ISSN 0378 - 8024


# THE JOURNAL OF TURKISH PHYTOPATHOLOGY

PUBLISHED BY THE TURKISH PHYTOPATHOLOGICAL SOCIETY

Volume: 25 Number: 3 September: 1996

The Journal of Turkish Phytopathology is published by Turkish Phytopathological Society and issued twice or three times a year to from volume. The subscripton rate per volume is $ 21.00

EGE ÜNİVERSİTESİ BASIMEVİ

BORNOVA - İZMİR, 1996

# THE JOURNAL OF TURKISH PHYTOPATHOLOGY

TURKISH PHYTOPATHOLOGICAL SOCIETY

VOL. 25 SEMP NO. 3


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# Effects of Root, Leaf and Flower Extracts of Oriental Larkspur *Consolida orientalis* (Gay) Schröd. on Germination and Seedling Growth of Wheat

**Solmaz SÖZERİ**
Ankara University, Faculty of Agriculture, Department of Plant Protection
06110 Dışkapı, Ankara / TÜRKİYE

**Ayşegül SOLMAZ**
Ankara University, Faculty of Agriculture, Department of Plant Protection
06110 Dışkapı, Ankara / TÜRKİYE

## ABSTRACT

Root, leaf and flower water extracts of Oriental larkspur at 1/10, 1/20 and 1/40 dilutions did not affect germination of wheat when the seeds were dipped in the extracts for 1 h before sowing; but post-emergence death was significantly higher in the treated seeds. Extracts also caused weakness and dwarfing on the seedlings. When the same extracts, were applied to the seed bed, 1 ml/ seed bed, similar effects were observed.

## INTRODUCTION

Oriental larkspur is a weed o Ranunculaceae and has synonims as *Delphinium ajacis* L., *D. orientale* Gay. and *D. hispanicum* Wilk. It is a common weed, flowering in 5-8 th months in cultivated areas and steps (Davis 1965).

Population of Oriental larkspur in wheat fields has recently increased and its intensity reached 2.13 - 52.52 plant /$m^2$ in some places, in Ankara region (Sözeri 1994).

Allelopathic effects of Oriental larkspur on animals and human beings have been emphasized by various authors and this effect has been attributed to diterpenoid alkaloids (Olsen and Manners 1989; Özden et al., 1992; Waller 1989; Williams 1984) but its effect on wheat has not been taken into consideration so far.

In this study, allelopathic effects of Oriental larkspur in wheat emergence and seedling growth were considered.

## MATERIALS AND METHODS

Root, leaf and flower extracts of Oriental larkspur in water were prepared from the plant specimens collected from wheat fields in Ankara.

Extracts of Oriental larkspur were prepared as follows. 10 g of plant parts based on dry matter was placed in 100 ml distilled water and blended with a waring blender for 10 min, and then filtered through double layer muslin. This stock extract was used directly for 1/10 dilution. The other dilutions were made by distilled water from this stock extract. The extracts were applied either as a seed dip for 1 h or seed bed (1 ml/ bed). Seeds of cultivar Gerek 79 were applied either as a seed dip for 1 h or seed bed (1ml/bed). Seeds of cultivar Gerek 79 were used in this experiment. Seeds were disinfected in 0.1 % NaOCl for 3 min, rinsed in sterile distilled water 3 times and treated with the extracts or sown directly to the soil.

The trial was carried out in green house and 10 seeds were sown in plastic pots having a soil mixture of 1: 1: 2 perlite, sand and field soil. Each treatment in two application form was replicated 4 times (total 40 seeds).

Germination and seedling growth was observed for 30 days.

## RESULTS

Seed dip application of various extracts of Oriental larkspur at 3 dilutions affected wheat germination and seedling growth on varying degrees (Table 1).

Table 1. Effects of seed dip application of Oriental larkspur extracts on germination and seedling growth of wheat

| | root extracts | | | leaf extracts | | | flower extracts | | |
|---|---|---|---|---|---|---|---|---|---|
| Dilution of extracts | Germination (%) | Post-emergence death (%) | Mean seedling height (cm) | Germination (%) | Post-emergence death (%) | Mean seedling height (cm) | Germination (%) | Post-emergence death (%) | Mean seedling height (cm) |
| 1/10 | 95 a | 96.8 a | 7.5 bc | 72.5 c | 88.8 a | 15.6 b | 65 a | 77.5 a | 7.53 c |
| 1/20 | 85 a | 95 ab | 5.37 c | 80 bc | 37.5 bc | 20.1 ab | 67.5 a | 73.7 a | 8.82 bc |
| 1/40 | 80 a | 85 b | 14.5 abc | 92.5 a | 20 cd | 21.1 ab | 82.5 a | 52.7 a | 15.4 abc |
| Control | 97.5 a | 2.5 c | 32.3 a | 95 a | 2.5 d | 31.4 a | 95 a | 2.5 b | 32.95 a |

Root extracts at all dilutions did not affect germination but caused post-emergence death and dwartfing of seedlings at decreased rates paralel to the decreased dilutions. Leaf extracts, on the other hand an impact at both germination and post-emergence death at the 2 higher dilutions.

Seedling height was not altered much with this application.

Even though percent germination for flower extracts showed variation they were not statistically significant due to variation in the experiment. Flower extracts also yielded significant post-emergence death and stunting.

When root and leaf extracts of Oriental larkspur were applied directly to the soil similar results were obtained as in seed dip application. Root extract did not prevent germination but killed the seedlings at a high rate (Table 2). In this treatment root extracts were more deleterious than leaf extracts.

Table 2. Effects of extracts of Oriental larkspur applied to seed bed on the germination and seedling growth of wheat

| | root extracts | | | leaf extracts | | |
|---|---|---|---|---|---|---|
| Dilution of extracts | Germination (%) | Post-emergence mortality (%) | Mean seedling height (cm) | Germination (%) | Post-emergence mortality (%) | Mean seedling height (cm) |
| 1/10 | 87.5 a | 92.5 a | 3.2 c | 72.5 c | 63.3 a | 22.3 d |
| 1/20 | 87.5 a | 78.7 a | 15.2 bc | 80 bc | 42.4 ab | 18.8 cd |
| 1/40 | 95 a | 65.6 a | 16.4 abc | 92.5 ab | 25.7 ab | 20.2 bcd |
| Control | 95 a | 13.7 b | 36.3 a | 97.5 a | 13.7 b | 36.3 a |

## DISCUSSION

Oriental larkspur which hes diterpenoid alkaloids toxic to blooded animals had also an allelopathic effect on wheat. This effect was evident on mean seedling height for all types of extracts, while germination was affected only by leaf extracts. In practice this effect might be important in reduction of wheat yield. Its widespread occurence in ceral fields deserves more detailed studies related to allelopathic effects, chemical control and ecological considerations. Its existence in wheat fields might create a poisoning effect on cattle due to the alkaloids that it contains (Williams, 1984; Olsen and Manners, 1989).

Idendification of the allelopathic compounds to wheat might throw light on the mechanism involved.

## ÖZET

**TİTREK ÇİÇEĞİ (*Consolida orientalis* (Gay) Schröd)'NİN KÖK, YAPRAK VE ÇİÇEK SU EKSTRAKTLARININ BUĞDAY TOHUM ÇİMLENMESİ VE FİDE GELİŞİMİNE ETKİLERİ**

Titrek çiçeği (*Consolida orientalis* (Gay) Schröd)'nin 1/10, 1/20 ve 1/40 oranlarında sulandırılmış kök, yaprak ve çiçek-su ekstraktlarında bir saat tutulan buğday

tohumlarının çimlenmesi ekstraktlardan etkilenmemiş ancak çıkış sonrası fide ölümü kontrole göre yüksek oranda olmuştur. Ekstratlar bitki boylarında kısalma ve bitkide cılızlaşma meydana getirmiştir. Aynı bitkinin kök ve yaprak-su ekstratları aynı konsantrasyonlarda tohum yatağına 1 ml uygulandığında da buğday çıkışını etkilememiş, ancak bitki gelişimini engellemiş ve fide ölümlerine yol açmıştır.

## AKCNOWLEDGEMENT

The auther is thankful to Prof. Dr. Salih Maden (University of Ankara, Department of Plant Protection) for directed our study.

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J. Turk. Phytopath., Vol. 25, No.3, 93-101, 1996 ISSN 0378 - 8024

# Seed Transmission of Some Viruses in Chickpea and Lentil

**Gürsel ERDİLLER**
A.Ü.Z.F. Bitki Koruma Bölümü
06110, Ankara / TÜRKİYE

**Birol AKBAŞ**
A.Ü.Z.F. Bitki Koruma Bölümü
06110, Ankara / TÜRKİYE

## ABSTRACT

Three hundred seeds from two accessions of chickpea and three accessions of lentil which are used frequently by the farmers of Middle Anatolia Region were sown in steril soil in pots and grown under greenhouse conditions for four weeks. After germination, seedlings were observed daily. The leaves of seedlings which showed virus like symptoms were inoculated to herbaceous plants and tested serologically by ELISA and microprecipitation tests.

Result showed that broad bean mottle bromovirus were transmissible by chickpea seeds. Broad bean stain comovirus, bean yellow mosaic potyvirus and pea seedborne mosaic potyvirus were transmissible by lentil seeds.

## INTRODUCTION

Chickpea and lentil are important and widely cultivated field crops in Middle Anatolia Region. As a source of food they rank next to cereals and constitute an inexpensive source of protein for a large part of the population. According to the statistical data of The State Insitute of Statistics, their planted area have increased (Anonymous, 1994). These crops also improve the soil by giving nitrogen and fertilizer (Elçi et al., 1987), and are used at rotation in this area.

Virus diseases have been known for a long time on pulse crops and have caused economically important losses (Kaiser and Hannan, 1983; Kaiser et al., 1988; Fidan and Yorgancı, 1989; Kaiser et al., 1991). The most critical event with pulse crops viruses is their seed transmissible fact (Phatak, 1974; Kaiser et al., 1991; Makkouk et al., 1992). There are a lot of pulse crop viruses which induce distortions on both chickpeas and lentils (Kaiser and Danesh, 1971; Russo et al., 1981; Hampton, 1982; El Maataoui and Ameziane - El Hassani, 1984; Goodell and Hampton, 1984; Chalam et al., 1986a; Chalam et al., 1986b; Aydın et al., 1987; Fidan and Yorgancı, 1989; Kumari et al., 1993; Makkouk et al., 1993). In addition, some of chickpea and lentil viruses are transmissible by seeds (Hampton and Muehlbauer, 1977; Alconero et al., 1986;

Makkouk and Azzam, 1986; Fidan and Yorgancı, 1990; Fortass and Bos, 1992; Kumari et al., 1993; Makkouk et al., 1992; Makkouk et al., 1993).

In this study it is aimed to check the seeds of chickpea and lentil for their virus transmission ability.

## MATERIALS AND METHODS

From the collected seed samples, three hundred of seed samples of two chickpea *(Cicer arietimum L.)* accessions, Eser 87, ILC 95 and three lentil *(Lens culinaris L.)* accessions, Kırmızı 51, Pul 11, Yeşil 21 were sown in steam sterilized soil in thirty groups and grown under greenhouse conditions for four weeks. The leaves which showed virus symptoms from chickpea and lentil varieties were ground in a morter and pestle with 0.01 M phosphate buffer saline, pH 7.2 mixed with celite and inoculated nine herbaceous plants of selected test species *(Chenopodium amaranticolor, C. murale, C. quinoa, Datura stramonium, Lycopersicum esculentum, Gomphrena globosa, Nicotiana clevelandii, N. glutinosa, N. tabacum* Samsun). The plants were kept in a climate chamber at 20-25°C and observed for symptom development for at least four weeks. Also from the developing seedlings, shoots were extracted and tested serologically to eight different virus antisera (Alfalfa mosaic alfamovirus, AIMV; Broad bean mootle bromovirus, BBMV; Broad bean stain comovirus, BBSV; Bean common mosaic pothyvirus, BCMV; Bean yellow mosaic pothyvirus, BYMV; Cucumber mosaic cucumovirus, CMV; Pea seed borne mosaic potyvirus, PSbMV; Soybean mosaic potyvirus, SMV) by indirect ELISA as described by Lommel et al. (1982) and microprecipitation test as described by Noordam (1973).

The rates of seed transmission were calculated using the formula of Maury et al. (1985): $p=[1 - (Y/N)^{1/n}] \times 100$, where p is the percentage of infection, Y the number of seedling groups free of virus, N the number of group tested and n the number of seedlings per group.

## RESULTS AND DISCUSSION

All varieties of chickpea and lentil seedlings showed virus symptoms. The most important symptoms observed on chickpea accessions were stunted seedlings, yellowing, narrowing and reducing both size and number of leaves (Fig 1), which are related with bean yellow mosaic potyvirus according to Chalam et al. (1986b), broad bean mottle bromovirus symptoms according to Fortass and Bos (1992), cucumber mosaic cucumovirus symptoms according to El Maataoui and Ameziane - El Hassani (1984), pea seed borne mosaic potyvirus symptoms on chickpea according to Makkouk et al. (1993). The symptoms observed on lentil accessions were yellow mosaic, leaf

narrowing, stunting and reducing both size and number of leaves (Fig 2, 3), which are related with bean yellow moaic potyvirus symptoms according to Russo et al. (1981), broad bean mottle bromovirus symptoms according to Fortass and Bos (1992) and pea seed borne mosaic potyvirus symptoms according to Makkouk et al. (1993).

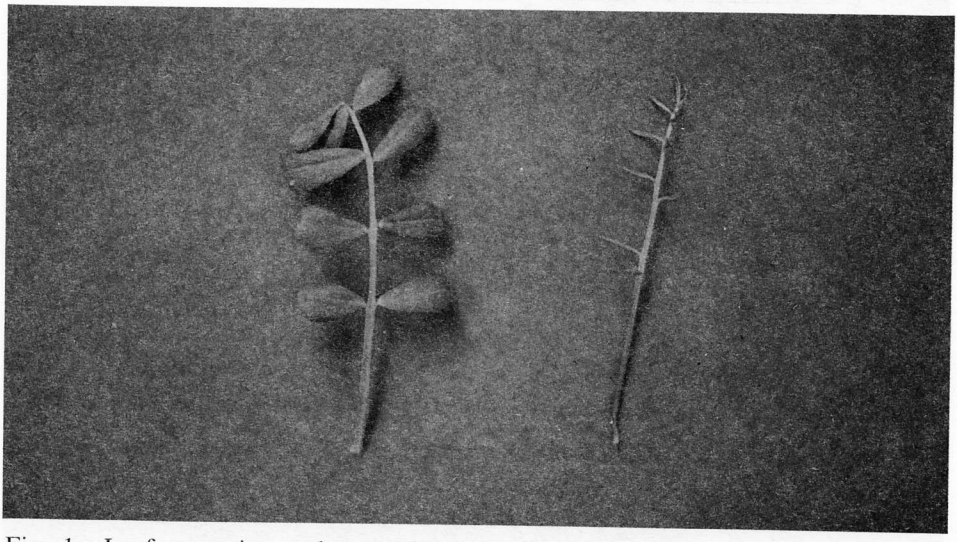

Fig. 1. Leaf narrowing on leaves of ILC 95 chickpea accession on the right. Healty leaves on the left.

Fig. 2. Mosaic symptoms on leaves of Pul 11 lentil accession.

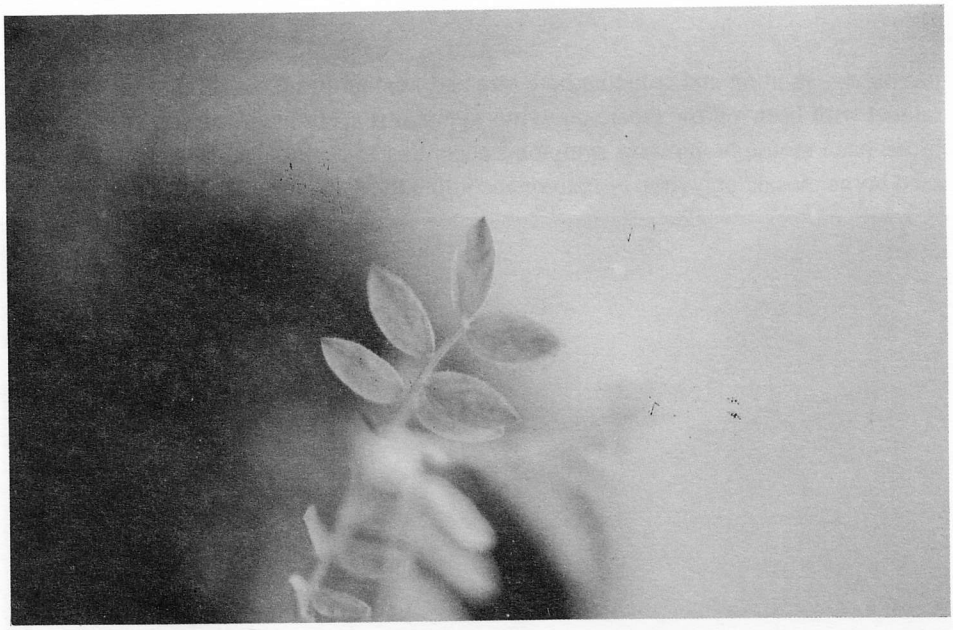

Fig. 3. Yellow mosaic on Yeşil 21 lentil accession.

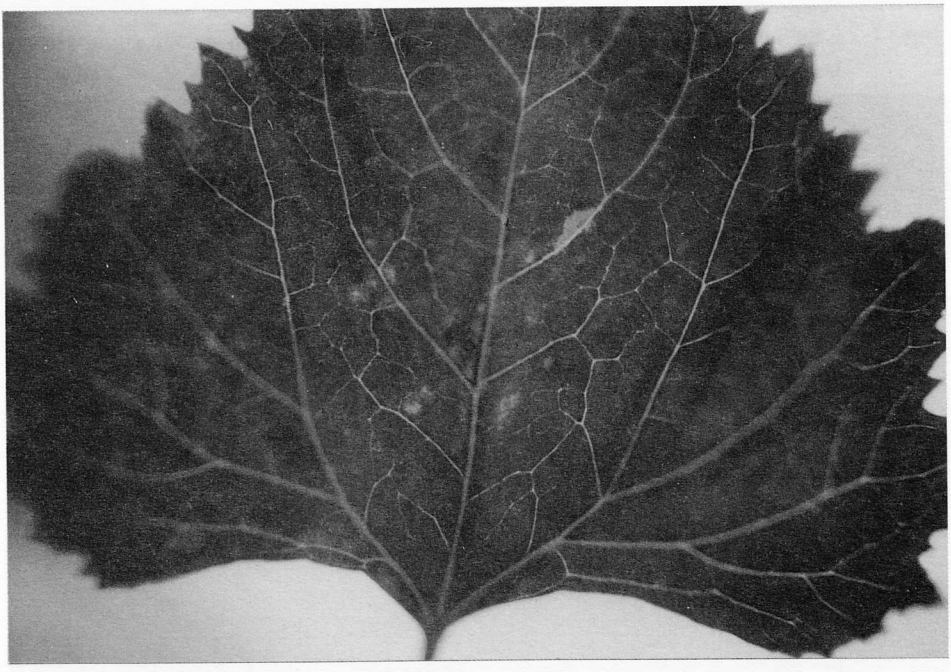

Fig. 4. Chlorotic local lesions on leaf of *C. amaranticolor.*

Virus symptoms of these accessions were summarized as follows;

Eser 87 accession of chickpea: yellowing, reducing both size and number of leaves, stunting.

ILC 95 accession of chickpea: yellowing, leaf narrowing, mild mosaic, reducing both size and number of leaves and stunting.

Kırmızı 51 accession of lentil: mild mosaic and yellowing, reducing size of leaves, and stunting.

Pul 11 assecssion of lentil: mild or severe mosaic, yellowing, leaf narrowing, reducing size of leaves and stunting.

Yeşil 21 accession of lentil: mild yellow mosaic, reducing size of leaves and stunting.

The test plant reactions were shown in Table 1.

Table 1. Reactions of test plants infected with chickpea and lentil extracts

| Test Plants | Symptoms |
|---|---|
| *Chenopodium amaranticolor* Costa et Reyn | CLL |
| *C. murale* L. | NLL |
| C. quinoa Willd. | CLL |
| *Datura staramonium* L. | - |
| *Gomphrena globosa* L. | S |
| *Lycopersicum esculentum* L. | - |
| *Nicotiana clevelandii* Gray | SMot |
| *N. glutinosa* L. | - |
| *N. tabacun* L. Samsun | - |

CLL: Chlorotic local lesion
NLL: Necrotic local lesion
S: Systemic symptoms
Smot: Systemic mottle

Infection remained restricted to the inoculated leaves in *C amaranticolor, C. murale* and *C. quinoa* (Fig 4). These species gave the local lesions, reacting in 7-12 days after inoculation. *G. globosa* gave systemic mild reactions in 12-15 days after

inoculation. *N. clevelandii* was also infectious as showed systemic mottle symptoms in 12-15 days after inoculation. On the contrary *D. stramonium, L. esculentum, N. glutinosa* and *N. tabacum* Samsun were not infected. In the mechanical inoculation test, reactions obtained in the indicator plants were similar to those reported earlier (Bos, 1970; Gibbs and Smith, 1970; Gibbs, 1972; Hampton and Mink, 1975; Fortass and Bos, 1992).

Some seedlings grown from pooled seeds were found to be infected with BBSV, BYMV and PSbMV in lentil accessions, and with BBMV in chickpea accessions after ELISA and microprecipitation testing as seen Table 2. But Yeşil 21 lentil accession was not infetious with BYMV. Moreover seed transmission of AIMV, BCMV, CMV and SMV was not detected on chickpea and lentil. The transmission rates were calculated and found to be 0.68 and 1.04 % by BBMV in Eser 87 and ILC 95 of chickpea accessions, 0.68, 1.04 and 0.33% by BBSV, 0.33, 0.68 and 0 % by BYMV, 1.04, 2.62 and 0.68 by PSbMV in Kırmızı 51, Pul 11 and Yeşil 21 of lentil accessions, respectively as seen Table 3. These results are in agreement with earlier reports Hampton and Muehlbauer, 1977; Makkouk and Azzam, 1986; Makkauk et al., 1992; Fortass and Bos, 1992; Kumari et al., 1993; Makkauk and Azzam, 1986; Makkouk et al., 1992; Fortass and Bos, 1992; Kumari et al., 1993; Makkouk et al., 1993).

These data is the first report on seed-transmision of certain viruses in chickpea and lentil in Turkey.

Table 2. Detected viruses in chickpea and lentil accessions by serological tests

| Viruses | Kırmızı 51 Lentil Accession | Pul 11 Lentil Accession | Yeşil 21 Lentil Accession | Eser 87 Chickpea Accession | ILC 95 Chickpea Accession |
|---|---|---|---|---|---|
| AIMV | - | - | - | - | - |
| BBMV | - | - | - | + | + |
| BBSV | + | + | + | - | - |
| BCMV | - | - | - | - | - |
| BYMV | + | + | - | - | - |
| CMV | - | - | - | - | - |
| PSbMV | + | + | + | - | - |
| SMV | - | - | - | - | - |

Table 3. Seed transmission rates of viruses in chickpea and lentil accessions

| Accessions | BBMV | BBSV | BYMV | PSbMV |
|---|---|---|---|---|
| | I II III IV | I II III IV | I II III IV | I II III IV |
| Eser 87 | 30 10 2 0.68 | 30 10 0 0 | 30 10 0 0 | 30 10 0 0 |
| ILC 95 | 30 10 3 1.04 | 30 10 0 0 | 30 10 0 0 | 30 10 0 0 |
| Kırmızı 51 | 30 10 0 0 | 30 10 2 0.68 | 30 10 1 0.33 | 30 10 4 1.42 |
| Pul 11 | 30 10 0 0 | 30 10 3 1.04 | 30 10 2 0.68 | 30 10 7 2.62 |
| Yeşil 21 | 30 10 0 0 | 30 10 1 0.33 | 30 10 1 1 | 30 10 3 1.04 |

I: Number of groups tested
II: Number of seedlings per group
III: Number of groups positive in ELISA
IV: Rate of transmission in %

## ACKNOWLEDGMENTS

We are grateful to Dr. S. Kumari, Genetic Resources Unit, International Center for Agricultural Research in Dry Areas (ICARDA), Aleppo, Syria for kindly supplying antisera of AIMV, BBMV, BBSV, BYMV and PSbMV.

## ÖZET

## NOHUT VE MERCİMEKLERDE BAZI VİRUSLARIN TOHUMLA NAKLİ

Orta Anadolu Bölgesinde çiftçiler tarafından kullanılan iki standart nohut ve üç standart mercimek çeşidinden üçyüzer adet tohumun ekimi yapılarak, bunların virus taşıyıp taşımadığı araştırılmıştır.

Bu testler sonucunda, nohut tohumları ile Bakla benek virusunun (BBMV), mercimek tohumları ile Bakla leke (BBSV), Fasulye sarı mozaik (BYMV) ve Bezelye tohum kökenli mozaik /PSbMV) viruslarının taşındığı saptanmıştır.

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J. Turk. Phytopath., Vol. 25, No.3, 103-107, 1996 ISSN 0378 - 8024

# Root-Knot Nematode [*Meloidogyne javanica* (Treub, 1885) Chitwood, 1949] Damage on Russett Burbank Potato Tubers Centrifugation - Floatation Technique

**İbrahim ÇINARLI**
Plant Protection Research Institute,
Bornova, 35040 İzmir / TÜRKİYE

**N. Nurdan ERTEKİN**
Plant Protection Research Institute,
Bornova, 35040 İzmir / TÜRKİYE

Root-knot nematodes are soil-borne pathogens which cause galls on the below parts of plants where they enter at 2. stage, became sedentary and feed. This feeding stimulates giant cell formation by secreting esophageol secretions which dissolve middle lamella. Root-knot galls are a result of this hyperplasia phenomenon and occur a part of the infected tissue (Figure 1).

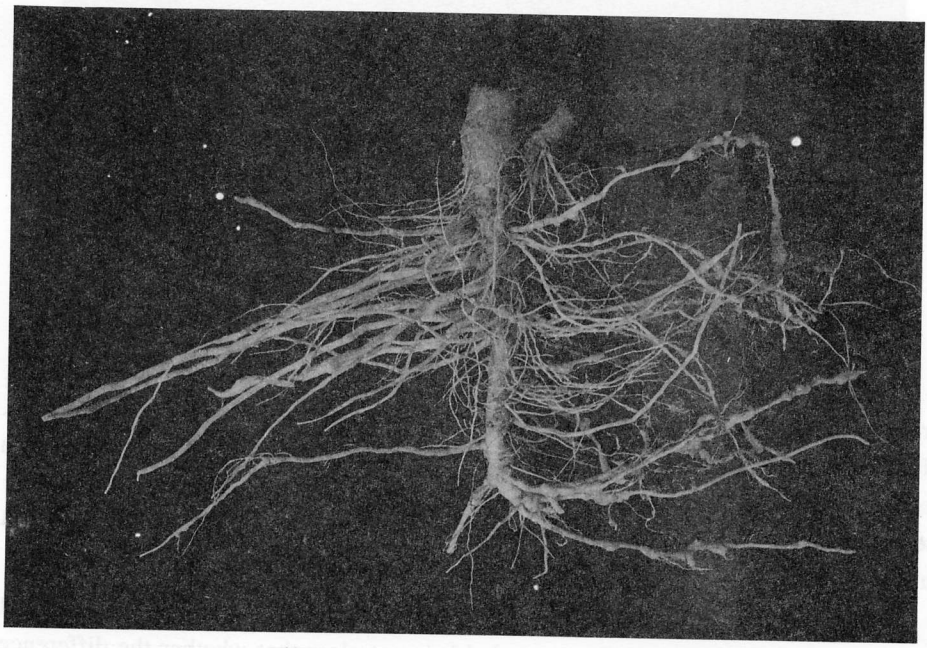

Fig. 1. Left, root-knot damage on tomato caused by *M. Javanica.* Right, health root system.

Root-knot nematode damage on Russett Burbank potato variety in the Aegean Region was first recorded in 1985 (Yıllık 1985). Warts caused by the nematode were visible (Figure 2).

Fig. 2. *Meloidogyne* spp. Gall formation on potato tuber.

In 1992 the same potato variety were used and the tubers transferred into the test area which noted that the tubers and the cuts were seen healthy during harvest (Figure 3). Numerous juveniles, adult females and eggs were obtained by centrifugation floatation technique (Figure 4). After these tubers were kept in + 4°C for 2-3 months, there were no visible symptoms on them, but brownishband caused by adult female feedings and embedded females existed on the surface of the cross-section (Figure 5).

The identification of root-knot nematode species was done by Dr. Mohammad Rafig Siddiqui. Because the first recorded it is not clear that whether the difference between symptomless and visible damage is the result of species or race variation or of abiotic factors.

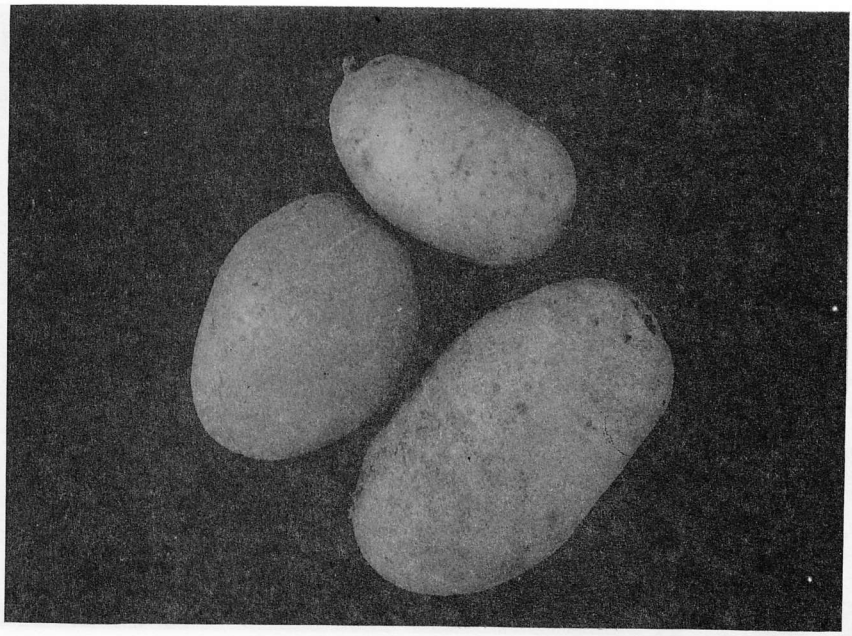

Fig. 3. Tubers infected with *M. javanica* with no symptoms.

Fig. 4. Adult females were seen in potato.

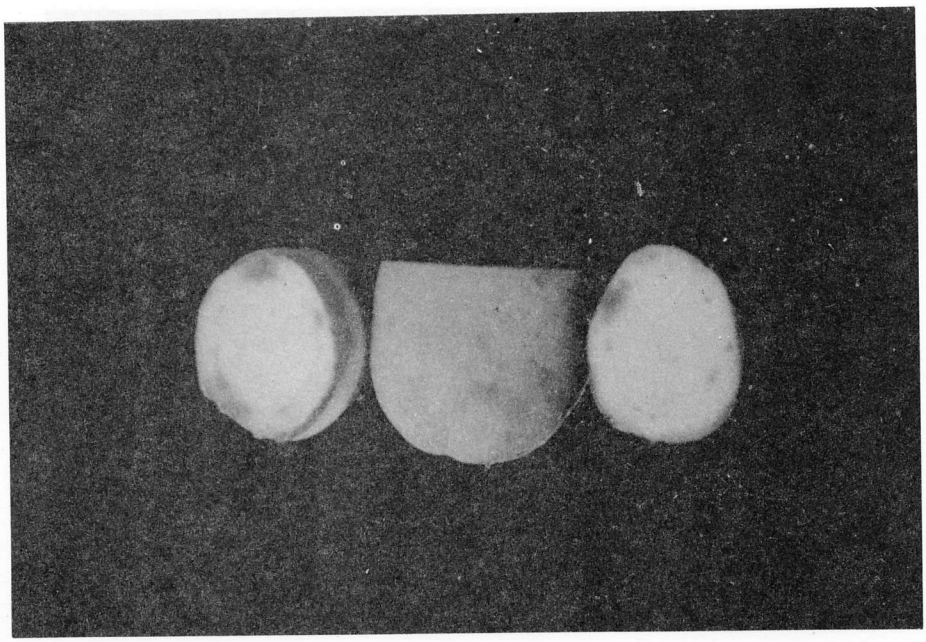

Fig. 5. Brownish band caused by adult females on the surface of the cross-section.


## ÖZET

### KÖK-UR NEMATODUNUN (*Meloidogyne javanica* (Treub, 1885) Chitwood, 1949) RUSSETT BURBANK ÇEŞİDİ PATATES YUMRULARINDAKİ ZARARI

Kök-ur nematodları toprakta yaşar ve 2. birey döneminde toprakaltı bitki dokuları içine girerek kendilerini sabitler, beslenir ve gelişmelerini tamamlayarak çoğalırlar. Beslenmeleri esnasında salgıladıkları özsularla hücreler arası duvarları yıkarak dev hücreler oluşturmasına neden olurlar. Bu dev hücreler bitki dokularında ur oluşumu şeklinde kendini gösterir. Beslenmeleri toprakaltı aksamı olan kök veya yumrularda olabilir (Şekil 1).

Ege Bölgesinde patates yumrularında kök-ur nematodu zararı ilkkez 1985 yılında saptanmıştır (Yıllık, 1985). Şekil 2'de *Meloidogyne* spp. ile bulaşık Russett Burbank patates çeşidine ait yumrulardaki siğil şeklindeki belirtiler açıklıkla görülebilmektedir.

1992 yılında yürütülen bu çalışmada yine aynı patates çeşidi kullanılmış, yumrular *Meloidogyne javanica* ile bulaştırılmış deneme alanına dikilmiştir. Hasattan sonra Şekil 3'de görüldüğü üzere yumrularda hiçbir belirti gözlenmemiştir. Sağlıklı

görülen bu yumrular enine kesildiğinde yine hiçbir belirti gözlenmemiştir. Söz konusu yumrular blender ile parçalanıp, şekerli su santrifüj yöntemi ile muamele edildiğinde çok sayıda dişi, genç birey ve yumurtalara rastlanmıştır (Şekil 4). Aynı yumrular + 4°C'de 2-3 ay bekletildikten sonra incelenmiş, yumrular yine belirtisiz olmakla beraber, kesit alındığında kök-ur dişilerinin kahverengi bir hat halinde dizildiği belirtilmiştir (Şekil 5).

Kök-ur nematodunun tür teşhisi Dr. Muhammed Rafig Siddiqui tarafından yapılmıştır. 1985 yılında bulunan patates yumrularında zarar yapan kök-ur nematodunun tür teşhisi yapılmadığından, patateslerde belirti olup olmamasının tür yada ırk farkından mı yoksa abiotik faktörlerden mi kaynaklandığı açıklık kazanmamıştır.

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J. Turk. Phytopath., Vol. 25, No.3, 109-116, 1995 ISSN 0378 - 8024

# Investigation on Biology of Root-knot Nematode [*Meloidogyne incognita* (Kofoid and White) Chitwood] Harmful on Tomatoes

**Sebahat ENNELİ**
Plant Protection Research Institute, 06172, Ankara / TÜRKİYE

**Seval TOROS**
University of Ankara, Faculty of Agriculture, Department of Plant Protection, 06110, Ankara / TÜRKİYE

## ABSTRACT

Connected with study egg groups and females of *M. incognita* are obtained knotted roots of tomatoes that collected from Bozaniç village of Sarıcakaya county in Eskişehir province. Identification of the nematode was made from the females and their eggs groups were used for production.

Biology of the nematode were investigated at two different places in a culture chamber and at the garden in the flowerpots at Ankara Plant Protection Research Institute. One generation culture chamber and 48 days in the nature.

Average nubmer of eggs laid by one female were 325.92 ±19.60 (150-516).

Egg hatching was studied at different temperatures (10, 15, 20, 25, 30, 35°C) and the maximum egg hatching occured at 25°C on the nineth day.

The nematode was overwintered as egg and juvenile formation in Bozaniç village (Eskişehir, Sarıcakaya).

## INTRODUCTION

In some localities with microclimatic conditions of Central Anatolia Region, summer and winter vegetables are being produced and annually 2-3 crop are being harvested depending on cultivation, especially in tomato, yield reductions, retards in developments and even dieing in groups occure because of root-knot nematodes.

Although several studies have been carried out in world beginning from 1855 (Whitehead, 1968), studies in Turkey has been started in 1934 (İyriboz, 1934) and various researches have done later (Diker, 1959; Alkan, 1962; Yüksel, 1966, Ertürk et al., 1973; Gürdemir and Ağdacı, 1975; Borazancı, 1977; Ediz, 1978; Ağdacı, 1978; Gürdemir, 1979). However, these studies are generally on the distribution and control

methods of root-knot nematodes. Diker (1952) had studied briefly biology of *Meloidogyne incognita* in samsun and its surroundings.

Ediz and Enneli (1978) have determined that *M. incognita* is the most distributed species of what in Eskişehir, sarıcakaya county vegetable cultivations.

Root-knot nematodes have a great range of host and differ in their parasitic effects according to the environmental conditions. The biology of the root-knot nematodes in Turkey have not been investigated in details. In order to perform more effective control measures against to root-knot nematodes, this study has been carried out to enlighten the biology of *M. incognita.*

## MATERIALS AND METHODS

For pure culture production, eggs of *M. incognita* females (Identified by S' JACOB-Wageningen Netherlands) were used.

Two tomato varieties, 110-234 and 110-9 Wisconsin 55, were used in the biological studies.

In studies related with the larvae entrances through the roots, 50 second instar larvae were given to the tomato seedlings in pots each. The seedlings were kept in culture chambers at 27°C, for 10 days, and 5 plants were pulled off daily in this period for examination. Southey (1970) is accepted as reference in these studies.

In studies related with the biological development, following the management of the larval entrances through plant roots within 48 hours, seedlings were taken into pots and placed in culture chambers, the parameters in culture chamber were the temperature 27°C, relative humidity 70-80 % and 13 hours light/daily and another trial resic in wire cages in the experimental garden of the Institute; the parameters for the natural conditions were the average soil temperature 21.95 (19-26)°C, avarage temperature 23.5 (15-28)°C and average relative humidity 41.17 % (27-70). In every alternate day, 3 plants were pulled off, painted and examined after their preparations done according to Southey (1970).

In studies related with teh egg hatchings depending on various temperatures, egg groups with the same color, size and type were put in culture chambers of 10, 15, 20, 25, 30, 35°C, in specially developed containers. Special containers are glass box of 5 riameter which have a little water and plastic hole in it.

The eggs were checked in every 3 days during one month. The hatched larvae were counted and the rate of egg hatchings depending on temperature was determined.

The wintering status of the species was examined by supplying soil and knotted plant roots from the fields highly contaminated by *M. incognita* in Mayıslar Village

Eskişehir - Sarıcakaya County. The harvae obtained from the soil, and the egg groups obtained from the plant roots were given to post with tomato seedlings, and the adults developed were compared, identified and both is determined to be the same species.

## RESULTS AND DISCUSSION

Since *M. incognita* is an endoparasitic nematode. It is impossible to follow up one individual from egg stage to adult. Therefore, biological stages were tried to be determined by using random individuals exist in carious stages on the plant seedlings.

The highest rate of larvae entrances average 9.4 ± 0.28 (1-32) in tomato seedling roots occured in the second day on culture chambers (Fig. 1).

*M. incognita* has completed the pariod from 2nd larvae to 2 nd larvae in 30 days in culture chambers and 48 days in natural conditions (Table 1). Since the parameters in culture chambers were much better regarding to the natural conditions, the developmental stages were found to be shorter. Taylor and Saccer (1978) reported that the duration of the developmental stages in root-knot nematodes is highly depending on the temperature and 25-30°C is the optimum temperature for *M. incognita.*

Since the duration of the 3rd stage larvae is relatively short 3rd and 4th stage female larvae were observed in the same days during the survey studies. 3rd stage male larvae could not be detected. Triantaphyllou (1960) reported that the duration of the 3rd stage is very short like a few hours.

The population densities of different stages in culture chambers and in natural conditions are given in Figure 2. Nematode populations of various stages have differed in variyng conditions. Preparasitic 2 nd stage juvenil populations are equal in culture chambers and innature. The population densities of 2 nd stage males, 3 rd stage females, 4 th stage males, early adult male are little in culture chambers and innature.

*M. incognita* lays its eggs in groups in gel matrix formed by females. In these gel matrix, an average of 325.92±19.60 (150-516) eggs was determined. Thorne (1961) and Ritter (1973) reported that this number varied between 200-500.

In studies to determine the effect of the temparature (10, 15, 20, 25, 30, 35°C) on egg hatchings, the highest number of egg hatching was found at 25°C and in 9 th day (Table 2). Studying with Holland and Venezuela populations of *M. incognita,* Dao (1970) has determined the optimum temparature to be 25-30°C and the highest hatching to be also in the 9th day.

Eggs loose their vitality in absolutely water-free conditions and larval exit is hindered in much water availability (Taylor and Sasser, 1978).

In the studies related with the overwintering properties of *M. incognita,* it was determined that the nematode overwintered in egg stage and also in larval stage in Bozaniç Village (Eskkişehir - Sarıkaya). Here, average temparatures for the winter months have found to be varying between 5.5 (-4; 11) and 9.1 (1:20). Taylor and Sasser (1978) reports that this nematode may overwinter in egg and also in larval stage in mild climate regions.

Although there exists enough number of studies on the root-knot nemadodes, there isn't any study comprehensivly deal with the biological satges of one species. With this sudy which covers the studies on the biologies of the root-knot nematodes in our country, the biology of *M. incognita* an important nematode pest of vegetable grown areas, especially the biology of *M. incognita* an important nematode pest of vegetable grown areas, especially the tomatoes in Central Anatolia Region has been enlightened. This will result to establish more conscious control programs againts this pest.

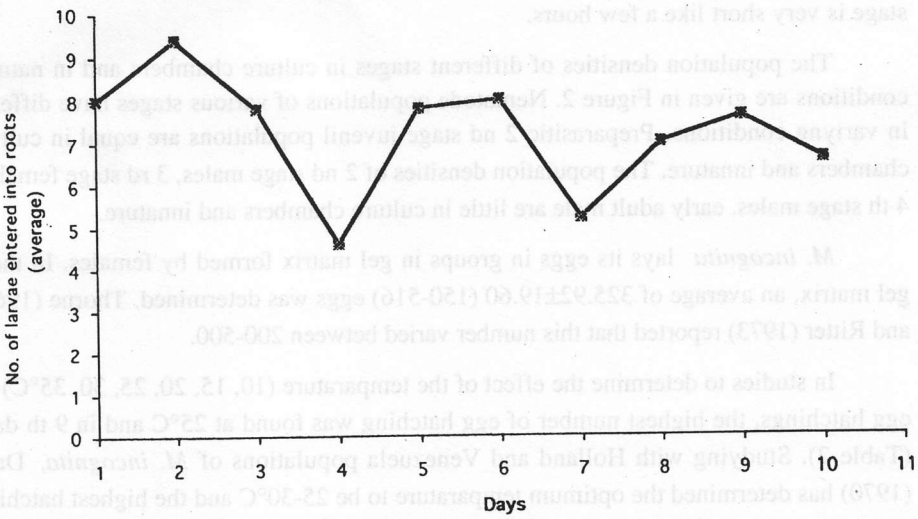


Fig. 1. Number of *M. incognita* larvae that enter into the tomato roots in various days in culture chambers (27±1°C)

Table 1. Development of *M. incognita* in culture chambers (27±1°C) and in nature (21.95±3.56 (19-26)°C) on tomato plants.

| Stages | Culture chambers (days) | In Nature (days) |
|---|---|---|
| 1. Preparasitic 2 nd stage larvae (entrance in roots) | 2 | 2 |
| 2. Parasitic 2 nd stage larvae | 4 | 4 |
| 3. 2 nd stage females | 6 | 14 |
| 4. 2 nd stage males | 8 | 16 |
| 5. 3 rd stage females (2 nd moulting) | 14 | 20 |
| 6. 4 th stage females (3 rd moulting) | 14 | 20 |
| 7. 4 th stage males | 16 | 22 |
| 8. Adult females (4 th moulting) | 20 | 26 |
| 9. Early adult male | 20 | 30 |
| 10. Gelatinial matrix occurrence | 22 | 34 |
| 11. Egg laying (Females with eggs) | 22 | 36 |
| 12. 1 st stage larvae | 26 | 42 |
| 13. 2 nd stage larvae | 30 | 48 |

Table 2. Hatching rates of *M. incognita* eggs in various temperature

| Days | Hatching rates of eggs (%) Temperature (°C) | | | | | |
|---|---|---|---|---|---|---|
| | 10 | 15 | 20 | 25 | 30 | 35 |
| 3 | 0.20 | 0.21 | 4.89 | 0.09 | 17.42 | 5.34 |
| 6 | 0.67 | 1.73 | 7.54 | 16.29 | 17.64 | 4.87 |
| 9 | - | 2.49 | 34.12 | 54.15 | 25.64 | 2.60 |
| 12 | - | 1.51 | 17.17 | 13.50 | 18.85 | 0.39 |
| 15 | - | 1.24 | 10.48 | 5.01 | 0.42 | 1.87 |
| 18 | - | 1.14 | 6.32 | 0.31 | - | 0.60 |
| 21 | - | 1.63 | 1.29 | - | - | - |
| 24 | - | 0.98 | - | - | - | - |
| 27 | - | 0.38 | - | - | - | - |
| 30 | - | 0.21 | - | - | - | - |
| Total egg hatching (%) | 0.87 | 11.52 | 81.81 | 89.35 | 79.55 | 15.67 |

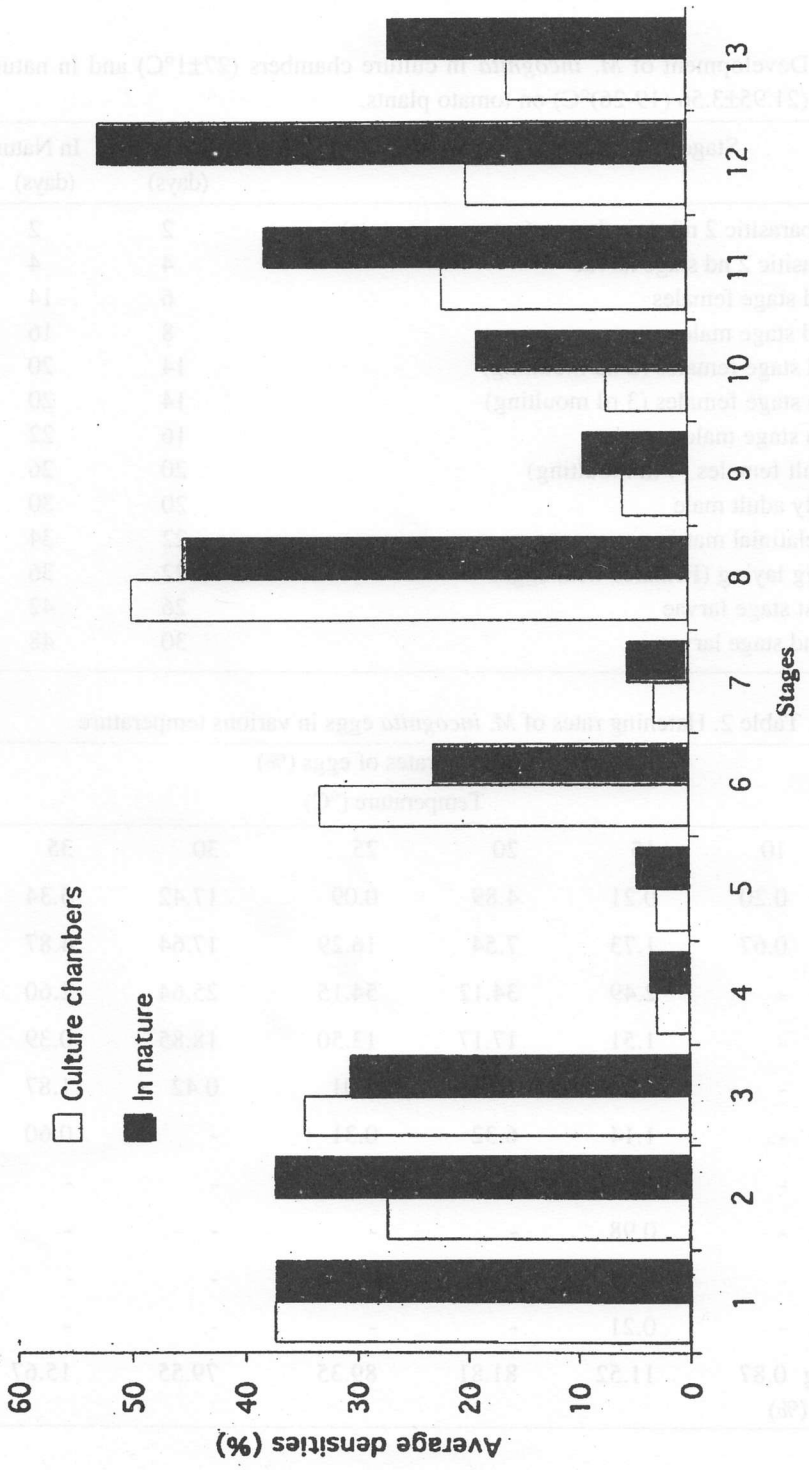


Fig. 2. Average densities of *M. incognita* of varios stages during their developments in culture chambers and in nature on tomato plants (Stages are same as cited in Table 1).

## ÖZET

### DOMATESLERDE ZARARLI KÖK-UR NEMATODU [*Meloidogyne incognita* (Kofoid and White) Chitwood]'NIN BİYOLOJİSİ ÜZERİNDE ARAŞTIRMALAR

Biyoloji çalışması ile ilgili olarak *M. incognita* yumurta kümeleri ve dişileri Eskişehir ili Sarıcakaya ilçesi Bozaniç köyünden alınan urlu domates köklerinden elde edilmiştir. Dişilerden nematodun tür teşhisine gidilmiş, bunların yumurta kümeleri ise üretimde kullanılmıştır.

Biyoloji takibi Ankara Zirai Mücadele Araştırma Enstitüsü'nün bahçesi ve kültür dolabındaki saksılar içinde iki ayrı yerde yapılmıştır. Nematodun bir dölü (2. dönem larvadan tekrar 2. dönem larvaya kadar) kültür dolabında 30 günde, doğada ise 48 günde tamamlanmıştır.

Bir dişinin bıraktığı ortalama yumurta sayısı 325.92±19.60 (150-516) adettir.

Değişik sıcaklıklardaki (10, 15, 20, 25, 30, 35°C) yumurta açılımı takibinde en fazla açılımın 25°C'de 9. günde olduğu saptanmıştır.

Kök-ur nematodu bulaşıklılığının olduğu Bozaniç köyünde (Eskişehir, Sarıcakaya) bu nematodun kışı yumurta ve larva halinde geçirdiği saptanmıştır.


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J. Turk. Phytopath., Vol. 25, No.3, 117-125, 1996 ISSN 0378 - 8024

# Investigations on the Significant Fungal Pathogens for Biological Control of Certain Weed Species in the Aegean Region

**Tanju NEMLİ**
Department of Plant Protection
Faculty of Agriculture
University of Ege, 35100
Bornova, İzmir / TÜRKİYE

**Ata TÜCER**
TURNAK Tic. Nak. Ltd. Şti.
Şehit Fethibey Cad. Hür İş. Merkezi,
No. 53, Kat 2
Pasaport, İzmir / TÜRKİYE

## ABSTRACT

To find out possible weed biocontrol agents, nonsistematic surveys were carried out on fungal diseases of certain weed species in Aegean region between the years of 1993 and 1994. On the diseased samples collected from the survey area, one leaf spot, three powdery mildews, three smuts and twentyone rust were found, and the pathogens were evaluated from the point of view of weed biocontrol. Among the identified pathogens *Puccinia notobasidis* Savu. et Rayss, and *Puccinia rhagadioli* (Pass). were recorded first time for Turkish parasitic mycoflora and seven weed species were new hosts for their pathogens in Türkiye.

## INTRODUCTION

The agricultural chemical applications against weeds have taken an most important part in the control means. On the other hand, the economical and ecological problems have been created by the applications are well known subjects in agriculture. In addition to these problems, there are still some weed species which are not controlled by the chemicals. These kind of deficiencies in chemical weed control methods have directed to develope new strategies in weed control and the studies on biological control of weeds have taken importance.

Biocontrol of weeds has two main strategies: calssical (inoculative) strategy- where releases are made for an imported natural enemy or inundative (bioherbicidal) strategy - where an agent (usually already occurring in the same area as the weed) is applied in high concentrations (Adams, 1988; Charudattan, 1988; Hasan and Ayres, 1990).In the recent years there has been an increasing intrest in the deliberate use of all possible organisms, especially fungal pathogents as biocontrol agents after the successes of these two startegies were shown in Australia (Hasan, 1970) and the USA (TeBeest and Templeton, 1985).

The variations in climatic conditions and diversity of vegetation in a conutry can provide potential for the presence of different microbial agents. The experimental results with the rust fungus, *Puccinia chondrillina* Bub et Syd. against *Chondrilla juncea* L. so

far indicate that Turkey has such a potential at least for fungal pathogens. However, the expected developments in research and practical use have been inhibited by the lack of appropriate investigations in this field (Nemli, 1991).

There are more than 800 species of parasitic fungi on plants. This is far greater than the combined number of all other plant parasites (viruses, mycoplasmas, bacteria, nematodes and higher plants) (Burge, 1988). Therefore to obtain promising weed biocontrol agents, nonsystematic surveys on fungal diseases of certain weed species have been carried out in Ege Region. The most important measure was to fing out host specific pathogens for target weeds. At the begining of studies to take attention on rust fungi which are significantly host specific pathogens could be useful early finding out the promising weed biocontrol agents. Therefore, in the study observations on rust pathogens of the weed species had priority. This fungal species have been appreciated as biocontrol agents and companents of Turkish parasitic mycoflora.

## MATERIALS and METHODS

The essential surveys on diseased weeds for this study were carried out around İzmir and its surroundings, and secondarily around other cities of the Ege Region. The weeds infected by the fungal pathogens were collected in the spring, summer and autumn of the year 1993 and in the spring and summer of 1994. The serial volumes of P.H. Davis on Flora of Turkey and valuable criticism on the collected plant species by the members in the Department of Botany of the University of Ege have been useful for distributions and identifications of the weed species (Davis, 1967 and 1975).

The book of E. Gaumann was the fundamental reference for the identification of the rust fungi (Gaumann, 1959). The rust pathogens were examined under the light microscope and observations were made on 40 times magnified teliospores. Thirty spores were measured for each identified species. PDA medium were used for isolations of the necrotrophic fungi and saprophytic species were discarded.

In addition to nonsistematic surveys on diseased weeds in above mentioned area, rust pathogen *P. chondrillina* of skeleton weed were investigated in more detail as field experiment level. Because, an international project have been carried out in the Department of Plant Protection, to increase the possibilities to find suitable strains of the rust fungus, and three experimental plots have been established in western Turkey near Uşak and Afyon, the region with high diversity of skeleton weed forms, with the aim of to trap suitable strains.

## RESULTS and DISCUSSION

The pathogenic fungi which were observed on collected weed members of *Chenopodiaceae* and *Compositae* were shown in Table 1. In this group. *P. notobasidis* and *P. rhagadioli* have been determined for the first time in Turkish parasitic mycoflora (Fig 1).

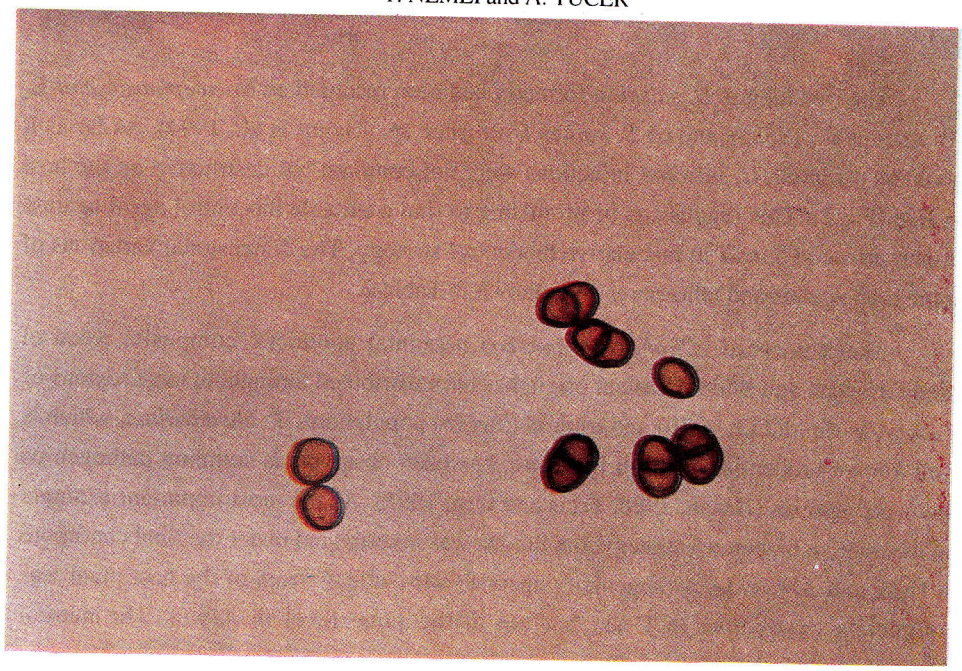

Fig. 1. Uredospores and teliospores of *Puccinia rhagadioli* (x 220).

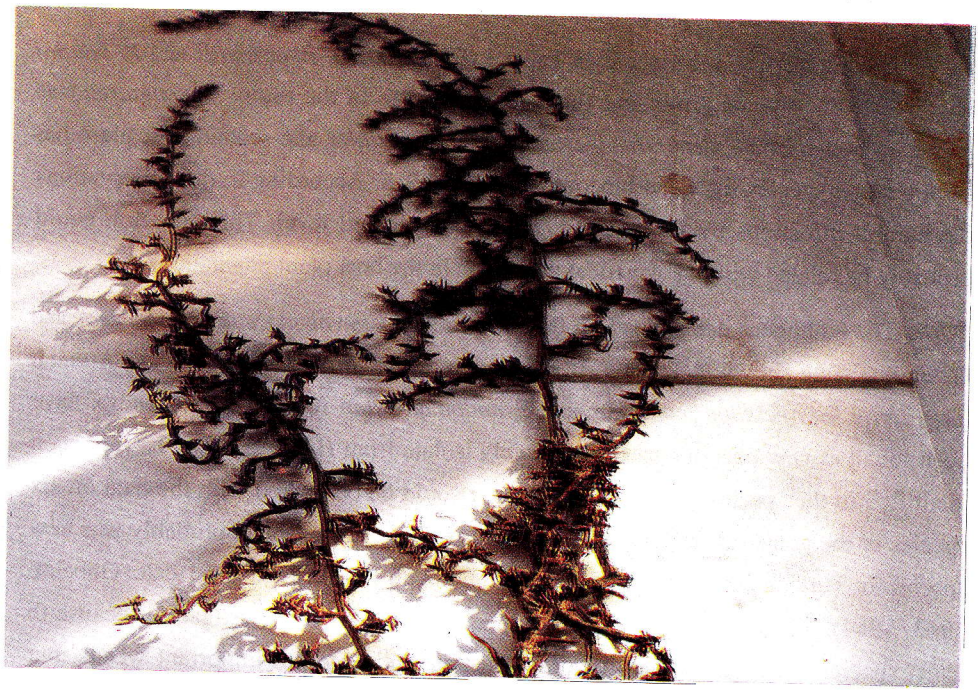

Fig 2. *Salsola kali* plants infected by *Uromyces salsolae.*

The rust fungus *U. salsolae* formerly had been recorded on *Noea epinosissima* L. (Bremer et al., 1952a), and on *S. kali* as *Uromyces* sp. (Uygur et al., 1994). As far as it could be osserved, *U. salsolae* infections were not common but destructive on the host in Ege (Fig 2). This fungus can be promising to find a suitable biocontrol agent against important weed *S. kali* in inoculative biocontrol strategy. The dimensional variations of some uredospores and teliospores were thown in Tabla 2.

Skeleton weed (*Chondrilla juncea*) perennial apomictic composite weed of Mediterranean and Middle Eastem origin has been disributed throughout most regions of Turkey, as diploid (2n = 10) and triploid (3n=15) populations. *P. chondrillina,* which is well known biocontrol agent in literature, has been observed as common pathogen on this weed species (Hasan, 1988; Erciş and İren, 1993). As the most important example on inoculative biocontrol strategy, the fungus was investigated under the field conditions in Uşak and Afyon. Its pathogenicity against "narrow leaf" from of the host plant was completely destructive in Uşak, but not al the same level in Afyon. The natural infections were individually destructive on "intermediate leaf" form. This limited success of the pathogen could be a subject for genetical engineering studies in Turkey (Hasan and Ayres, 1990; Nemli, 1991).

Among the listed pathogens in Table 1, *P. centaurea, P. acroptili* and *P. xanthii* have taken importance promising fungi to investigate in the future *P. centaurea* was found on two species. *Centaurea iberica* and *C. colstitialis,* the second host plant has been a target species for weed biocontrol in the U.S.A. According to our observations the natural infections by *P. centaurea* was not expected level. This situation could probably be related with the genetical variations in the host plant populations.

The pathogens determined on the members of *Convolvulaceae, Dipsacaceae* and *Graminae* were shown in Table 3. In this group, *Cephalaria transsilvanica* and *Knauita integrifolia* for *Aecidium scabiosae*, and *Cynodon dactylon* for *Heterosporium sp.* have been found as new host plants. Unfortunately isolate from *Heterosporium* has not been identified in the species level, but, as far as it could be compared with the data on six species of the genus which had been recorded in Turkey, the isolate probably was new species for Turkish parasitic mycoflora (Beremer et al. 1948; 1952b and 1952c; Göbelez, 1963, 1964). The strains of rust fungus *A. scabiosae* can be investigated, because th ehost species which have beed recorded in this study are not important weeds, but *Cephalaria syriaca* L. a significant weed for cereal fields in Turkey.

Table 1. Pathogens on collected weed members of Chenopodiaceae and Compositae (years 1993 and 1994).

| Host Plants | Pathogens | Locality |
|---|---|---|
| CHENOPODIACEAE | | |
| *Salsola kali L.* | *Uromyces salsolae* | Akkum |
| COMPOSITAE | | |
| *Acroptilon repens* (L.) D.C. | Puccinia acroptili Syd. | Çay |
| *Carduus pycnocephalus* L. | P. cardui-pycnocephali Syd. | Bornova, Balçova, Kemalpaşa |
| *Centaurea iberica* Trev. ex Spre | P. centaureae Mart. | Çaltıdere (New host) |
| *Centaurea solstitialis* L. | P. centaureae Mart. | Çay, Yakasinek, Bergama, Kemalpaşa, Bornova, Çaltıdere, Horozköy, Muradiye |
| *Chondrilla juncea* L. | *P. chondrillina* Bub. et Syd. | Most common in the region |
| *Crepis foetida* L. | *P. crepidicola* Syd. | Kemalpaşa |
| *Echinops ritro* L. | *P. pulvinata* Rbh. | Dedegöl dağı |
| *Inula viscosa* (L.) Ation. | *P. gnaphali* Speg. | Özdere |
| *Notobasis syriaca* (L.) Cass. | *P. notobasidis* Savu & Rayss. | Teos, Horozköy, Özdere (New species) |
| *Picnomon acarna* (L.) Cass. | *Puccinia acarnae* Syd. | Uşak, Aliağa, Bornova, Foça, Horozköy |
| *Rhagadiolus stellatus* (L.) Gaert. | *Puccinia rhagadioli* (Pass) Syd. | Pınarcık köyü (New species) |
| *Taraxacum* sp. | *P. taraxaci* (Reb). Plow. | Bornova, balçova, Çaltıdere, Aliağa, Kemalpaşa |
| *Xanthium strumarium* L. | *P. xanthii* Schwein | Saruhanlı, Bornova |

Table 2. Dimensional variations of measured uredospores and teliospores of some rust fungi (microns)

| Pathogens | Uredospores | Teliospores |
|---|---|---|
| *Puccinia centaurea* | 24 - 28 x 20 -24 | 32 - 40 x 21 - 27 |
| *P. rhagadioli* | 25 - 30 x 22 - 27 | 32 - 39 x 24 - 32 |
| *P. notobasidis* | - | 34 - 43 x 25 - 32 |
| *Uromyces salsolae* | 20 - 29 x 13 - 20 | - |

Table 3. Pathogens on collected weed members of Convolvulaceae, Dipsacaceae and Graminae (1993 and 1994)

| Host Plants | Pathogens | Locality |
|---|---|---|
| CONVOLVULACEAE | | |
| *Convolvulus arvensis* L. | *Erysiphe convolvuli* D.C. | Most common in the region |
| DİPSACACEAE | | |
| *Cephalaria transsilvanica* (L.) Schrad. | *Aecidium scabiosae* Wint. | Çiniliköy (New host) |
| *Knautia integrifolia* (L.) Var. *bidens* (Sibit s. Sn.) Babat. | *Aecidium scabiosae* Wint. | Çay (New host) |
| GRAMINAE | | |
| *Avena* spp. | *Ustilago avenae* (Pers) Jens. | Bergama, Bornova |
| *Cynodon dactylon* L. | *Heterosporium* sp. | Mütevelli (New host) |
| | *Ustilago cynodontis* (Pass) Henn. | Saruhanlı, Germencik |
| *Sorghum halepensis* (L.) Pers. | *Ustilago sorghi* (L.K.) Pass. | Bornova |

The pathogenic fungi from other six families were shown in table 4. Among the examined plant species. *Trifolium pilulare* for *U. trifolii* and *Pimpinella peregrina* for *P. pimpinellae* have been determined new hosts (Table 4). The rust pathogens *P. malvacearum* and *Phragmidium violaceaum* could be promising fungi for weed biocontrol studies in our country. The latter has been well known biocontrol agent in some countries out of Turkey (Öner et al. 1974, Tamer and Öner, 1978).

Because of the limited space was avaiable in the text, a part of data have been presented from the unpublished MS thesis prepared in the department and a CSIRO project which was carried out in the Plant Protection Department. The documents could be useful for more detail intrests.

Table 4. Pathogens on collected weed members of other six families

| Host Plants | Pathogens | Locality |
|---|---|---|
| LEGUMINACEAE | | |
| *Abagyris foetida* L. | *Uromyces anagyridis* Rab. | Teos |
| *Trifolium pilulare* Boiss. | *U. trifolii* (Hodw) Lew. | Karagöl (New host) |
| MALVACEAE | | |
| *Malva silvestris* L. | *Puccinia malvacearum* Mont. | Common in the region |
| PLANTAGINACEAE | | |
| *Plantago major* L. | *Erysiphe lamprocarpa* (Wallr) Duby. | Bornova |
| POLYGONACEAE | | |
| *Polygonum aviculare* L. | *Erysiphe polygoni* D.C. | Bornova |
| ROSACEAE | | |
| *Rubus fruticosus L.* | *Phragmidium violaceaum* (Schultz) Wint | Özdere, Yiğitler |
| UMBELLIFERAE | | |
| *Eryngium campestre* L. | *Puccinia eryngii* D.C. | Aliağa, Bornova, Tire, Uşak |
| *Pimpinella peregrina* L. | *Puccinia pimpinellae* (Straus) Röhl. | Seferihisar, Teos (New host) |
| *Smyrnium rotundifolium* Mill. | *Puccinia smyrnii* Biv. Bemh. | Bademler, Teos |


## ÖZET

## EGE BÖLGESİNDE BAZI YABANCI OT TÜRLERİNİN BİYOLOJİK SAVAŞIMINDA ÖNEMLİ OLAN FUNGAL PATOJENLER ÜZERİNDE ARAŞTIRMALAR

Yabancı otların fungal patojenleri son yıllarda otlarla biyolojik savaşım için önemli bir konu olmuş bulunmaktadır. Bu amaçla, olası biyolojik savaş etmenlerini bulmak için 1993 ve 1994 yılları arasında Ege Bölgesinde bazı yabancı otların fungal hastalıklarını gözlemeye yönelik sistematik olmayan surveyler yürütüldü. Survey alanından toplanan hastalıklı örneklerde, bir yaprak leke hastalığı, üç külleme, üç rastık ve yirmibir pas hastalığı bulundu. *Puccinia notabasidis* Savu et Rayss ve *Puccinia rhagadioli* (Pass). Syd. Türkiye Parazitik Mikoflorası için ilk kayıt olurken, yedi yabancı ot türü de patojen funguslara tür düzeyinde yeni konukçular olarak saptandı.

## ACKNOWLEDGEMENTS

The authors gratefully acknowledge the invaluable help of Prof. Dr. Ö. Seçmen and his colleagues from the Department of Botany of the University of Ege.

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J. Turk. Phytopath., Vol. 25, No.3, 127-131, 1996 ISSN 0378 - 8024

# Mineral Contents of Broomrape (*Orobanche cernua* Loefl.) and Infested Sunflower Varieties

**Dilek ANAÇ**
University of Ege, Department of Soil Science,
35100, Bornova, İzmir / TÜRKİYE

**Mehmet DEMİRCİ**
University of Ege, Department of Plant Protection,
35100, Bornova, İzmir / TÜRKİYE

**Hasan DEMİRKAN**
University of Ege, Department of Plant Protection,
35100, Bornova, İzmir / TÜRKİYE

**Burçin ÇOKUYSAL**
University of Ege, Department of Soil Science,
35100, Bornova, İzmir / TÜRKİYE

## ABSTRACT

Mineral content (N, P, K, Ca, Mg, Fe, Zn, Mn, Cu) of broomrape *(Orobanche cernua* Loefl.) and the infected sunflowers with different resistance were studied to highlight the host influence.

It is concluded that all the examined broomrapes possessed higher P than the host plant. The broomrape parasiting the resistant variety was rich in P and Zn concentrations. It is also put forth that host plant leaf N content decreased as resistance in varieties increased.

## INTRODUCTION

It is well known that parasitic weed infestation depress crop yield due to losses arising from the competition for light, water, growing space and nutrient where the weed acts as an extra strong sink. Eventhough several control measures are available for the elimination of this problem, integrated management practices is a prerequisite to achieve the solution.

Generally it is a stated that manure and fertilizers reduce parasitic effect and consequently crop yield (ABU-IRMAILEH, 1979). It is also reported that weeds usually have a higher nutrient content than the crop plants (ALKAMPER, 1976). The other best approach to control the parasitic weeds is reported to be the identification and breeding of resistant varieties.

In Turkey 613.000 ha of land is cultivated by sunflower, a plant easily attacked by the broomrape, *O. cernua* (ANONYMOUS, 1993). From 1983 to 1985 more than 50 % of sunflowers in Eastern Thracia were infested (PETZOLDT et all., 1993). Even though research on resistant varieties has gained motion, mineral composition of host-parasite system has not been examined until recently.

This study was set up to determine the mineral content of *O. cernua* and different sunflower varieties for high lighting the host influence.

## MATERIALS and METHODS

*Layout and Treatments*

Resistant, tolerant and susceptible sunflower varieties namely Edirne, Nurtingen B and Confictionary were planted in the experimental field of Ege University-İzmir and were infected with *O. cernua.* Experimental soils had a clay-loam texture, slightly alkaline reaction and was rich in plant available N, P, K contents. Plots were arranged in randomized block design with 3 replications. All the cultural measures were guided by the recommendations.

*Sampling and Analysis*

After a 3 month of (15 May - 8 August 1991) growing period, the aerial parts of the broomrape, *O. cernua* and sun flower leaves and stems were harvested, dried at 60°C and ground. Samples were analysed for their N by a distilation method, P by colorimetry, K and Ca by flamephotometry and Mg, Fe, Zn, Mn and Cu by AA spectrometry.

## RESULTS

Mean concentration of mineral nutrients regarding sunflower leaves, stems and the broomrapes *(O. cernua)* are presented in Table 1.

With respect to sunflower varieties. *O. cernua* parasiting Nurtingen B tolerant variety, made up the top position in N, K, Fe, Cu and Mn contents. Highest Mg was measured in the *O. cernua* attacking the susceptible variety (Edirne). Phosphorus and Zn concentrations were noticeable high in the broomrape of the resistant variety (Confictionary) and was calculated as 0.620 % and 42 ppm respectively.

Statistical analysis of variance showed significant differences in mineral contents of the 3 considered broomrapes. The grouping according to their least significant differences is given Table 2.

Table 1. Mineral content of sunflower leaf, stem and broomrape related to susceptibility.

| Mineral Nutrients | Edirne | | | Nurtingen | | | Confictionary | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | B | | | | | |
| | Stem | Leaf | B.rape | Stem | Leaf | B.rape | Stem | Leaf | B.rape |
| N (%) | 0.84 | 2.238 | 1.58 | 1.427 | 1.86 | 1.973 | 0.924 | 1.604 | 1.477 |
| P (%) | 0.061 | 0.157 | 0.463 | 0.087 | 0.188 | 0.493 | 0.106 | 0.238 | 0.62 |
| K (%) | 4.244 | 4.096 | 3.963 | 3.954 | 3.581 | 4.22 | 3.705 | 4.05 | 3.7 |
| Ca (%) | 1.49 | 5.591 | 0.477 | 1.922 | 5.943 | 0.483 | 1.487 | 5.936 | 0.627 |
| Mg (%) | 0.333 | 0.14 | 0.163 | 0.148 | 0.349 | 0.157 | 0.273 | 0.172 | 0.127 |
| Fe (ppm) | 51 | 890 | 425 | 39 | 618 | 555 | 78 | 624 | 350 |
| Cu (ppm) | 13 | 39 | 31 | 17 | 72 | 54 | 13 | 56 | 43 |
| Zn (ppm) | 71 | 121 | 38 | 102 | 84 | 38 | 78 | 98 | 42 |
| Mn (ppm) | 13 | 94 | 10 | 26 | 87 | 12 | 18 | 81 | 10 |

Data releated to P concentrations of each *O. cernua* revealed that the broomrapes possess higher levels compared to host plant. A similar result was also determined for the K content of the tolerant variety broomrape as 4.220 %.

Table 2. Analysis of variance of broomrape mineral contents.

Completed Analyses of Variance Table

| Source of Variance | F Ratio | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | P | K | Ca | Mg | Fe | Cu | Zn | Mn |
| Repli. | 0.487ns | 0.400ns | 0.300ns | 0.700ns | 1.273ns | 4.799ns | 0.438ns | 0.077ns | 0.100ns |
| Sunflower Vari. | 105.469** | 106.686** | 43.050** | 244.300** | 187.727** | 10428.039** | 216.813** | 9.538** | 4.300ns |
| LSD Groups | | | | | | | | | |
| Susceptible | 1.583B | 0.463B | 3.963B | 0.447B | 0.163A | 424.703B | 31.00C | 38.33B | - |
| Tolerant | 1.973A | 0.493B | 4.220A | 0.483B | 0.157A | 554.770A | 54.00A | 37.67B | - |
| Resistant | 1.477A | 0.620A | 3.700B | 0.627A | 0.127B | 349.614C | 43.00B | 41.67A | - |
| LSD (0.05) | - | - | - | - | - | - | - | 2.724 | - |
| LSD (0.01) | 0.166 | 0.052 | 0.258 | 0.04 | 0.029 | 6.618 | 5.012 | - | - |

In the case of host plants, leaves generally had more minerals than stem. Nitrogen trend decreased as resistance in host plant varieties increased. Results confirmed opposite behavior for the P concentration. Other examined minerals were considerably variable i.e. K, Fe, Zn being lowest and Ca, Mg, Cu highest in the tolerant variety.

## DISCUSSION

Results pointed out that parasitic weeds compete with host plants for their nutrients. In this considered study this concept has been confirmed particularly for the P concentration of broomrapes. Data are general agreement with the conclusions of ALKAMPER (1976) and ERNST (1986), who explain the case by the transportation of carbonhydrates as phosphorilated sugars from host plant to *O. cernua.*

It is also evident that N content of sunflower leaves increased as resistance decreased which may be attributed to the succulence tissue texture in enhanced N concentrations. Whereas opposite trend is achieved for the P concent which puts forth that attention should be focused on P concentration of sunflowers since *O. cernua* is a very strong sink in this respect. Results pointed out the significance of a balanced mineral composition in host plants.

## ÖZET

### CANAVAROTU (*Orobanche cernua* Loefl.) VE PARAZİTLENEN AYÇİÇEĞİ ÇEŞİTLERİNİN MİNERAL İÇERİKLERİ

Farklı dayanıklılık gösteren canavarotu ile parazitlenmiş ayçiçeği çeşitlerinin ve canavarotunun (*O.cernua*) mineral içerikleri (N, P, K, Ca, Mg, Fe, Zn, Cu) üzerinde çalışılmıştır.

Canavarotu konukçu bitkiye göre daha fazla fosfor içeriğine sahiptir. Yüksek miktarda P ve Zn içerikli canavarotu, dayanıklı ayçiçeği çeşitleri parazitlemektedir. Aynı zamanda ayçiçeği yapraklarındaki N içeriği azaldığında, çeşitlerindeki dayanıklılık artmaktadır.

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2. Manuscripts must be written in English, German or French.

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## YAYIN İLKELERİ

1. Yayın için gönderilen araştırma makaleleri, Fitopatoloji ana bilim dalında yer alan mikoloji, bakteriyoloji, viroloji, herboloji, toksikoloji ve nematoloji alanında orijinal çalışmalar olmalıdır.

2. Makaleler İngilizce, Almanca veya Fransızca yazılmalıdır.

3. The Journal of Turkish Phytopathology'de yayınlanması kabul edilen makaleler başka bir yerde, herhangi bir şekilde veya dilde yayınlanamaz.

4. Araştırma makalelerinin yanısıra, dergide editöre mektuplar, kitap tanıtımı ve kısa bildiriler yayınlanır.

5. Makaleler başlık, yazar adı, abstrakt, giriş, materyal ve metot, sonuçlar, tartışma ve kanı, özet, teşekkür (gerekli ise) ve kaynaklar bölümlerini içerecek şekilde düzenlenmeli ve derginin yazım kurallarına göre hazırlanmış olmalıdır.

6. Tüm makaleler, redaksiyon kurulunca incelenir, Dernek Yönetim Kurulu tarafından değerlendirilir ve sonuç yazarına bir yazı ile iletilir. Kabul edilmeyen makaleler yazarına geri gönderilir. Makalelerin kabulü sadece onların bilimsel değerlerine bağlıdır. Yayınlanacak makaleler alındıkları sırayla yayınlanır. Redaksiyon kurulu Fitopatoloji ana bilim dalındaki öğretim üyeleri ve Zirai Mücadele Araştırma Enstitüsünde çalışan tüm uzman araştırıcılardan oluşur.

7. Yazar veya yazarlar grubuna yirmibeş adet ayrı basım gönderilir. Ayrıca telif hakkı ödenmez.

8. Yayınlanan yazıların tüm sorumluluğu yazı sahiplerine aittir.

All Correspondance Should Be Made To:
TÜRKİYE FİTOPATOLOJİ DERNEĞİ
Zirai Mücadele Araştırma Enstitüsü
35040 Bornova , İzmir - TÜRKİYE