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INCIDENCE OF PLANT-PARASITIC NEMATODES IN PLOTS GROWN TO CHRYSANTHEMUM AND CARNATION

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ABSTRACT

A survey of plant-parasitic nematodes in plots grown to Chrysanthemum and Carnation at Institute of Himalayan Bioresource Technology, Palampur, India showed that Pratylenchus spp., Tylenchulus spp., Hoplolaimus spp., Longidorus macrosoma, Paratylenchus spp., Tylenchorhynchus spp., Aphelenchus avenae, Ditylenchus spp., Criconemoides spp. and Tylenchus spp. were associated with the crops. Low (1-100 / 200 ml soil), moderate (101-500/200 ml soil) to high (≥501/200 ml soil) populations of phytonematodes were extracted from soil around the roots of different cultivars of the crops. Relationships between soil chemical properties and mean nematode populations across cultivars indicate that suitability of host plant had greater effect on the abundance of nematodes than the soil chemical composition.

Keywords: Chrysanthenum, carnation, soil chemical properties, phytonematodes

INTRODUCTION

Chrysanthemum is one of the most important global cut flower and pot plants. Commercial cultivars are usually cultivated by vegetative cuttings or suckers. Traditional breeding and more recently, together with genetic, molecular techniques has focused on enhancement of the plant's ornamental value through the improvement of flower colour, size and form, vegetative height, growth form and sensitivity to light quality and quantity (Rout and Das, 1997). The production value of flowers in Japan has more than doubled in the last decade as a result of rapid improvement of living conditions, occupying 35% of the total cut-flower production (Teixeira da Silva, 2003). Carnation is a major ornamental crop, ranking third in importance in Japan after chrysanthemum and rose (Takashi *et al.*, 2001). It has an important position in the world floral industry. The total area given to carnation production in Spain is approximately 1300ha and about 166 x 10^6 dozen are produced each year (Sanchez-Navarro *et al.*, 1999)

It is well known that Chrysanthemum and Carnation are susceptible to plant-parasitic nematodes, but published reports on nematodes associated with the crops are few (Mizukubo, 1992; Rama Krishnan and Vadivelu, 1995; Fawzy *et al.*,1991; Khanna *et al.*,1999). The present study was therefore designed to isolate and identify phytonematodes associated with chrysanthemum and carnation and investigate relationships, if any, between nematode populations and some chemical soil properties. This was against the background that plant-parasitic nematodes inhabit the soil for varying length of time during their life cycle. Thus they are exposed to abiotic influences, which may affect their density and behaviour, among others, for as long as they remain in the soil.

MATERIALS AND METHODS

Study site

The present study was conducted at the Institute of Himalayan Bioresource Technology, Palampur, India (32° 04' 00" N latitude, 76° 29' 00"E longitude at 1270 m a.s.l). Soils from the roots of different cultivars of chrysanthemum and carnation grown in microplots with a surface area of 2.7 square metre and a volume of 294 litres, filled with sandy loam soil under greenhouse conditions were sampled in rainy season during the month of August, 2003.

Soil sampling

Soil samples for nematode and soil analyses were collected around the roots of 14 cultivars of chrysanthemum and 25 cultivars of carnation. For each cultivar, a bulk sample, consisting of 20 cores (diameter 1.9 cm; depth 0-20 cm) removed from 20

plants randomly selected (representing 80% of plants per cultivar) was collected around plant roots.

Nematode analysis

Nematodes were extracted from 200 ml sub-sample of the bulk soil sample using the method described by Whitehead and Hemming (1965). Nematode suspension was concentrated using a 325-mesh sieve, killed by heat over spirit lamp and fixed in 4% formaldehyde (Ruess *et al.* 1998). The bulk sample was properly mixed and 200 ml soil was taken from it in quadruplicates prior to nematode extraction. Nematodes were counted from the whole sub-sample by taking a portion at a time in a Doncaster counting dish (Doncaster, 1962) under a stereomicroscope (80 X magnification) and individuals from each sample were further identified under a compound microscope (400 X magnification). Identification was to genus level and in a few cases to species level (Mai and Lyon, 1960; Goodey and Hooper, 1965; Aboul-eid and Coomans, 1966; Foreman and Taylor, 1966).

Soil analysis

Sieved soil from each bulk sample was analyzed for soil pH, measured using a pH meter (Singh, 1997a), electrical conductivity by the digital electrical conductivity method (Singh, 1997b), available nitrogen by the alkaline potassium permanganate method (Singh, 1997c), and available phosphorus by HACH DR/2000 direct reading spectrophotometer (Singh, 1997d). Available potassium was determined by digital flame photometer (Schollenberger and Simon, 1945; Knudsen *et al.*, 1982) while the method described by Chopra and Kanwar (1991) was used to determine percentage organic matter.

Statistical analysis

Data were subjected to statistical analysis using the SAS (1985) statistical package. Differences between means of nematode populations were tested using Duncan's Multiple Range Test (DMRT) at P=0.05. Population densities per sample of plant-parasitic nematodes across cultivars of chrysanthemum and carnation regressed against soil pH, electrical conductivity (EC), percent carbon (C %), percent organic matter (OM%), available nitrogen (N), available phosphorus (P) and available potassium (K).

RESULTS

Plant-parasitic nematodes associated with chrysanthemum in the study site were: *Pratylenchus* spp., *Tylenchulus* spp., *Hoplolaimus* spp., *Paratylenchus* spp., *Longidorus macrosoma* and *Criconemoides* spp. while *Aphelenchus avenae* is known to occur on decaying roots (Table 1a). Low (1-100 / 200 ml soil) to moderate (101-500 /200 ml soil) densities of nematodes were recovered from the soil samples. Mean nematode densities across cultivars were negatively correlated with pH, EC, C%, O.M%, available P and available K but positively correlated with available N (Tables 1a and 1b). The highest nematode density was found in soil around the roots of Chandrama cultivar, but this was not significantly higher than the nematode density in Pink gin and Thinching queen cultivars of Chrysanthemum (Table 1a). Nematodes extracted from soil around the roots of carnation included: *Pratylenchus* spp., *Tylenchulus* spp., *Hoplolaimus* spp., *Longidorus macrosoma*, *Paratylenchus* spp., *Tylenchorhynchus* spp., *Aphelenchus avenae*, *Ditylenchus* spp., *Criconemoides* spp. and *Tylenchus* spp. (Table 2a). The nematode densities were low (1-100 /200 ml soil), moderate (101-500 / 200 ml soil) or high (≥501 / 200 ml soil) across cultivars. Nematode densities across cultivars were negatively correlated with pH and C%, positively correlated with EC, O.M%, available N and available P but not correlated with available K (Tables 2a and 2b). The highest nematode density was associated with Arthur Sim cultivar but this was not significantly higher that the density of nematodes associated with New espana, Pink aicardi, Orange triumph, White candy, Jose, Etore, Cabaret and Talima cultivars of Carnation (Table 2a).

DISCUSSION

The present study shows that plant-parasitic nematodes associated with chrysanthemum and carnation in the study site were: *Pratylenchus* spp., *Tylenchulus* spp., *Hoplolaimus* spp., *L. macrosoma*, *Paratylenchus* spp., *Tylenchorhynchus* spp., *A. avenae*, *Ditylenchus* spp., *Criconemoides* spp. and *Tylenchus* spp. Khanna *et al.* (1999) had earlier reported that the most prevalent pathogenic nematodes in carnation in Himachal Pradesh, India were: *Helicotylenchus varicaudatus*, *Meloidogyne incognita*, *Paratylenchus curvitatus*, *Pratylenchus pratensis*, *Macroposthonia xenoplax* and *Tylenchorhynchus mashhoodi*. Also Fawzy *et al.* (1991) reported incidence of *Meloidogyne incognita* in carnation, while Mizukobo (1992) and Ramakrishnan and Vadivelu (1995) reported the association of *Pratylenchus pseudocoffeae* and *Pratylenchus penetrans*, *M. incognita*, *Rotylenchulus reniformis*, *Helicotylenchus* spp. respectively with chrysanthemum in various parts of the world. The earlier workers also suggested that management of

phytonematodes was necessary to minimize crop losses that could arise from pathogenic activities of the pest. The relationships between mean nematode densities and soil chemical properties observed in the present study indicate that density of nematodes was more dependent on host suitability rather than soil chemical composition as suggested by Cuc and Prot

Table 1a: Plant-parasitic nematodes recovered from cultivars of chrysanthemum at Institute of Himalayan Bioresource Technology, Palampur (Number / 200 ml soil) in August 2003

Cultivar	A. avenae	*Pratylenchus* spp.	*Tylenchulus* spp.	*Hoplolaimus* spp.	*Paratylenchus* spp.	L. macroscoma	*Criconemoides* spp.	Total
Bronze Mundiyal	0	15	17	21	0	0	0	(53) 3.95g
White Stafour	73	26	25	21	37	0	0	(182) 5.20 d
Regol time	25	23	0	32	28	0	0	(108) 4.67 ef
Mundiyal	15	20	13	18	22	0	20	(108) 4.67 ef
Funshine	30	68	70	35	91	0	0	(294) 5.67 bc
Pink gin	51	57	48	75	62	49	0	(342) 5.83 ab
Royal mundiyal	48	41	23	25	07	07	0	(151) 4.99 d
Fish tail	09	21	25	15	0	0	34	(104) 4.63 f
Shyamal	45	38	51	22	40	0	45	(241) 5.47 c
Chandrama	43	62	43	41	72	35	104	(400) 5.99 a
Inga	12	14	0	0	06	0	10	(42) 3.71 g
Otme zakura	23	17	19	23	0	31	28	(141)4.94 de
Thiching queen	0	58	61	39	45	52	51	(306) 5.72 abc
Japanese	32	25	27	21	27	0	30	(162) 5.08 d

Each value is a mean of four replicates. Analysis of variance is based on logarithm-transformed data. In the Total column, figures in parenthesis are means of untransformed data, prior to transformation. Values with same letter(s) are not significantly different (P= 0.05) by Duncan's Multiple Range Test.

(1992). It is well known that nematode population dynamics is determined by inherent characteristics of individual nematodes subject to modification by environmental factors, food resources and interacting biotic agents. In the present study, food resources appear to be an important factor influencing nematode density.

Table 1b: Soil properties of Chrysanthemum plot at Institute of Himalayan Bioresource Technology, Palampur.

Cultivar	PH	EC (μ S)	C%	O.M.%	Available N (kg/ha)	Available P (mg kg^{-1})	Available K (mg kg^{-1})
Bronze mundiyal	6.19	698	0.75	1.30	157.5	248.75	180.0
White stafour	5.37	525	0.87	1.50	175.0	510.0	160.0
Regol time	5.34	731	1.27	2.20	157.0	519.0	260.0
Mundiyal	5.65	820	0.56	0.97	192.5	294.5	150.0
Funshine	5.80	530	0.72	1.25	175.0	291.0	80.0
Pink gin	5.52	467	0.97	1.68	140.0	293.5	80.0
Royal mundiyal	5.97	570	0.83	1.44	140.0	260.0	110.0
Fish tail	5.50	660	1.11	1.92	175.0	444.0	120.0
Shyamal	5.75	408	0.75	1.31	140.0	364.0	100.0
Chandrama	5.55	719	0.63	1.09	192.5	289.5	170.0
Inga	5.96	236	0.89	1.54	157.5	244.0	120.0
Otme zakura	5.64	590	0.99	1.71	140.0	400.0	120.0
Thiching queen	5.69	356	0.58	1.00	157.5	284.5	60.0
Japanese	6.76	195	0.59	1.03	140.0	131.75	70.0

Table 2a: Plant-parasitic nematodes recovered from cultivars of carnation at Institute of Himalayan Bioresource Technology, Palampur (Number / 200 ml soil) in August 2003.

Cultivar	*Pratylenchus* spp.	*Tylenchulus* spp.	*Hoplolaimus* spp.	*L. macrosoma*	*Paratylenchus* spp.	*Tylenchorhynchus* spp.	A. avenae	*Dityleuchus* spp.	*Criconemoides* spp.	*Tylenchus* spp.	Total
Sultan	102	0	52	45	10	65	0	0	0	0	(274) 5.61 f
Pink aicardi	65	33	28	120	72	127	35	0	0	0	(480) 6.17 ab
Irlamda	0	25	0	0	35	0	0	0	0	0	(60) 4.07 j
Madame collette	120	0	0	86	81	0	0	0	0	0	(287) 5.65 ef
Pirandello	30	0	0	28	0	0	0	32	0	0	(90) 4.8 i
Shocking pink	82	0	53	0	45	0	0	0	0	0	(180) 5.18 g
Summer god	0	10	12	0	0	0	16	0	0	0	(38) 3.61 k
Kalahari	0	36	0	0	44	0	0	0	0	0	(80) 4.36 i
Angelica	51	0	58	43	52	46	74	0	0	0	(324) 5.78 def
Aicardi	74	51	48	61	62	65	0	0	0	0	(361) 5.88 cde
Nachos	21	19	0	0	0	0	0	0	0	0	(40) 3.65 k
Trisco	72	70	64	0	0	0	0	0	0	0	(206) 5.33 g
Talima	61	65	72	58	63	45	74	0	0	0	(438) 6.08 abc
Erma	0	45	32	33	51	61	0	0	0	0	(222) 5.39 g
New	102	0	83	105	10	0	201	33	0	0	(534) 6.28 a

espana											
Orange triumph	72	0	83	0	98	0	86	105	0	0	(444) 6.09 abc
White pink	70	0	53	48	55	0	60	0	0	0	(286) 5.65 ef
Arthur sim	98	0	73	102	94	0	98	93	0	0	(558) 6.32 a
White candy	72	0	91	75	108	0	0	122	0	0	(468) 6.14 ab
Desio	45	0	13	0	68	0	0	0	0	0	(126) 4.83 h
Jose	87	84	0	85	102	0	0	98	0	0	(456) 6.12 abc
Flair	111	58	0	35	0	0	0	0	72	84	(360) 5.88 cde
Etore	82	85	32	102	78	125	0	0	0	0	(504) 6.22 a
Espana	85	71	72	65	92	0	0	0	0	0	(385) 5.95 bcd
Cabaret	103	0	72	65	45	78	0	117	0	0	(480) 6.17 ab

Each value is a mean of four replicates. Analysis of variance is based on logarithm-transformed data. In the Total column, figures in parenthesis are means of untransformed data, prior to transformation. Values with same letter(s) are not significantly different (P= 0.05) by Duncan's Multiple Range Test.

Table 2 b: Soil properties of carnation plot at Institute of Himalayan Bioresource Technology, Palampur

Cultivar	pH	EC (μ S)	C%	O.M.%	Available N (kg/ha)	Available P (mg kg^{-1})	Available K (mg kg^{-1})
Sultan	5.22	1259	1.60	2.76	175.0	400.00	280.0
Pink aicardi	5.19	2760	1.83	3.16	192.5	432.0	300.0
Irlamda	5.35	1314	1.74	3.01	210.0	323.0	270.0
Madame collette	5.13	1788	1.73	2.99	175.0	313.5	340.0
Pirandello	4.87	1050	2.62	4.53	210.0	810.0	540.0
Shocking pink	4.90	541	1.59	2.75	280.0	875.0	450.0
Summer god	5.90	253	1.94	3.35	192.5	310.0	300.0
Kalahari	5.96	714	1.67	2.88	192.5	425.0	270.0
Angelica	5.26	1565	1.62	2.80	210.0	285.5	470.0
Aicardi	5.20	1028	1.40	2.42	175.0	641.0	410.0
Nachos	5.40	820	1.76	3.04	192.5	347.0	420.0
Trisco	5.22	1302	1.31	2.26	175.0	400.00	290.0
Talima	4.80	856	1.24	2.14	140.0	799.0	330.0
Erma	4.65	500	1.67	2.89	157.5	810.0	300.0
New Espana	4.66	713	1.91	3.18	175.0	800.0	260.0
Orange triumph	4.85	565	1.46	2.53	175.0	663.0	230.0
White pink	4.76	485	1.13	1.96	140.0	497.0	260.0
Arthur sim	4.72	607	1.11	1.93	192.5	605.0	250.0
White candy	4.65	628	1.62	2.80	280.0	765.0	580.0
Desio	4.52	592	1.31	2.26	280.0	658.0	360.0
Jose	4.64	650	1.40	2.43	140.0	655.0	290.0
Flair	4.50	481	1.20	2.07	192.5	797.0	510.0
Etore	4.70	1647	2.13	3.68	262.5	850.0	750.0
Espana	4.50	733	1.62	2.80	210.0	800.0	360.0
Cabaret	4.51	539	1.39	2.35	297.5	590.0	370.0

CONCLUSION

A survey of nematodes in plots grown to chrysanthemum and carnation revealed that *Pratylenchus* spp., *Tylenchulus* spp., *Hoplolaimus* spp., *L. macrosoma*, *Paratylenchus* spp., *Tylenchorhynchus* spp., *Ditylenchus* spp., *Criconemoides* spp. and *Tylenchus* spp. were associated with the crops. Relationships between soil chemical properties and nematode densities across cultivars indicate that suitability of host plant was a key factor that influenced density of nematodes.

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