[1]Institute of Agriculture and [2]Department of Botany, Aligarh Muslim University, Aligarh-202 002, India

DEVELOPMENT OF ROOT-KNOT AND ROOT-NODULES ON COWPEA AS INFLUENCED BY SULPHUR DIOXIDE

by
M. R. KHAN [1] and M. W. KHAN [2]

Summary. The effect of SO_2 at 0.1 ppm on the development of root-knot disease caused by *Meloidogyne incognita* and root nodulation by *Rhizobium* was studied on two cultivars of cowpea viz. V-38-1 and V-218 in artificial treatment condition. Single and combined effects of SO_2 and the nematode on plant growth and dry matter production were also determined. The nematode and SO_2, independently caused significant suppression of plant growth and dry weights. The suppressions were synergistic in the combined treatments of the two stresses. Sulphur dioxide induced foliar chlorosis on both the cultivars of cowpea which appeared earlier in the presence of root-knot nematode. Galling and egg mass production were greater on the exposed plants. Development of functional nodules was significantly suppressed in all the treatments.

Sulphur dioxide is a common pollutant in the countries and areas which experience excessive use of fossile fuels. Leguminous plants are susceptible to SO_2, the adverse effect on plant growth and yield being aggravated due to the effects on root nodule bacteria (Heck *et al.*, 1986). In addition to this effect, SO_2 may influence the population and pathogenicity of plant parasites (Khan and Khan, 1993b). Among the plant parasites, nematodes have received little attention. Weber *et al.*, (1979) reported that intermittent exposures to 0.23 ppm SO_2 enhanced the reproduction of *Pratylenchus penetrans* on soybean, but inhibited the reproduction and developement of *Heterodera glycines* and *Paratrichodorus minor*. Recently, Khan and Khan (1994b and 1994c) observed a favourable effect of coal-smoke pollution (primarily SO_2) on root-knot disease and reproduction of *Meloidogyne incognita* on egg plant and okra. The present study was undertaken to determine the influence of SO_2 on the host-parasite relationship of *M. incognita* and two cultivars of cowpea.

Materials and methods

Seeds of cowpea, *Vigna sinensis* (L.) Savi cvs V-38-1 and V-218 were treated with the commercial *Rhizobium* of cowpea strain. Treated seeds of each cultivar were sown in twenty 15 cm diameter clay pots containing sterilized field soil and compost (3:1) (5 seeds/pot). A week after sowing, the germinated seedlings were thinned to one per pot. Ten pots of each cultivar were inoculated with 2000 freshly hatched juveniles of *Meloidogyne incognita* ((Kofoid *et* White) Chitw. Immediately after inoculation five pots each of inoculated and uninoculated for both cultivars were subjected to SO_2 at 0.1 ppm by enclosure in a closed-top chamber (Khan

and Khan, 1993a); plants designated to receive SO_2 were exposed intermittently for 3 h every third day for 75 days. The pots were placed in a glasshouse and were regularly observed for the appearance of any symptom attributable to SO_2 and/or the nematode. At the completion of 27 exposures, the plants were harvested and lengths and fresh and dry weights of shoots and roots, and number of functional nodules (pink coloured), galls and egg masses were determined.

Results

Sulphur dioxide at 0.1 ppm caused a mild chlorosis of leaf margins and interveinal areas of uninoculated plants of both V-38-1 and V-218. Nematode infection did not influence the intensity of leaf chlorosis but symptoms appeared earlier on inoculated plants, especially in V-218. The nematodes induced severe galling on the roots of cowpea plants and in the presence of SO_2, there was a significant increase in the number of galls and egg masses on V-38-1 (12.7 and 8.2%) and V-218 (11.2 and 11.8%) (Table I and II). There were 12.7 and 11.2% more galls on exposed plants of V-38-1 and V-218 compared to unexposed-inoculated plants, respectively.

M. incognita, acting alone caused significant suppressions of plant growth and dry matter production of cowpea (Table I and II). SO_2 significantly suppressed dry weight of shoot and root of V-218 and dry weight of root of V-38-1. The combined treatments of SO_2 and *M. incognita* caused significant reduction in all the considered variables of cowpea. Development of functional nodules was also significantly suppressed by SO_2 and the nematode alone or jointly (Table I and II). The reductions were generally greater than the sum of the reductions caused by SO_2 and the nematode separately. For example, the combined treatment decreased the dry shoot weight of V-38-1 and V-218 by 20.6 and 33.3% whereas the sum of the decrease caused by SO_2 and *M. incognita* was 14.7 and 24.5%, respectively.

Discussion

Sulphur dioxide diffuses into the leaf tissue through stomata and interferes with biochemical processes causing damage to the leaf tissue. Early appearance of foliar chlorosis on nematode infected plants can be attributed to greater SO_2 uptake by the leaves as a result of a higher rate of transpiration induced by nematode infection (Khan and Khan 1987; 1993a). It is also possible that the nematode enhanced the sensitivity of

TABLE I - *Interactive effects of* Meloidogyne incognita *and* SO_2 *on cowpea cv. V-38-1.*

Treatments	Length cm		Fresh weight g		Dry weight g		Functional nodules	Galls	Egg masses
	Shoot	Root	Shoot	Root	Shoot	Root			
Control	28.6	12.8	9.6	4.9	3.4	2.0	61	–	–
Nematode	25.2*	10.3*	8.5*	4.2*	3.0*	1.8*	46*	126	109
SO_2	27.0	12.6	9.5	4.8	3.3	1.9*	53*	–	–
Nematode + SO_2	22.0*	8.3*	7.9*	3.9*	2.7*	1.6*	37*	142*	118*
L.S.D. P = 0.05	1.9	0.82	0.41	0.27	0.15	0.09	3.2	11.5	9.2

* = Significantly different from the control at P = 0.05.

TABLE II - *Interactive effects of* M. incognita *and* SO_2 *on cowpea cv. V-218.*

Treatments	Length cm		Fresh weight g		Dry weight g		Functional nodules	Galls	Egg masses
	Shoot	Root	Shoot	Root	Shoot	Root			
Control	31.0	14.5	11.3	5.5	4.5	2.5	67	–	–
Nematode	24.9*	11.8*	9.7*	4.6*	3.7*	2.1*	48*	116	102
SO_2	29.4	14.1	10.8	5.3	4.2*	2.3*	57	–	–
Nematode + SO_2	21.5	10.7*	8.5*	4.1*	3.0*	1.8*	42*	129*	114*
L.S.D. P = 0.05	2.6	1.2	1.0	0.25	0.18	0.11	4.1	7.3	8.1

* = Significantly different from the control at P = 0.05.

plants to SO_2. The severe galling on the roots and greater production of egg masses revealed the favourable effect of SO_2 on the nematode, possibly through host-mediated effects of SO_2. Sulphur dioxide can decrease the soil pH by combining with soil moisture. The lower pH in between 6 and 5 is reported to stimulate root penetration, galling and egg mass production of *M. incognita* compared to pH 6.8 (Khan and Khan, 1994a).

Sulphur dioxide reduces the translocation of photosynthates to roots and make the host substrate less favourable for the nodule forming bacteria (Jahan, 1993). Similarly, root-knot nematodes compete with the bacteria for space (Taha, 1993). Apparently for these reasons, the nodule development was significantly less on exposed and/or inoculated plants. Hence, higher galling by the nematode and lower number of functional nodules coupled with the early appearance of foliar injury led to synergistic suppressions in the considered variables of plant growth of both the cultivars of cowpea.

Acknowledgements. The financial assistance through a research project no. 19/85/89 sponsored by the Ministry of Environment and Forests, New Delhi is gratefully acknowledged.

Literature cited

HECK W. W., HEAGLE A. S. and SHRINER D. S., 1986. Effects on vegetation: native, crops, forests. In *Air Pollution* A. S. Stern, ed. Academic Press, New York, U.S.A. Vol. 6, pp. 247-350.

JAHAN K., 1993. Studies on mycorrhizal fungi in relation to environemntal pollution. Ph. D. Thesis, Aligarh Muslim University, Aligarh, India, pp. 227.

KHAN M. R. and KHAN M. W., 1987. Histo-physiological alterations induced by *Meloidogyne incognita* in tomato leaves. *Int. Network Newsl., 4* (4): 10-12.

KHAN M. R. and KHAN M. W., 1993a. The interaction of SO_2 and root-knot nematode on tomato. *Environ. Pollut., 81*: 91-102.

KHAN M. W. and KHAN M. R., 1993b. Relationship of plant pathogenic microbes with air pollution. In: Frotiers in *Applied Microbiology*, K. G. Mukerji and V. P. Singh, eds. Rastogi Publishers, Meerut, India, pp. 131-151.

KHAN M. R. and KHAN M. W., 1994a. Effects of simulated acid rain and root-knot nematode on tomato. *Pl. Pathol., 43*: 41-49.

KHAN M. R. and KHAN M. W., 1994b. Single and interactive effects of root-knot nematode and coal-smoke on okra. *New Phytol., 126*: 337-342.

KHAN M. R. and KHAN M. W., 1994c. Smoke pollution and the effects of root-knot nematodes on the growth of egg plant. *Pl. Pathol., 43*: 683-693.

TAHA A. H. V., 1993. Nematode interactions with root-nodule bacteria. In *Nematode Interactions*, M. W. Khan, ed. Chapman & Hall, London, U. K., pp. 175-202.

WEBER D. E., REINERT R. A. and BARKER K. R., 1979. Ozone and sulphur dioxide effects on reproduction and host parasite relationship of selected plant-parasitic nematodes. *Phytopathology, 69*: 624-628.

Accepted for publication on 14 September 1995.