate	Infection severity (%)
A. cilicica subsp.*cilicica*	-	-	-	-	-
Cedrus libanii	-	-	-	-	-
	Viscum album ssp. *austriacum*				
P. n. subsp. *pallasiana*	0.25	-	10	-	2.2
	Arceuthobium oxycedri				
*J. o.*subsp.*oxycedrus*	-	-	-	-	-
J. excelsa	-	-	-	-	-
J. drupacea	-	-	-	-	-

IV. Conclusion

The ratio of infection severity of *V. a.* subsp. *abietis* was determined severe (44.16%) on *A. c.* subsp *cilicica* in Andırın, moderate to severe (34.51%) in Göksun, (18.77%) in Caglayancerit and (18.31%) in Ekinozu, less severe (9.43%) in Afsin and (9.26%) in Center. It was found moderate to severe (10.06%) on *C. libanii* in Goksun while less severe (8.39%) in Andırın and (5.6%) in Ekinozu.

V. album subsp. *austriacum* was found severe (40.06%) on *P. nigra* subsp. *pallasiana* in Andırın, moderate to severe 39.43% in Göksun, (20.29%) in Ekinozu, (19.44) in Caglayancerit, (16.90%) in Afsin and (11.74%) in Center.

The ratio of infection severity of *A. oxycedri* was calculated the according to *J. oxycedrus* subsp. *oxycedrus* on *J. excelsa* and *J. drupacea*. It was calculated moderate to severe (24.04%) on *J. oxycedrus* subsp. *oxycedrus* in Andırın, (17.34%) in Göksun, (14.95%) in Ekinozu, (13.74) in Caglayancerit, (12.96%) in Nurhak, (12.02%) in Afsin also less severe (7.86%) in Center. Besides it was moderate to severe (17.41%) for *J. excelsa* in Andırın, (13.70%) in Göksun, (12.35%) in Ekinozu, (11.60) in Caglayancerit, (10.68%) in Nurhak, and also less severe (9.61%) in Afsin, (5.76%) in Elbistan, (4.60%) in Center. At the same time it was moderate to severe (14.66%) for *J. drupacea* in Andırın, (11.75%) in Ekinozu, (11.39%) in Göksun, (11.38) in Caglayancerit, (10.15%) in Nurhak, and also less severe (9.56%) in Afsin, (4.83%) in Elbistan, (4.12%) in Center.

However infection severity of *L. europaeus* was found moderate to severe for *Q. cerris*; (17.50%) in Ekinozu, (14.54%) in Nurhak, (12.25%) in Göksun, (11.98%) in Caglayancerit, (10.76%) in Andırın, (10.45%) in Elbistan and also less severe (9.50%) in Afsın. But it was not seen on host in Center, Turkoğlu anda Pazarcık subregions. At the same time it was found moderate to severe for *Q. infectoria* (17.06%) in Ekinozu, (11.96%) in Nurhak, (11.05%) in Göksun, (10.53%) in Caglayancerit, (10.30%) in Elbistan, (10.12%) in Andırın, and also less severe (8.77%) in Afsın. But it was not seen on host in Center, Turkoğlu anda Pazarcık subregions.

As a result, disease of *V. album* ssp. *abietis* was found important on *A. cilicica* subsp. *cilicica* while it was found unimportant on *C. libanii*. Disease of *V. a.* spp. *abietis* and *V. a.* subsp. *austriacum* were found serious for hosts in forest area of Andırın and Göksun subregion. *A. oxycedri* is seen as a potential threat for hosts Besides *L. europaeus* is seen as a danger for oaks species in Kahramanmaras region.

In Turkey, six taxa have been determined*: V. album, V. a.*subsp. *austriacum, V. a.* subsp. *abietis*, *V. a.* subsp. *album, L. europaeus* and *A. oxycedri* (Dutkuner 1999). Infection severity of mistletoe was caused 26% for light, 39% for moderate and 63% for severe infection groups on hosts in Turkey (Catal and Carus 2011). Infection severity of yellow mistletoe (*L. europaeus*) was found 59.7% on Sessile oak (*Q. petraea*), 26.1% Hungarian oak (*Q. frainetto*) and 14.2% Turkey oak (*Q. cerris*) (Kumbasli *et al*. 2011). In Nigde region of Turkey, the severity of the disease caused by *V. album* ssp. *album* was determined as the highest on Almond (*Amygdalus* spp.) 48.54%, Apricot (*Prunus armenica* L.) 34.98 % and Pear (*Pyrus communis* L.) 28.64% (Ustuner 2003, Ustuner *et al.* 2015). But *V. a.* ssp. *album* has not been found on any hosts in regions of Kahramanmaras while it was reported in the different region of Turkey.

Whereas the distribution and frequency of infection by dwarf mistletoe in Western Montana, 10% of the 22,863 trees on all plots were infected, but 38% of trees on the 474 infected plots had dwarf mistletoes (Graham 1964). White mistletoe was found very high levels of infestation, with severe infection levels on individual trees (Wicker and Leaphart 1976). 42% on Douglas-fir (Bolsinger 1978), 57% on conifer (Marsden *et al*. 1991). The mistletoe was caused 25% moderate degrees, 10% severely damaged on hosts (Tsopelas *et al.* 2004). Also *V. album* ssp. *austriacum* has dried more than 5% dead branches or twigs. Mistletoe had discolouration 15-20% of the trees of *Pinus sylvestris* (Dobberting and Ringling 2006). The incidence of mistletoe was 14% in Spain (Oliva and Colinas 2007), 30% in Croatia (Idžojtić et al. 2008) and 22% in Romania (Barbu 2009) 30% on *Pinus nigra* (Rigling *et al.* 2010). Mistletoe has been found in 22% on Silver fir. *V. album* ssp. *abietis* was found 20-40% on Silver fir (Barbu 2010 and 2012). Dwarf mistletoes cause the most serious diseases of conifers in many forests of western North America, but they also occur in Europe, Asia and northern Africa (Worrall and Geils 2006, Agne 2013). Besides, the infection rate of *V. album* ssp. *album* on oak stems was 12.9% similarly, the whole tree infection rate was 14.8% (Matula *et al.* 2015). The ratio of existence of *Arceuthobium oxycedri* on the host were determined as high dense and it was 16.990 number/host for *Juniperus*

oxycedrus subsp. oxycedrus, 15.331 for *Juniperus excelsa* and 14.388 for *Juniperus drupacea.* Also *Loranthus europaeus* was found dense 3.327 on *Quercus cerris* and 2.741 on *Q. infectoria.* Another semi-parasite plant, *Viscum album subsp. abietis* was determined as dense 9.922 number/host on *Abies cilicica subsp cilicica*, while it was mid dense 0.449 on *Cedrus libanii.* Besdies, *V. album subsp. austriacum* was found as high dense 14.535 on *Pinus nigra subsp. pallasiana.* Whereas, *Viscum album* ssp. *album* was not found on any host in Kahramanmaras, Turkey (Ustuner, 2016a). The mistletoe shoots (Haustorium) are caused to swelling at the site germinated in the branches of the host end result was observed in the backward. It has also been observed to cause the tree to dry out completely in some host such as almonds and apricot in Nigde and Kahramanmaras,Turkey (Ustuner, 2016b).

In conclusion, the infection severity rates can vary from region to region, host to host and mistletoe density to density. So in the present study, different results were obtained with the previous studies. Viscum, Arceuthobium and Loranthus species which were determined in different ratio of infection severity and hosts; *V. album* subsp. *abietis* on *A. cilicica* subsp. *cilicica* and *C. libanii*. *V. album* subsp. *austriacum* on *P. nigra* subsp. *pallasiana*; *A. oxycedri* on *J. drupacea*, *J. oxycedrus* subsp. *oxycedrus* and *J. excelsa*; *L. europaeus* on *Q. cerris* and *Q. infectoria* in Kahramanmaras region, as reported by Miller 1982, Hawksworth and Wiens 1996, Dutkuner 1999, Ustuner 2003, Catal and Carus 2011, Kumbasli *et al.* 2011, Üstüner *et al.* 2015, Ustuner 2016a and 2016b in Turkey. At the same time Graham 1964, Wicker and Leaphart 1976, Bolsinger 1978, Hawksworth and Scharpf 1986, Marsden *et al.* 1991, Ball 1993 , Tsopelas *et al.* 2004, Dobberting and Ringling 2006, Worrall and Geils 2006, Oliva and Colinas 2007, Idžojtić *et al.* 2008; Rigling *et al.* 2010, Barbu (2009, 2010 and 2012), Agne 2013, Baltazar *et al.* 2013, Matula *et al.* 2015, Raftoyannis *et al.* 2015, Wahid *et al*. 2015 were reported partially similar results in the world with the present study.

It has been thought that may change ratio of infection severity of Viscum, Arceuthobium and Loranthus species were affected by biological and morphological properties of the hosts, semi parasites density, semi parasite coverage, host age, regional ecology, alttitude difference, population of vector and differences in the vegetation.

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