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ALLELOPATHIC EFFECTS OF DOPA AGAINST FOUR WEED SPECIES

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ABSTRACT

Dopa is a natural product of some plants such as velvetbean. Its herbicidal effects on weed species; wild mustard (*Sinapis arvensis*), creeping thistle (*Cirsium arvense*), field poppy (*Papaver rhoeas*) and henbit (*Lamium amplexicaule*) were investigated using wheat (*Triticum vulgare*) and barley (*Hordeum vulgare*) species as control plants. Dopa showed suppressive herbicidal effect at 1500 and 3000 mg/l concentrations on the weeds without significantly affecting wheat and barley growth. The most affected weed species was found field poppy. Comparing growth of all weeds, inhibition in the growth of roots was more prominent compared to the growth of shoots.

Key Words: *Allelochemical, dopa, herbicidal effect, seedling growth, weed control.*

DOPA'NIN YABANCI OTLAR ÜZERİNDE ALLELOPATİK ETKİSİ

ÖZET

Dopa kadife bakla gibi bazı bitkilerin tabi bir ürünüdür. Bu çalışmada yabancı otlar; Yabani hardal (*Sinapis arvensis*), köy göçüren (*Cirsium arvense*), gelincik (*Papaver rhoeas*) ve ballıbaba (*Lamium amplexicaule*) türleri ile buğday ve arpa üzerine dopanın herbisit etkisi araştırılmıştır ve karşılaştırılmıştır. Dopanın 1500 ve 3000 mg/l konsantrasyonları yabancı otların gelişimini istatistiksel olarak önemnli derecede azalma fakat buğday ve arpada çok olumsuz bir etkisinin bulunmadığı gösterilmiştir. Dopadan en çok etkilenen türün *Papaver rhoeas* olduğu bulunmuştur. Kullanılan yabancı otların geneline bakıldığında kök uzamasındaki azalma gövde uzamasından daha fazla olmuştur.

Anahtar Kelimeler : *Allelokimyasal, dopa, herbisit etkisi, fide büyümesi, yabancı ot kontrolü.*

1. INTRODUCTION

Weed control research during last 50 years has focused exclusively on the development of synthetic herbicides (e.g., 2,4-D, amitrole, atrazine). But widespread use of synthetic herbicides has resulted in herbicide-resistant weeds, with disturbed ecological balance and human health [1]. There has been an increasing interest in weed control strategies with natural compounds released by plants, called allelochemicals. During recent years, because, they have short half-life as they are biodegradable and are more safe than synthetic compounds with little damage to the environment. That is, compared with long persistence, non-target toxicity, pollutant, carcinogenic and mutagenic activity of synthetic herbicides, natural plant products are biodegradable and are likely recycled in nature [2,1].

The release of allelochemicals from plants occur by volatilization, leaching especiallyy from leaves, exudation from roots and degradation of dead plant parts. Sometimes an allelochemical produced by a plant is harmful to another and beneficial to a third one; but they are, generally, toxic and causes stress and even death [3-6].

Phenolic allelochemicals are belived to function as defensive agents against invading microbes and as signal molecules in plant interactions with pathogens and parasitic angiosperms [5]. Dopa, an allelochemical, belong to phenolic compounds has been shown to be synthesized in broad bean (*Vicia faba*) leaves and localized in the apoplast as well as the symplast [7].

Some allelochemicals such as tentoxin, sorgoleone, artemisinin, hydantocidin, chaparrinone, pelargonic acid, and parthenin indicate inhibition in weed growth [8,2]. However, we have not encountered any reports about the herbicidal effect of dopa. Therefore, we studied the effect of dopa against four broadleaf weed species *Sinapis arvensis*, *Cirsium arvense*, *Papaver rhoeas* and *Lamium amplexicaule*.

2. MATERIALS AND METHODS

Seeds of wheat (*Triticum vulgare* cv. Gerek 79) and barley (*Hordeum vulgare* cv. Kışlık) were obtained from the Depertment of Agriculture in Kütahya. These seeds were sown in plastic pots filled with sterilized turf. Wheat and barley were used to compare the effects of dopa on weeds and determine dopa doses harmful to these cultured plants.

Four weed species, wild mustard (*arvensis*), creeping thistle (*arvense*), field poppy (*rhoeas*), henbit (*amplexicaule*) are the most common weeds of wheat and barley in the Kütahya province were used as test plants to observe the herbicidal activity of dopa. These weed species are also common in most of the world. The seedlings of the weeds with two or three leaves were taken from the field during May and brought to the laboratory; where their roots were washed to remove mud and measure root, shoot lengths and fresh weights of the seedlings determined. These values were recorded as initial growth values. The seedlings were planted into plastic pots filled with sterilized turf. All plants were maintained on laboratory benches. The temperature and relative humidity were measured as 20/15 ^{o}C (day/night) and 45/60 % (day/night), respectively. All seedlings were left to grow for ten days.

After that, the dopa solutions were sprayed on the foliar parts of the plants at concentrations of 0, 750, 1500 and 3000 mg/l. Dopa (L-3,4-dihydroxyphenylalanine) was purchased from SIGMA company as a pure chemical. Dopa solutions were prepared freshly prior to application by dissolving the chemical in a small amount of KOH (1%) and making up the desired volume in distilled water. Tween-20 was mixed with the solutions at a concentration of 0.01% to facilitate absorption of dopa, with application of 0.01% solution of Tween-20 only to the plants which served as control. The solutions were sprayed on the foliar parts of the plants until the solutions began to drop from the leaves. After 10 days, all plants were taken out of the pots; to compare their root, shoot lengths and seedling weights. These values were assumed as the final growth values. Change in growth was determined by subtracting initial growth values from the final growth values.

The experiment was conducted using a completely randomized design with three replicates. The data were analyzed by ANOVA. Significant differences between the treatmentmeans of dopa and control were determined using Dunnet test.

3. RESULTS AND DISCUSSION

A typical property of an allelochemical is to have a growth inhibiting effect on some species, with rarely growth stimulating effect on certain other species. We have hypothesized that this property may be useful in weed management if dopa is harmful on weeds but not on cultivated plants. In agreement with this hypothesis, it was found that dopa was harmful for all the weeds studied here without causing any significant damage to in wheat and barley (Table 1). Just like, parthenin which showed a significant herbicidal effect against *Ageratum conyzoides* with marginal effects on wheat growth [8].

TABLE 1. Effect of dopa on growth parameters of wheat, barley and weeds. Each value in the table is mean of three replicates. Values in parentheses are percent inhibition.

	Dopa			
Species	0(Control)	750mg/l	1500mg/l	3000mg/l
Root length (cm)				
Wheat	22.56	22.87 (0)	20.25 (10)	20.06 (11)
Barley	27.44	26.75 (3)	26.75 (3)	26.37 (4)
Wild mustard	7.22	6.84 (5)	5.74 (20)*	4.70 (36)**
Creeping thistle	16.00	14.75 (8)	12.50 (22)*	10.62 (34)**
Field poppy	4.10	3.50 (15)*	2.52 (39)**	1.78 (57)**
Henbit	2.44	2.18 (11)	1.78 (27)*	1.38 (43)**
Shoot length (cm)				
Wheat	28.81	27.94 (4)	26.19 (9)	25.31 (12)
Barley	27.31	26.62 (3)	26.50 (3)	26.25 (4)
Wild mustard	41.46	38.80 (6)	37.64 (10)*	35.66 (14)*
Creeping thistle	11.37	10.37 (9)	9.87 (13)*	7.50 (35)**
Field poppy	11.20	10.64 (5)	7.82 (30)**	7.32 (35)**
Henbit	6.74	6.00 (11)	5.34 (21)**	4.70 (31)**
Fresh weight (mg)				
Wheat	0.221	0.227 (0)	0.218 (1)	0.204 (8)
Barley	0.356	0.340 (4)	0.329 (8)	0.319 (11)
Wild mustard	1.862	1.370 (26)**	1.130 (39)**	1.048 (44)**
Creeping thistle	1.313	1.052 (20)**	0.813 (38)**	0.437 (67)**
Field poppy	0.420	0.360 (14)*	0.150 (64)**	0.081 (81)**
Henbit	0.218	0.204 (6)	0.196 (10)	0.178 (19)*

* * ($P < 0.01$), * ($P < 0.05$). Treatments differ significantly from the control (Dunnet).

Although dopa has insecticide activity [9], no information is available about its herbicidal activity. However, it has been indicated that velvetbean, with L-dopa as the responsible chemical for velvetbean phytotoxicity, is a good candidate to smoother weeds [10]. Among all dopa concentrations, 1500 and 3000 mg/l significantly inhibited root and shoot growth, wheras, 750 mg/l dopa did not affect weed growth. However, this concentration of dopa resulted significant decreased of fresh weight of all weeds except henbit. The results (Table 1) further show that, the most affected weed species by dopa was the field poppy. Generally, root elongation of the weeds was affected more compared to shoots. The percent inhibition of root, shoot elongation and fresh weight were 57%, 35% and 81% in field poppy by 3000 mg/l of dopa. Whereas percent growht inhibitions of wheat and barley by 3000 mg/l dopa were nonsignificant with a range of 4-12%.

In conclusion, this study indicates that dopa has a growth suppressive effect on weeds especially field poppy without affecting growth of wheat and barley significantly. This ability of dopa can be utilized for future weed management strategies and increase crop yield. As synthetic herbicides disturb ecological balance of natural environment and human health, dopa may be more safe than synthetic herbicides used in weed management because of containing biodegradable compounds with natural origin.

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