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Full Length Research Paper

Rotational and nematicidal effect of lupine (*Lupinus albus* L.: Leguminosae)

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The study was conducted to evaluate the nematicidial and rotational activity of lupine (*Lupinus albus* L.), in completely randomized design in a growth room in pots, in 2011. Naturally infested soil, from an arable land containing root-lesion nematode Pratylenchus thornei Sher and Allen including several other genera of free-living was used. Firstly, lupine (*L. albus*) and wheat (*Tricum durum*- the variety Eyyubi) were sown and allowed to grow for 3 months. Secondly, differing doses of lupine extracts were applied to the infested bare soil and allowed for a week. *P. thornei* population was significantly suppressed in lupine planted pots compared to the wheat planted soil and bare control treatment soil. The nematicidal effect of lupin extract was found to be effective on suppressing *P. thornei*. The suppression effect of the extract increases as the dose increased. The study suggests the use of lupine plant in two ways: as an effective rotational plant against the root-lesion nematodes in wheat growing areas and as an amendment of its seed extract against plant parasitic nematodes.

Key words: Lupine, lupine seed extract, nematodes, nematicidal effect.

INTRODUCTION

Alternative nematode control methods to the conventional ways are a growing concern in agricultural nematology. Especially, after the worldwide ban of methyl-bromide, most growers seek a chemical control agent as effective as it was. Sometimes one single chemical agent cannot provide the expected effect and a second chemical agent is ultimately leading to the increased costs and environmental hazards. On the other hand, parallel to the increasing popularity of organic farming which currently more than 31 million hectares are under organic management in 120 countries worldwide (Willer and Yussefi, 2001), the demand for effective and additional alternative control methods grows even more.

For more than 6 decades, many plants and their components have been tested for their potential in controlling plant-parasitic nematodes. Plants have been selected for local convenience or on the basis of reported efficacy against nematodes or other pests (Ferris and Zheng, 1999; McSorley, 1999; Wang et al., 2007; Marla et al., 2008; McSorley et al., 2009; Barbosa et al., 2010).

Lupine seeds have long been used as a source of food, rich in proteins, for animal feeding and human consumption. Besides, their antioxidant phytochemicals that have many health benefits including prevention of various diseases associated with oxidative stress such as cancer, cardiovascular disease, neuro-degeneration and diabetes (Wang and Clements, 2008), and containing alcholoids such as spartein and anagryne, lupine has an important place in pharmaceutical industry (Kayserilioglu, 1990).

Lupine is also considered to be a good yielding crop especially in poor and stressed environments, as an alternative in winter and dry land production systems where other legumes cannot perform well enough (Bhardwaj, 2002; Kephart et al., 1990; Yorgancilar et al., 2009).

Lupine has long been known locally in Destigin, Konya, Turkey for its bitter compounds that harm humans and animals when consumed in untreated form (Anonymous, 2011). Stobiecki et al. (1993) studied phenolic compounds isolated from bitter lupine seeds and their inhibitory effects on germination and seedling growth of lettuce. Yorgancilar et al. (2009) suggested that waste of boiled lupine water which contain bitter alcholoid compound might be used in organic farming against the pests.

Lupine have been used as a rotational crop with cereals to explore its effect on plant parasitic nematode population reduction (Osler et al., 2000; Harries and

Table 1. The effect of lupine plant as a cover plant on nematode reproduction rate compared to wheat and bare soil.

Nematode	Control P_i	Control P_f	Lupine P_i	Lupine P_f	Wheat P_i	*Wheat* P_f	Control R_0	Lupine R_0	Wheat R_0
P. thornei	187	96	167	5	191	290	0.51	0.03	1.52
Tylenchus	43	128	40	32	37	92	2.98	0.80	2.49
Geocenamus	20	10	20	0	17	20	0.50	0.00	1.18
Aphelenchus	127	312	120	5284	145	988	2.46	44.03	6.81
Aphelenchoides	23	68	20	0	26	12	2.96	0.00	0.46
Ditylenchus	67	156	53	20	61	180	2.34	0.38	2.95
Cephalobus	40	44	43	16	37	22	1.10	0.37	0.59
Panagrolaimus	27	20	34	3260	41	26	0.75	95.88	0.63
Acrobeloides	140	197	132	21	147	360	1.41	0.16	6.80
Dorylaimids	60	36	40	24	36	40	0.60	0.60	1.11

$\mathbf{P_i}$, Initial population; $\mathbf{P_f}$, final population.

Peek, 2011), however, there has not been any record on lupine extract that can be used against plant parasitic nematodes.

Therefore, the objectives of the study were to evaluate lupine's nematode suppressive activity to both plant parasitic and free-living nematodes: (a) when to use it as a cover plant (b) when to use its extract.

MATERIALS AND METHODS

A completely randomized experimental design was set in micro pots of 300 g, with 5 replicates, in a growth room at 22°C with 16:8 lightening period. Soil, taken from an arable land containing root-lesion nematode *Pratylenchus thornei* Sher and Allen and several other genera of nematodes including free-living (Table 1), was used in the experiment. Soil type was clay-loamy with low organic matter and lime, and neutral pH. The soil was thoroughly mixed before transferred into pots, wheat and lupine seeds were sown, control pots were left unplanted, all the pots were irrigated and maintained for 3 months, from January to April in 2011.

Lupine seed extract was obtained by boiling 100 g of seeds in 1 liter of water for 1 h and left a day in the container to obtain the most extraction out of the seeds. The extract was amended into pots at 1 cc, 3 cc and 5 cc doses and allowed for a week to interact with nematodes.

Soil samples were collected from harvested pots and soil samples of 100 g run for nematode extraction by using modified Baermann funnel technique, based on self-mobility of nematodes. Nematodes were counted and allocated under light microscope.

Multiplication rates (R_0) of nematodes were calculated based on final population/initial population (Pf/Pi) ratios. An accurate impression of nematode multiplication and host status can be obtained by examining a range of Pi (McSorley and Gallaher, 1992). The suppressive or mortality effect of varying doses of lupine seed extract besides effect of wheat and lupine root systems were examined.

RESULTS AND DISCUSSION

The effect of lupine was examined in two ways: its rotational effect as non-host plant of root-lesion nematode, *P. thornei*, and the effect of lupine seed extracts as suppressive substance.

Rotational effect of lupine

Pi and Pf numbers of nematodes subjected to lupine and wheat planted pots and their R_0 are given in Table 1. Nematode suppressive effect of lupine on plant parasitic nematode *P. thornei* is obvious with R_0=0.03 when compared to the control and wheat pots R_0=0, 51 and R_0=1.52, respectively. Lupine planted pots gave a R_0 value for *P. thornei* much lower than, bare soil containing, control pots which may suggest that lupine plant is not only a good rotational plant of non-host but also a good suppressive plant (Harries and Peek, 2011).

A similar result is also seen on *Geosenamus* not as obvious as in the *P. thornei*. Free-living nematodes are also affected in lupine pots with varying degrees (ranging between R_0=0.00 to 0.80). When compared to the control pots (ranging between R_0=0.50 to 2.98), the same suppressive effect is still present. However, free-living genera *Panagrolaimus* and *Aphelenchus* surprisingly increased their population in lupine pots (R_0=95.88 and 44.03) compared to the control (R_0=0.75 and 2.46) and wheat (R_0=0.63 and 6.81) (Table 1). *Panagrolaimus,* is a bacterial-feeding nematode of opportunistic character*,* and their population growth is closely related to their substrate level (Yeates et al., 1993). Therefore, this much increase in the *Panagrolaimus* population can be attributed to lupine's ability of symbiotic nitrogen fixation.

Harries and Peek (2011), provides plenty of food. But, the increase of *Aphelenchus* population should be closely examined in a separate study for the actual cause. Some of the researchers found similar results with the present study that lupine suppressed plant parasitic nematodes whereas increased some of the free-living nematode populations (Osler et al., 2000; Harries and Peek, 2011).

Nematicidal effect of lupine seed extract

Nematode suppressive effects of differing doses of lupine seed extract compared to control pots are given in Table 2. All the nematode genera have been affected by the

Table 2. Suppression effect of differing doses of lupine seed extract on nematode genera.

Nematode	K	D_1		D_2		D_3	
		D_1 Number	D_1 Effect (%)	D_2 Number	D_2 Effect (%)	D_3 Number	D_3 Effect (%)
P. thornei	187	104	44.29	67	64.29	45	76.00
Tylenchus	43	20	53.6	11	74.29	8	81.21
Geocenamus	20	13	33.7	9	57.3	6	69.3
Aphelenchus	127	87	31.71	50	60.98	33	73.78
Aphelenchoides	23	16	31.25	6	75.00	1	93.75
Ditylenchus	67	39	42.19	36	46.88	23	65.63
Cephalobus	40	32	21.11	13	66.67	9	77.78
Panagrolaimus	47	30	35.53	18	61.13	11	76.06
Acrobeloides	140	104	25.56	100	28.89	48	65.56
Dorylaimids	60	40	33.33	33	44.44	17	72.22

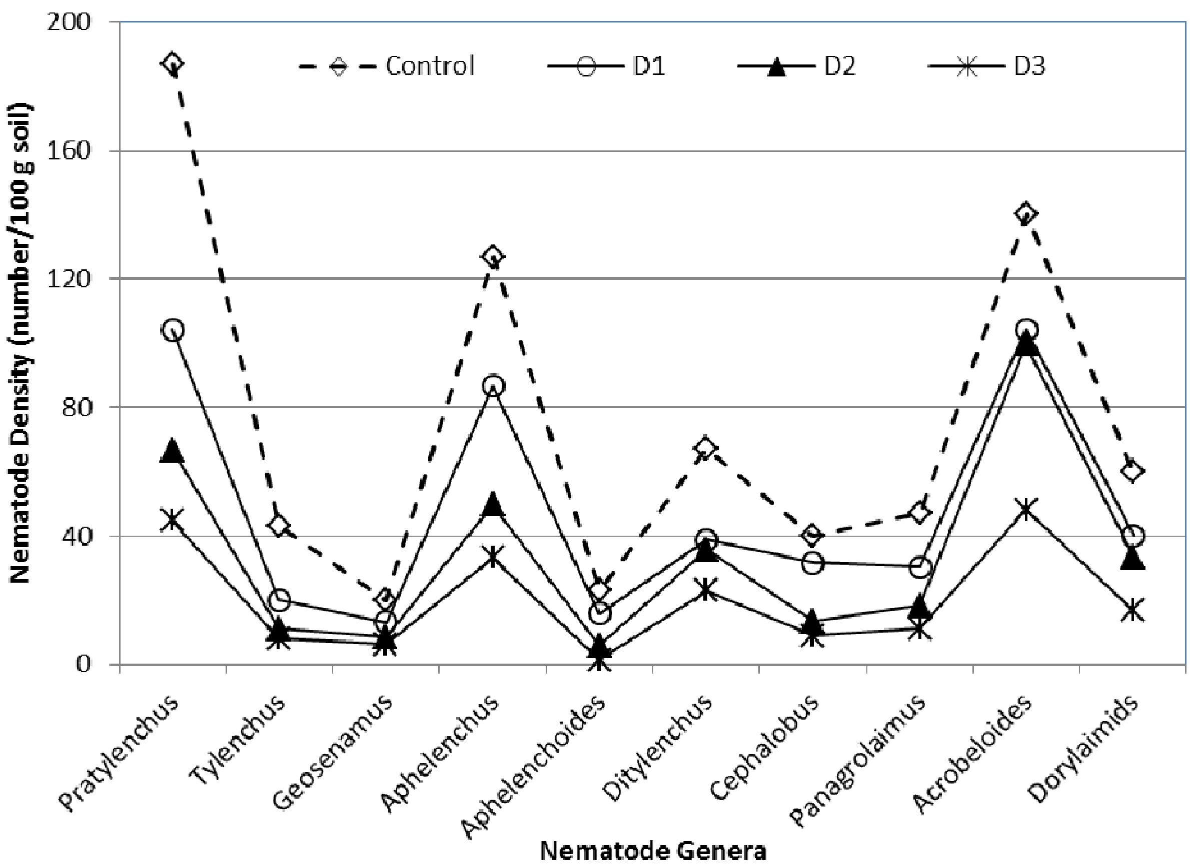

Figure 1. The suppressive effect of lupine seed extract on nematode genera. **D_1**, 1 cc; **D_2**, 3 cc; **D_3**, 5 cc lupine seed extract.

lupine extract in varying degrees (Figure 1). Average effect of amended doses are dose 1 (D_1) 35.23%, dose 2 (D_2) 58.0% and dose 3 (D_3) 75.13%. The most affected nematode genera are *Tylenchus* and *Pratylenchus* with 53.6%, 74, 3% and 81.2 %, and 44.3%, 64, 3% and 76.0% suppression, respectively.

Free living nematode fauna are affected by extract less than the plant parasitic nematodes. Among the free living nematodes, bacterivore group are more resistant to lupine seed extract than fungivore groups. Resistance of free-living nematodes to amended substances or the cover plants is desired to save the free-living fauna of the soil.

Lupine extract is found to be as effective as its rotational effect as a cover plant. Therefore, lupine extract can be used especially in organic farming practices of vegetables in limited areas. It also can be incorporated with chemical control practices to increase the effect of nematode management in conventional agriculture, as well.

Conclusion

The study suggests that lupine is a good candidate of a rotational crop for cereals grown especially in dry conditions. Sometimes cover crops do not have an encouraging commercial value nor need extra cost to grow that make them undesirable. Finding an effective rotational crop against some polyphagous nematodes that is, *Pratylenchus* spp. is also another frequently faced problem. Thus, lupine appears to be a promising crop for solving these problems. Moreover, the suppressive effect of its extract on plant parasitic nematode *P. thornei* gives the lupine one more place to be considered in nematode control programs in organic farming practices.

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