

## EFFECTS OF PHYTOPHTHORA ROOT ROT AND METALAXYL TREATMENT ON THE YIELD OF SOME FORAGE BRASSICA SPECIES

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### BAZI YEM BİTKİSİ BRASSICA TÜRLERİNDE PHYTOPHTHORA KÖK ÇÜRÜKLÜĞÜNÜN VE METALAXYL UYGULAMASININ ÜRÜNE YANSIYAN ETKİLERİ

**ÖZET:** Yem bitkisi olarak kullanılan üç *Brassica* türü Kayalık Dağlar bölgesinde (ABD) yetiştirilmesi, şartlara ve çevreye uyum yetenekleri yönünden incelenmiştir. *Brassica* türleri önceden *Brassica oleracea* var. *acephala* 'kale' üzerinde gözlemlenen bir *Phytophthora* hastalığı ile enfekteli tarlalarda yetiştirilmiştir. Metalaxyl muamelesinin *Brassica* mahsul miktarını önemli bir ölçüde etkilemediği görülmüştür. Zararlı problemlerinin olmasına rağmen, *Brassica* türleri düşük ısı derecelerine tolerans göstermişler ve 9.90 Mg/ha a kadar ürün alınmıştır. *Brassica* türlerinden izole edilen *Phytophthora* izolatları *Phytophthora megasperma* olarak teşhis edilmiştir. Bu izolatlar konukçuya özelleşmiş olarak gözüken yonca izolatı *Phytophthora megasperma* f.sp.*medicaginis* izolatından farklılıklar göstermiştir.

**SUMMARY:** Three forage *Brassica* species were evaluated for their growth and adaptability to the Rocky Mountain region. Brassicas were grown in fields infested with a *Phytophthora* disease previously observed on kale (*Brassica oleracea* var. *acephala*). Metalaxyl treatment did not affect *Brassica* yields significantly. Although pest problems were detected, *Brassica* crops tolerated low temperatures and produced excellent yields ( up to 9.90 Mg/ha). The *Phytophthora* isolates from *Brassica*, which were identified as *Phytophthora megasperma*, differed from the alfalfa (*Medicago sativa*) pathogen *Phytophthora megasperma* f.sp.*medicaginis* which appeared to be host specific.

### INTRODUCTION

*Brassica* species offer the opportunity of producing a second crop, even in northern climates. In addition to rapid maturity, they are relatively easy to establish and provide a high quality forage for extending the grazing season (Jung et al., 1986; Koch et al., 1987; Guillard and Allinson, 1988). Productivity and usefulness of the *Brassica* forages for livestock production and as a rotational crop depends, to a certain degree, on the impact of diseases and pests.

In previous *Brassica* studies conducted at Powell, Wyoming, a *Phytophthora* sp., resembling the alfalfa (*Medicago sativa* L.) pathogen *P. megasperma* Drechs. f. sp. *medicaginis* Kuan and Erwin, was isolated from kale (*Brassica oleracea* L. var. *acephala* DC.) roots showing root rot symptoms. The area was previously planted to alfalfa. *Phytophthora* root rot (PRR) of alfalfa is

common throughout Wyoming (Gray et al., 1983).

In Wyoming, studies on the diseases and pests on forage *Brassica* species have been limited. Susceptibility to pests and discases, particularly *Phytophthora*, the organism which attacks alfalfa, has not been reported for the forage brassicas. *Brassica* species can be grown as a break crop following plow down of alfalfa. Efficient use of residual N from alfalfa would reduce the cost of producing these crops. However, disease susceptibility may limit use of these crops in a rotation.

The objectives of this study were to determine adaptation and yield of *Brassica* species, determine susceptibility to *Phytophthora*, determine if the PRR organism attacking alfalfa also attacks forage brassicas and to determine if fungicide application is necessary or effective in disease control under field conditions where PRR is present.

## MATERIALS AND METHODS

The experiments were conducted at the University of Wyoming Research and Extension Center at Powell, Wyoming and Honor Farm at Riverton, Wyoming during 1990. Three *Brassica* species, 'Premier' kale (*Brassica oleracea* L. var. *acephala* DC.), 'Emerald' rape (*Brassica napus* L.), 'Tyfon' (*Brassica rapa* L. x *Brassica pekinensis* (Lour.) Rupr.), a turnip x Chinese cabbage hybrid, and 'Ranger' alfalfa (*Medicago sativa* L.) were seeded. The experiments consisted of metalaxyl-treated and untreated plots. Seeds were treated with Apron® (0.5 kg a.i./100 kg seed), a powder formulation of metalaxyl (N - (2, 6 - dimethyl - phenyl) - N - (methoxyacetyl) alanine methyl), before planting. Ridomil® 2E, a liquid formulation of metalaxyl, was applied at 1.17 liter a.i./ha to the treated plots 3-5 weeks later. Seeding rate was 4.48 kg/ha of pure live seed. All studies were split plot designs with five replications. Main plots consisted of fungicide treatments and subplots were species.

May 23 planting, Powell. In the experimental plot area 'Decathlon' alfalfa was grown since 1985. On April 18, 2, 4-D (2, 4-dichlorophenoxy acetic acid) was applied to the alfalfa (2.24 kg a.c./ha) and the area was plowed on April 23. On April 23, 56 kg/ha each of N and P, and trifluralin ( $\alpha, \alpha$ -trifluoro-2, 6-dinitro-N, N-dipropyl-p-toluidine) at 0.78 liter a.i./ha were applied and incorporated to the entire experimental area. On May 23, another 56 kg/ha N was applied and plots were seeded. Plots were irrigated by way of furrows spaced 91.5 cm on May 24. Seeding was accomplished with a tractor mounted cone planter. Ten rows were spaced 17.8 cm apart in two, 91.5 cm beds. Subplot size was 1.83 x 6.56 m. Entire plots were hand harvested on October 2-4.

July 25 planting, Powell. This experiment was set up adjacent to the May 23 experiment. Alfalfa was plowed on July 10 and harrow leveled on July 16. On July 23, 112 kg/ha P, 45 kg/ha N as ammonium nitrate, and trifluralin were broadcast and incorporated over the experimental area. Harvesting was on November 18.

May 22 planting, Riverton. The cropping history of the experimental area was: 1986, alfalfa; 1987, corn; 1988, sorghum and sudangrass; 1989-1990, alfalfa. On May 22, the experimental area was moldboard plowed, tandem disked, and roller harrowed twice. Also the same day, trifluralin was applied to the entire area. Seeding was with a cone planter. Ten rows were spaced 12.7 cm apart.

Subplot size was 1.52 x 4.57 m. Entire plots were hand harvested on September 18.

July 24 planting, Riverton. The experimental area was tilled on July 23. Subplot size was 0.76 x 4.57 m. Harvesting was on November 12.

General procedures. Plots were flood irrigated at Powell and sprinkler irrigated at Riverton. Plots were examined for the presence of the *Phytophthora* disease and other diseases and pests. Roots of 5 randomly selected plants from each plot were examined for the presence of root rot symptoms. Suspected plants were taken to the laboratory. In order to determine if *Phytophthora* was present, roots were washed, blotted dry and were placed into petri dishes containing corn meal agar (17 g/l) amended with dextrose (2 g/l), pimaricin (1 ml/l), penicillin (0.1 g/l) and streptomycin sulfate (0.1 g/l). Plates were examined daily and agar pieces from suspected colonies, 0.7 mm in diameter, were transferred to 5.5 cm petri dishes containing sterile water. Agar pieces were examined daily for oospore and sporangia production.

Plant samples were taken for dry matter determination. Samples were dried in ovens at 80°C to a constant weight.

## RESULTS AND DISCUSSION

May 23 planting, Powell. Analysis of variance showed significant species effect (Table 1). There was no significant metalaxyl treatment effect. Since there was no metalaxyl x species interaction, yields were averaged over fungicide treatments. Average kale, rape and Tyfon dry matter yields 133 days after planting were 2.79, 4.50 and 2.99 Mg/ha, respectively (Table 2). Alfalfa plots exhibited poor growth.

This could be due to the presence of pathogens in the soil, including

*Phytophthora megasperma* f.sp. *medicaginis*. It is also possible that alfalfa

Table 1. Analysis of variance for forage yield.

	Powell		Riverton	
	May 23 planting	July 25 planting	May 22 planting	July 24 planting
Fungicide	NS	NS	NS	NS
Species	**	NS	**	**
Fungicide x Species	NS	NS	NS	NS

NS= Not significant. \*\* Significant at P < 0.01

Table 2. Dry matter yield of forage *Brassica* species (Mg/ha).

	Powell		Riverton	
	May 23 planting	July 25 planting	May 22 planting	July 24 planting
Kale	2.79 B	1.12	3.40 B	6.93 A
Rape	4.50 A	1.60	9.90 A	5.90 A
Tyfon	2.99 B	0.75	3.29 B	2.95 B
LSD (0.05)	1.04	NS	1.45	1.51
Harvest date	October 2-4	November 18	September 18	November 12

NS= Not significant

residue exhibited an autotoxic effect towards germinating alfalfa seedlings. Rape yields were significantly greater (P < 0.05) than kale and Tyfon yields, which did not differ (Tables 1 and 2).

Rape was taller than both kale and Tyfon and still vigorously growing at harvest. Kale and Tyfon seemed to cease growth prior to harvest. Tyfon yields included root and shoot growth, since both are consumed by grazing livestock. At harvest, kale and rape were approximately 15% dry matter. The dry matter content of Tyfon averaged about 10.8%. Aphids and lepidoptera damage to the *Brassica* leaves was observed. Larvae damage was the highest in kale. Rape appeared to be the most resistant to the pests. There was a considerable number of weeds not controlled by trifluralin. The most abundant weeds were wild brassicas (*Brassica kaber* (DC.) Wheeler) and wild oats (*Avena fatua* L.). Rape and kale appeared to compete against weeds better than Tyfon. Dry matter content of the weeds was between 24% and 41%, considerably greater than that of the seeded brassicas. *Phytophthora megasperma* was isolated from untreated Tyfon plants showing root rot symptoms (Table 3.) *Phytophthora megasperma* f.sp.

*medicaginis* was isolated from alfalfa roots only.

July 25 planting, Powell.

Metalaxyl treatment had no effect on plant yield (Table 1). Although *Brassica* dry matter yields 117 days after planting varied from 0.75 to 1.60 Mg/ha, differences were not significant (P < 0.05) (Table 2).

Even though some aphids and insect larvae were detected on the leaves, the damage was negligible with the late planting. All three crops tolerated low temperatures before the mid-November harvest. Kale exhibited the best cold tolerance. *P.megasperma* was not isolated from any root, however, *P.megasperma* f.sp. *medicaginis* was isolated from diseased alfalfa roots.

May 22 planting, Riverton.

Analysis of variance for forage yield showed that, only significant (P < 0.01) effect was species (Table 1). Dry matter yields were not significantly affected by fungicide treatment. Yield response was similar to that of the early planting at Powell. One hundred-twenty days after seeding average kale, rape and Tyfon dry matter yields were 3.40, 9.90 and 3.29 Mg/ha (Table 2). Tyfon yields included shoots in addition to the roots. Rape yield was significantly (P < 0.05) greater than

kale and Tyson yields, which did not differ. Kale and rape forage at harvest had low dry matter content, averaging about 11%. Dry matter content of Tyson was greater, averaging 17.8 percent.

Aphid and larvae damage to the leaves of brassicas was noted. Insect larvae damage to the kale leaves was the most serious. There was a considerable amount of weeds (0.94-1.56 Mg/ha). The most abundant weed was lambsquarter (*Chenopodium* sp.) Dry matter content of weeds was higher than the dry matter content of brassicas, averaging about 30%. Kale and rape appeared to compete better with weeds than Tyson. Rape was taller than kale and Tyson and was still vigorous at harvest. *P. megasperma* was not isolated from any root, however, *P. megasperma* f.sp. *medicaginis* was readily isolated from alfalfa roots showing root rot symptoms

July 24 planting, Riverton. In the analysis of variance, significant species effect was observed but there was no significant effect of metalaxyl treatment (Table 1). Average dry matter yields of kale, rape, and Tyson were 6.93, 5.90 and 2.95 Mg/ha, respectively, 113 days after planting. Kale and rape yields were similar and significantly ( $P < 0.05$ ) greater than Tyson yields. Tyson yields also included root yields. Average percent dry matter for kale, rape and Tyson was 16.6, 23.0 and 14.9, respectively.

Even though all three crops showed reasonable cold tolerance, kale was the least affected and produced a relatively high yield. Insect problems were less with the late compared to early planting. Again, *P. megasperma* was not isolated from any root. On the other hand, *P. megasperma* f.sp. *medicaginis* was readily isolated from diseased alfalfa roots.

Metalaxyl treatment of seeds and roots did not affect *Brassica* yields significantly. *P. megasperma*, which appears to be less virulent than the alfalfa pathogen, did not seem to affect *Brassica* yields significantly during the experimental period.

*Phytophthora megasperma* was detected in *Brassica* roots only once. The alfalfa pathogen *Phytophthora megasperma* f.sp. *medicaginis*, however, was readily isolated from diseased alfalfa roots (Table 3). *Phytophthora* root rot of alfalfa is common in Wyoming (Gray et al., 1983). This pathogen produced small oogonia ( $x = 31 \mu\text{m}$ ). In this study, we were unable to isolate the alfalfa pathogen from *Brassica* roots. This pathogen does not seem to affect *Brassica* crops under field conditions. Host specificity of the alfalfa pathogen was previously reported and Hansen and Maxwell (1991) named the alfalfa pathogen as *Phytophthora medicaginis*. *P. megasperma* isolated from *Brassica* grew faster than the alfalfa pathogen and its optimum growth was around 25°C. The *Brassica* isolate has large oogonia ( $x = 48 \mu\text{m}$  and  $54 \mu\text{m}$ , for kale and Tyson isolates, respectively) and it produced aerial growth in corn meal in contrast to the alfalfa pathogen which was non-fluffy in appearance. *Phytophthora megasperma* isolated from *Brassica* fits the description of Hansen and Maxwell (1991).

Throughout the experiments flea beetle, larvae and aphid damage to the leaves of brassicas were noted. Flea beetle (*Phyllotreta* sp.) damage was negligible. Larvae damage was highest in kale. Larvae damage to the rape and Tyson leaves was medium.

Table 3. Occurrence of *Phytophthora* during the experimental period of 1990.

	Powell		Riverton	
	May 23 planting	July 25 planting	May 22 planting	July 24 planting
<i>Phytophthora megasperma</i> (from <i>Brassica</i> )	+	-	-	-
(from alfalfa)	-	-	-	-
<i>P.m.f.sp.medicaginis</i> (from <i>Brassica</i> )	-	-	-	-
(from alfalfa)	+	+	+	+

These caterpillars attacking to the leaves were identified as *Autographa californica* (Speyer) (alfalfa looper), *Pieris rapae* (L.) (imported cabbageworm) and *Melanchra picta* (Harris) (Zebra caterpillar). Alfalfa looper was not detected in Riverton. Larvae damage was heavier with the earlier planting dates. Imported cabbageworm and flea beetle damage was also reported from Eastern USA (Jung et al., 1986). Heavy infestation of cabbage aphid (*Brevicoryne brassica* (L.)) was observed at both locations. Kale plants had heavy infestation. Rape and Tyfon were moderately affected by the aphids. Aphid damage was greater with the earlier planting dates. Powdery mildew caused by *Erysiphe cruciferarum* Opiz ex Junell was detected at both locations. This disease was also found on *Brassica* spp. grown in the Eastern USA (Jung et al., 1986).

All crops established quickly; however, a herbicide application, particularly before the early planting dates, might be necessary for crop establishment. Rape was the most consistently high producing crop at both locations and with early and late planting. Kale was much more variable in yield. Tyfon was the least productive with later planting. Additionally, low dry matter content of Tyfon forage may limit dry matter intake of grazing animals.

It appears that *Brassica* crops are adapted to the Rocky Mountain region. All crops tested tolerated low temperatures; however, a cooler than normal fall, particularly with late planting, might be expected to favor kale as it has superior cold tolerance. The *Brassica* yields obtained in Wyoming were comparable to those reported at other locations in USA (Jung et al., 1986; Rao and Horn, 1986; Guillard and Allinson, 1988). These crops showed promise for producing forages for fall livestock grazing under Wyoming irrigated conditions.

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