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Meloidogyne incognita Infection of Five Weed Genotypes

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Abstract.- A survey in 2007-08 indicated the presence of 5 weed species belonging to 5 genera and 4 families infesting 13 field and vegetable crops. Among these five weed genotypes, there were two annual weed species (*Brachiaria reptans* and *Chenopodium album*) and three perennials including *Achyranthes aspera, Rumex dentatus*, and *Solanum nigrum*. All the weeds had distinct *Meloidogyne incognita*-root galling and egg masses but their number and size varied among the 5 weed genotypes. The 3 genotypes including *A. aspera, C. album*, and *S. nigrum* were graded good hosts and *B. reptans* and *R. dentus* as poor hosts. Our findings suggest that, in addition to egg stages, weed plants provide a means of survival for nematode populations which may contribute to the maintenance, reinfestation, multiplication and spread of nematodes, within a field, thus increasing the potential for crops to be damaged by nematode attacks.

Key words: Egg masses, root galling, *Meloidogyne incognita,* weeds.

INTRODUCTION

Generally weeds grow in every agricultural field. They are viewed as a problem by growers because they compete for water, nutrients, light, and space, which reduce crop growth and yield. Competition is the most important effect weeds have on crop production but they are also alternative hosts for plant-parasitic nematodes and have long been recognized for their ability to maintain nematode populations. Weeds can have other less obvious effects, such as serving as a reservoir for insects (Marshall *et al.,* 2003; Penagos *et al.,* 2003), diseases (Gonzalez *et al.,* 1991; Marley, 1995; Ramappa *et al.,* 1998), and nematodes (Bélair and Benoit, 1996; Castillo *et al.,* 2008; Davidson and Townshend, 1967; Tedford and Fortnum, 1988; Venkatesh *et al.,* 2000).

Weeds cause economic losses. Total losses from weed competition with major crops produced in the United States and Canada were approximately $7 and 4.1 billion per year, respectively. Plant-parasitic nematodes are responsible for tremendous losses of many crops in Pakistan (Anwar and Din, 1986; Maqbool, 1992) as well as in the USA (Koenning *et al.,* 1999). Nematodes can be a limiting factor in field and vegetable crops (Baird *et al.,* 1996; Davis and May, 2003; Dickson, 1998).

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Meloidogyne incognita (Kofoid and White) Chitwood is one of the most damaging nematodes of many crops (Blasingame and Patel, 2003), and its wide host range includes weeds (Martin, 1958; Martin, 1961; Tedford and Fortnum, 1988). The interaction of weeds and nematodes can negatively impact crop production by reducing the nematode suppressive benefits of crop rotations (Bélair and Benoit, 1996; McSorley, 1996; O'Bannon *et al.,* 1982) and nematode resistant crops (Wong and Tylka, 1994). The abundance of a weed species and the amount of nematode reproduction on that species determines the magnitude of the effect the weed has on nematode population densities. We report here the association of *M. incognita* with five weed genotypes and their host status.

MATERIALS AND METHODS

During our survey of thirteen fields for nematodes we observed that weeds growing among field and vegetable crops were infested with root knot nematodes (Table I). In each field, five separate samples of each prevalent weed species were collected, amounting to a total of 25 samples for nematological analysis. Each sample was comprised of the aerial part of the plant and the corresponding roots with adhering soil collected between the 5 and 30-cm depth. After identification of the plant to species level (Fournet and Flore, 1978; Fournet and Hammerton, 1991) all root samples were carefully washed under tap water to remove adhering soil particles and fine entangled crop roots. Root systems of the plants were stained with Phloxine B (Holbrook *et al.*, 1983) and assessed for the presence of egg masses. The root galling and egg mass indices were assessed on 0 to 5 scale, where 0 = no gall, 1 = 1-2, 2 = 3-10, 3 = 11-30, 4 = 31-100, and 5 = >100 galls per root system (Quesenberry *et al.*, 1989). The nematodes were extracted from a fresh root composite sub-sample of 20 g by placing in a mist-chamber for 5 days (McKenry and Roberts, 1985).

Root knot nematodes were identified using perineal patterns of adult females as well as the morphology of second-stage juveniles (Hartman and Sasser, 1985; Jepson, 1987). The host status of weeds to *M. incognita* was assessed by the magnitude of root gall index and classified as S= susceptible, root galling > 3; MR= moderately susceptible root galling = 1-3; and R= resistant, root galling index = 0 (Buena *et al.*, 2007).

Data were subjected to analysis of variance using SAS (SAS Institute, Cary NC). Significant differences in means of nematode reproduction were separated using Duncan's Multiple Range Test at ($P = 0.05$).

RESULTS AND DISCUSSION

During this survey, five weed species belonging to five genera and four families infesting 13 field and vegetable crops were collected from growers' fields located at 4 production areas of the Punjab. Among these five weed genotypes, there were two annual weed species (*Brachiaria reptans* and *Chenopodium album*) and three perennials including *Achyranthes aspera*, *Rumex dentatus*, and *Solanum nigrum* (Table I).

Distinct root galling and egg masses were observed on the roots of all five weed species, thus indicating which weeds are suitable hosts of root-knot nematodes (Hussey, 1985), and suggesting that they may act as a host reservoir between crops (Table II). There was remarkable variability in gall size produced on roots of weeds in response to *M. incognita* infection. The roots of two weed species (*A. aspera*, and *C. album*) supported largest galls, one weed species (*R. dentatus*) had intermediate galls and the other two (*B. reptan*, and *Solanum nigar*) had smaller galls (Fig. 1). The difference in gall size might be related to root architecture. It appears that second- stage juveniles penetrated and reproduced more readily in weeds with soft-textured roots of *A. aspera*, *C. albums* compared to that of hard-textured roots of *B. reptans*, *S. nigrum*, and *R. dentatus* (Anwar and McKenry, 2002).

Although the roots of all five weed species produced root galls their number varied significantly ($P < 0.05$) among the weed genotypes. For *M. incognita*, the roots of *C. album* had ca 2, 3, 4 and 8 times more galls compared to that of *A. aspera*, *S. maniatum*, *R. dentatus, and B. reptans*, respectively. Adult females also produced significantly ($P < 0.05$) greater egg masses on the roots of *C. album* than on the other four weed genotypes (Table 2). *Achyranthes aspera* and *S. nigar* were moderate hosts of *M. incognita* relative to *C. album* because of less root galling (ca 52 and 64%) and egg masses (20 and 53%) than that of *C. album*. Two other weed genotypes including *B. repentes* and *R. dentus* were poor hosts having 88 and 78% fewer galls and lower egg indices than *C. album*. *Chenopodium album* has been reported an excellent host of *M. incognita* compared to other weed species (Anwar *et al.*, 1992; Castillo *et al.*, 2008; Davis and Webster, 2005).

The host status of a plant to nematodes may be estimated from the total number of nematodes produced or from the number of nematodes produced per gram of root, and these two measurements can result in very different conclusions (Gast *et al.*, 1984; Jordaan *et al.*, 1988). The host status may also be determined by their reproduction factor (Pf/Pi = final population of nematodes per initial population), which is frequently used as the most accurate measure of nematode-host relationship (Bélair and Benoit, 1996). Genotypes can also be evaluated for root knot nematode resistance based on the degree of root galling, egg mass number or total number of eggs collected per root system (Hussey and Boerma, 1981). In this study, host status was evaluated based on the root galling index (Buena *et al.*, 2007). Three weed species including *A. aspera*, *C. album*, and *S. nigrum* were ranked as susceptible hosts for having root galling > 3 and the other two weeds consisting of *B. reptans* and *R. dentus* ranked as moderately

Table I.- **Weed hosts of *Meloidogyne incognita* and infested crops.**

Weed species	Common name	Family	Name of crops	Life span	Location*
Achyranthes aspera	Prickly chaff flower	Amaranthaceae	Tomato, okra, cucumber, carrot,	Perennial	Faisalabad
Brachiaria reptans	Running grass	Poaceae	Okra, cucumber, bitter gourd	Annual	Shiekhpura
Chenopodium album	Lamb's quarter	Amaranthaceae	Tomato, okra, roses, cauliflower, carrot, onion	Annual	Faisalabad, Sheikhpura
Rumex dentatus	Broad leaf duck	Polygonaceae	Garlic, coriander, cauliflower, roses	Perennial	Faisalabad, Sheikhpura
Solanum nigrum	Black Nightshade	Solanaceae	Cotton, tomato, garlic, coriander, lettuce, roses.	Perennial	Faisalaabd, Attock

* Location of grower's fields

Table II.- **Induction of root galling and egg masses by *Meloidogyne incognita* on roots of 5 weed species.**

Weed species	Galls per root system	Egg masses per root system	Gall index	Egg mass index	Host** status
Achyranthes aspera	47b*	12b	4	3	S
Brachiaria reptans	12e	2d	3	1	MS
Chenopodium album	97a	15a	4	3	S
Rumex dentatus	21d	3d	3	2	MS
Solanum nigrum	35c	7c	4	2	S

*Means within a column followed by the same letter are not significantly different according to Duncan's Multiple Range Test at P = 0.05. **Host status: S: susceptible, root galling > 3; MS: moderately susceptible, root galling = 1-3; R: resistant, root galling index = 0 (Buena *et al*., 2007)

susceptible for having root galling < 3. Variability in host status among weed genotypes may be explained by genetic variability in the weed population (Griffin, 1982).

Meloidogyne incognita has an extensive host range including field and vegetable crops and weed plants (Sasser and Freckman, 1987). A plant may be classified as host because of having galls and egg masses, but these may be much less than on a susceptible crop plant. The susceptible cultivars of bitter gourd, eggplant, cucumber, okra, and tomato, exhibit a high degree of root galling and egg masses (Anwar *et al.*, 2007). Two weeds including *B. reptans* and *R. dentatus* should be considered poor hosts relative to these agricultural crops. Similarly, most weeds from tobacco fields are moderate to poor hosts for *M. incognita* (Tedford and Fortnum, 1988).

Running grass and broad leaf duck ranked as moderately susceptible weed hosts to nematodes suggest the possibility that nematodes could affect the plant competition between the nematode susceptible crop like okra, cucumber, bitter gourd, coriander, and cauliflower and weeds (Anwar *et al*., 1992, 2007). Starr (1998) found that nematode parasitism reduced cotton growth but the growth of weeds that were poor hosts was likely to be unaffected leading to more competition with crop plants. Extensive nematode parasitism of a crop has been shown to increase the competitive edge from weeds when soybean (*Glycines max*) growth was reduced by soybean cyst nematode, *Heterodera glycines* (Alston *et al.*, 1991). Conversely, the prickly chaff flower, lamb's quarter, and black nightshade good nematode weed hosts will also be damaged along with the crop resulting in less competition. Gonzalez Ponce *et al*. (1995) showed that tomatoes infected with *M. incognita* were less competitive with black nightshade (*S. nigrum*), a good host for root knot nematode.

Our findings suggest that weed plants can provide a means of survival for nematode populations which may contribute to maintenance, earlier infestation, and spread of *Meloidogyne* spp.

Fig. 1. Root galls induced on the roots of 5 weed genotypes by *Meloidogyne incognita* infection.

within a field, and thus an increase in the potential for crops to be damaged by nematode attacks (Castillo *et al.,* 2008). Weed infested fields act an important reservoir of nematodes (Patrick *et al*., 1995) and may aid in the dissemination of *Meloidogyne* spp. within or among crops by many agricultural operations like irrigation water (Orr and Newton, 1971) that can reduce the beneficial effects of the *Meloidogyn*e resistant crops. All five weed genotypes supported *M. incognita* reproduction but at different levels. It appears that moderately susceptible weeds (Running grass and broad leaf duck) have low potential to maintain high enough nematode population levels to perpetuate nematode problems. Meanwhile, nematode susceptible crops like tomato, egg plant, and okra if planted in such fields could suffer significant damage while weeds that are moderately susceptible host probably will not suffer significant damage (Bridges, 1992). In such situation minimizing nematode induced-damage to crop through effective nematode management minimize yield suppression from weeds by preserving the ability of the crop to be competitive with weeds. Nematode susceptible weeds (prickly chaff flower, lamb's quarter, and black nightshade) have the possibility of maintaining high nematode population levels. If so then the weed infested fields has the potential to reduce the effectiveness of nematode-resistant crops (Davis and Webster, 2005). It suggests minimizing the nematode damage to crops through use of nematicides, plant resistance or other management strategy or minimizing the weed infestation by herbicides, to preserve the ultimate ability of crop to be as competitive as possible with weeds. This study also suggests that these five weeds should be considered as bioindicators to assess the presence of root knot nematodes, the damaging pest of vegetable crops, in vegetable field prior to cultivation.

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REFERENCES

ALSTON, D.G., BRADLEY, J.R., COBLE, H.D. AND SCHMITT, D.P., 1991. Impact of population density of *Heterodera glycines* on soybean canopy growth and weed competition. *Pl. Dis.,* **75:**1016-1018.

ANWAR, S.A. AND DIN, G.M., 1986. Nematodes: Biotic constrains to plant health. *Proc. Parasitol.,* **3:**48-53.

ANWAR, S.A. AND MCKENRY, M.V., 2002. Developmental response of a resistance-breaking population of *Meloidogyne arenaria* on *Vitis* spp. *J. Nematol.,* **34**: 28-33.

ANWAR, S.A., RAUF, C.A. AND GORSI, S.D., 1992. Weeds as alternate hosts of phytonematodes. *Afro-Asian J. Nematol.,* **2:** 41–47.

ANWAR, S.A., ZIA, A., HUSSAIN, M. AND KAMRAN, M., 2007. Host suitability of selected plants to *Meloidogyne incognita* in the Punjab, Pakistan. *Int. J. Nematol.,* **17:** 144-150.

BAIRD, R.E., DAVIS, R.F., ALT, P.J., MULLINIX, B.G., AND PADGETT, G.B., 1996. Frequency and geographical distribution of plant-parasitic nematodes on cotton in Georgia. *J. Nematol.,* **28:**661-667.

BÉLAIR, G. AND BENOIT, D.L., 1996. Host suitability of 32 common weeds to *Meloidogyne hapla* in organic soils of southwestern Quebec. *J. Nematol.,* **28:**643-647.

BLASINGAME, D. AND PATEL, M.V., 2003. Cotton disease loss estimate committee report. In: *Proc. Beltwide Cotton Conf.,* Nashville, TN. 6-10 January 2003. National Cotton Council of America, Memphis, TN, pp. 252-253.

BRIDGES, D.C., 1992. *Crop losses due to weeds in the United States*. Weed Science Society of America, Champian, IL.

BUENA, A.P., GARCÍA-ÁLVAREZ, A., DÍEZ-ROJO, M.A., ROS, C., FERNÁNDEZ, P., LACASA A. AND BELLO, A., 2007. Use of pepper crop residues for the control of root-knot nematodes. *Biores. Tech***., 98:** 2846-2851.

CASTILLO, P., RAPOPORT, H.F., PALOMARES RIUS, J.E. AND JIMÉNEZ DÍAZ, R.M., 2008. Suitability of weed species prevailing in Spanish vineyards as hosts for root-knot nematodes. *Eur. J. Pl. Pathol.,* **120:** 43-51.

DAVIDSON, T.R. AND TOWNSEND, J.L., 1967. Some weed hosts of the southern root-knot nematode, *Meloidogyne incognita*. *Nematologica*, **13:**452-458.

DAVIS, R.F. AND MAY, O.L., 2003. Relationships between tolerance and resistance to *Meloidogyne incognita* in cotton. *J. Nematol*., **35:**411-416.

DAVIS, R.F. AND WEBSTER, T.M., 2005. Relative host status of selected weeds and crops for *Meloidogyne incognita* and *Rotylenchulus reniformis. J. Cotton Sci.,* **9:** 41–46.

DICKSON, D.W., 1998. Peanut. In: *Plant nematode interactions* (eds. K.R. Barker, G.A. Pederson and G.L. Windham) ASA, Madison, WI, pp. 523-566.

FOURNET, J. AND FLORE, F., 1978. *Illustrée des phanérogames de Guadeloupe et de Martinique*, INRA Edit., Paris, pp. 1654.

FOURNET, J. AND HAMMERTON, L., 1991. *Mauvaises herbes des Petites Antilles*, INRA Edit., Paris. pp. 214.

GAST, R.E., WILSON, R.G. AND KERR, E.D., 1984. Lesion nematode (*Pratylenchus* spp.) infection of weeds species and field beans (*Phaseolus vulgaris*). *Weed Sci.,* **32:** 616-620.

GONZALEZ PONCE, R., ZANCADA, C., VERDUGA, M. AND SALAS, L., 1995. The influence of the nematode *Meloidogyne incognita* on competition between *Solanum nigrum* and tomato. *Weed Res,*. **35:** 437-443.

GONZALEZ, C.F., XU, G.W., LI, H.L. AND COSPER, J.W., 1991. *Leersia hexandra*, an alternative host for *Xanthomonas campestris* pv. *oryzae* in Texas. *Pl. Dis.,* **75:** 159-162.

GRIFFIN, G.D., 1982. Differences in the response of certain weed species and their effects on *Pratylenchus zaea* infestation of maize. *J. Nematol.,* **21:** 20-624.

HARTMAN, K.M. AND SASSER, J.N., 1985. Identification of *Meloidogyne* species on the basis of differential host test and perineal pattern morphology. In: *An advanced treatise on* Meloidogyne. *Vol. 2. Methodology* (eds. K.R. Barker, C.C. Carter and J.N. Sasser). North Carolina State University Graphics, Raleigh, pp. 69-77.

HOLBROOK, C.C., KNAUFT, D.A. AND DICKSON, D.W., 1983. A technique for screening peanut for resistance to *Meloidogyne incognita*. *Pl. Dis.,* **57:**957-958.

HUSSEY, R.S., 1985. Host-parasite relationships and associated physiological changes. In: *An advanced treatise on* Meloidogyne (eds. J.N. Sasser and C.C. Carter), vol. I.

HUSSEY, R.S. AND BOERMA, H.R., 1981. A greenhouse screening procedure for root-knot nematode resistance in soyabean. *Crop Sci.,* **21:** 794-796.

JEPSON, S.B., 1987**.** *Identification of root-knot nematodes* (Meloidogyne *species*). CAB International, Wallingford, UK.

JORDAAN, E.M. AND DE WAELE, D., 1988. Host status of five weed species and their effects on *Pratylenchus zaea* infestation of maize. *J. Nematol.,* **21:** 620-624.

KOENNING, S.R., OVERSTREET, C., NOLING, J.W., DONALD, P.A. BECKER, J.O. AND FORTNUM, B.A., 1999. Survey of crop losses in response to phytoparasitic nematodes in the United States for 1994. *J. Nematol.,* **31:** 587-618.

MAQBOOL, M.A., 1992. *Distribution and host association of plant parasitic nematodes in Pakistan*. National Nematological Research Centre, University of Karachi, Karachi, Pakistan. Pp. 215.

MARLEY, P.S., 1995. *Cynodon dactylon* and alternative host for *Sporisorium sorghi*, the causal organism of sorghum covered smut. *Crop Prot.,* **14**: 491-493.

MARSHALL, E.J.P., BROWN, V.K., BOATMAN, N.D., LUTMAN, P.J.W., SQUIRE, G.R. AND WARD, L.K., 2003. The role of weeds in supporting biological diversity within crop field. *Weed Res.,* **43:**77-89.

MARTIN, G.C., 1958. Root-knot nematodes (*Meloidogyne* spp.) in the Federation of Rhodesia and Nyasaland. *Nematologica,* **3:**332-349.

MARTIN, G.C., 1961. Plant species attacked by root-knot nematodes (*Meloidogyne* spp.) in the Federation of Rhodesia and Nyasaland. *Nematologica,* **6:**130-134.

MCKENRY, M.V. AND ROBERTS, P.A., 1985. *Phytonematology study guide*. ANR Publications, University of California, Oakland, CA, pp. 56.

MCSORLEY, R., 1996. Impact of crop management practices on soil nematode populations. *Proc. Soil Crop Sci. Soc. Florida,* **55:**63-66.

O'BANNON, J.H., SANTO, G.S. AND NYCZEPIR, A.P., 1982. Host range of the Columbia root-knot nematode. *Pl. Dis.,* **66:**1045-1048.

ORR, C.C. AND NEWTON, O.H., 1971. Distribution of nematodes by wind. *Pl. Dis. Repr.,* **55:**61-63.

PATRICK, Q., FABRICE, D. AND PATRICK, T., 1995. Host status of some weeds to *Meloidogyne* spp., *Pratylenchus* spp., *Helicotylenchus* spp. and *Rotylenchulus reniformis* associated with vegetables cultivated in polytunnels in Martinique. *Nematropica,* **25**: 149-157.

PENAGOS, D.I., MAGALLANES, R., VALLE, J., CISNEROS, J., MARTINEZ, A.M., GOULSON, D., CHAPMAN, J.W., CABALLERO, P., CAVE, R.D. AND WILLIAMS, T., 2003. Effect of weeds on insect pests of maize and their natural enemies in southern Mexico. *Int. J. Pest Managm.,* **49:**155-161.

QUESENBERRY, K.H., BALTENSPERGER, D.D., DUNN, R.A., WILCOX, C.J. AND HARDY, S.R., 1989. Selection for tolerance to root-knot nematodes in red clover. *Crop Sci.,* **29:**62-65.

RAMAPPA, H.K., MUNIYAPPA, V. AND COLVIN, J., 1998. The contribution of tomato and alternative host plants to tomato leaf curl virus inoculum pressure in different areas of south India. *Annl. appl. Biol*., **133:**187-198.

SASSER, J.N. AND FRECKMAN, D.W., 1987. A world perspective on Nematology: the role of the society. In: *Vistas on nematology* (eds. J.A. Veech and D.W. Dickson). Society of Nematologists, Hyattsville, Maryland, pp. 7-14.

STARR, J.L., 1998. Cotton. In: *Plant nematode interaction* (eds. K.R. Barker, A. Pederson and G.L. Windham), ASS, Madison, WI. pp. 359-379.

TEDFORD, E.C. AND FORTNUM, B.A., 1988. Weed hosts of *Meloidogyne arenaria* and *M. incognita* common in tobacco fields in South Carolina. *J. Nematol*., **2:** 102-105.

VENKATESH, R., HARRISON, S.K. AND RIEDEL, R.M., 2000. Weed hosts of soybean cyst nematode (*Heterodera glycines*) in Ohio. *Weed Tech.,* **14**: 156-160.

WONG, A.T.S. AND TYLKA, G.L., 1994. Eight nonhost weed species of *Heterodera glycines* in Iowa. *Pl. Dis.,* **78:**365-367.

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