EFFECT OF CULTURAL PRACTICES ON NEMATODE POPULATIONS AND YIELD OF FRENCH BEANS

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Summary. Field studies were undertaken in 1998 in Himachal Pradesh (India) to see the impact of cultural practices on the nematode populations (*Helicotylenchus dihystera*, *Meloidogyne incognita* and *Quinisulcius indicus*) and yield of French bean (*Phaseolus vulgaris* cv. Contender). The treatments were four sowing times (1 May, 1 June, 1 July and 1 August), each with three weeding and hoeing treatment/s (after intervals of 10, 20 and 30 days). Populations of *H. dihystera* increased and crop yield decreased as the weeding and hoeing interval increased. Sowing time had significant effects both on the nematode populations and the yield of the crop. May and June sown crops were infested mainly with *H. dihystera* of which adversely affected crop yield. In July and August *M. incognita* was the major nematode infesting the crop but there was no adverse effect on the yields which were higher than in May and June. Populations of *Q. indicus* remained low throughout. Higher soil temperature (32-34.50 °C) and low relative humidity (46-57.5%) favoured *H. dihystera*, while lower temperature (29-30 °C) and higher relative humidity (79-80%) favoured *M. incognita.*

French bean is a vegetable crop of global importance that is consumed as a vegetable (green pods) and as a pulse (dry seeds). In India, its cultivation is mainly confined to hilly regions, among which the State of Himachal Pradesh is one of the pioneer producers. Various parasites are known to affect the yield of the crop, with nematodes being of particular importance. The most common nematode pests of French bean are root-knot nematodes, *Meloidogyne* spp., followed by lesion nematodes, *Pratylenchus* spp. (Anonymous, 1991; Rubatzky and Yamaguchi, 1996). *Meloidogyne* species are known te reduce the yield of beans by up te 45-60 per cent (Muffin *et al.*, 1991).

French bean fields in the State of Himachal Pradesh harbour mainly populations of *Helicotylenchus*, *Meloidogyne*, *Quinisulcius* and *Pratylenchus* species which cause considerable yield losses (up to 26.6%) (Bhatia, 1999).

Since, application of nematicides for the management of nematode problems in the vegetable crops is restricted by health hazards and high costs, the effects of two cultural practices, viz. (i) time of sowing and (ii) weeding and hoeing, on the nematode populations and yield of the crop were investigated.

MATERIALS AND METHODS

The experiment was conducted in a nematode infested field, on the Entomology farm of the University of Horticulture and Forestry, Solan (Himachal Pradesh) during the year 1998. Nematodes present included *Helicotylenchus dihystera* (Cobb) Sher, *Meloidogyne incognita* (Kofoid *et* White) Chitw. and *Quinisulcius indicus* Luqman *et* Khan; soil samples collected in the second week of April had population densities of 300, 150 and 50 per 200 cc soil, respectively. The experimental area was divided into 3m x 2m beds and the French bean (*Phaseolus vulgaris* L.) cv. Contender was sown in 45 cm rows spaced 15 cm apart (14 rows/plot). There were four sowings at monthly intervals; 1 May, 1 June, 1 July and 1 August. The plots were weeded and hoed at 10, 20 and 30 day intervals following germination until the crop was harvested 60 days later. There were five replicates of each of the treatment combinations i.e. sowing time x weeding/hoeing. Nematode populations were recorded from 200 cc soil composite samples from each plot immediately following picking of the crop. They were extracted by Cobb's sieving and decanting technique. Observations were also recorded on the vigour of the crop (at fruiting stage) and root galling (at the time of last picking). Monthly average soil temperature at 10 cm depth and per cent relative humidity were also recorded.

Data were analyzed by factorial RBD with sq. root n+1 transformation.

RESULTS

When beans were sown in May, populations of *H. dihystera* increased and *M. incognita* decreased with increase in weeding and hoeing interval (Table I). Weeding and hoeing intervals at 10 and 20 days improved yields (4.5 and 4.2 Kg, respectively) compared with the crop weeded at 30 day interval (2.3 Kg). *H. dihystera* was the dominant nematode species (268-423) compared with *M. incognita* (49-87) and *Q. indicus* (0-26).

In the crop sown in June, the population densities of *H. dihystera* and *M. incognita* were similar to the May sown crop. Yield from the 10 day weeding and hoeing

Table I. Effect of different sowing times and weeding and hoeing intervals on the nematode populations and crop yield.

Sowing time	Nematode populations (per 200 cc soil) in different weeding and hoeing treatments (days)									Mean pop.	Yield (Kg) in different weeding and hoeing treatments (days)			Mean Yield
	10			20			30							
	H. dihystera	*M. incognita*	*Q. indicus*	*H. dihystera*	*M. incognita*	*Q. indicus*	*H. dihystera*	*M. incognita*	*Q. indicus*		10	20	30	
May	268 (16.79)	88 (7.62)	26 (3.09)	354 (17.99)	60 (5.51)	o (1.00)	423 (20.19)	49 (5.04)	0 (1.00)	141 (8.62) ab	4.5	4.2	2.3	3.7 b
June	240 (15.36)	660 (16.85)	16 (2.60)	408 (16.99)	132 (9.32)	88 (7.58)	460 (20.55)	64 (5.67)	0 (1.00)	230 (10.06) ab	2.7	1.6	1.0	1.8 c
July	0 (1.00)	460 (14.17)	0 (1.00)	0 (1.00)	480 (14.45)	0 (1.00)	0 (1.00)	360 (18.52)	20 (2.81)	147 (6.10) b	5.1	5.1	3.3	4.5 ab -
August	42 (4.72)	816 (29.86)	0 (1.00)	0 (1.00)	2154 (44.92)	0 (1.00)	0 (1.00)	4176 (61.39)	0 (1.00)	799 (15.99) a	5.8	5.1	5.1	5.3 a
	138 (7.96)	506 (16.62)	11 (1.92)	191 (9.24)	70 (18.55)	22 (2.64)	221 (10.68)	1162 (22.65)	6 (1.45)	-	4.5 a	4.0 a	2.9 b	
	218 (8.83) a			306 (10.15) a			463 (11.60) a			-	-	-	-	-

Figures with same letters on either coloumns or lines do not statistically differ from each other (P = 0.05). C D (0.05): M (time of sowing) 8.79; W (weeding and hoeing) 7.16; M*W 15.23; Yield 0.99.

treatment (2.7 Kg) was much higher than in the 20 day treatment (1.6 Kg) and the 30 day treatment (1.0 Kg) and was similar to the May sown crop.

In the July sown crop, a significantly lower yield (3.3 Kg) was harvested from the 30 day weeding and hoeing plots than from 10 and 20 day intervals (5.1 Kg). *M. incognita* was the major nematode (average soil population ranged 360-480 J-2), while *H. dihystera*, which earlier was dominant was not recovered from the field.

In the August sawn beans considerably lower population densities of *M. incognita* (816) were found in the ten day weeding and hoeing treatment than in the 20 and 30 day treatments, where the populations were 2154 and 4176, respectively. In this month *M. incognita* was the only nematode found except for the ten day interval, where a few *H. dihystera* were recovered. The yields of the different weeding and hoeing treatments were similar.

An increasing trend in the root galling due to *M. incognita* with the advancement in sowing time from May to August was observed (Table I).

When weeding and hoeing were practiced at ten day interval, considerably fewer *H. dihystera* were recorded in July and August sown plots (0-42) compared with those sown in May and June (240-269). Conversely, the root-knot nematode infestation was significanfly greater during August (816) than May (88). However, the popuiation of *M. incognita* in June was 660. The population of *Q. indicus* remained very low. The lowest yield was harvested in June (2.7 Kg), followed by May (4.5 Kg) when a considerable population of *H. dihystera* (240-268) was found. For the other two months (July and August) yields were similar (5.1 and 5.8 Kg, respectively).

With the 20 day interval of weeding and hoeing, the population of *H. dihystera* recorded during May and June ranged from 354- 408 per 200 cc of soil, whereas in July and August, it was nil. On the other hand, the *M. incognita* (J2) soil population increased abruptly in August to 2154, which was significantly higher than the population recorded for the other three months (60-480). Considerably higher yields were obtained from the July and August sown crops (5 Kg), when no *H. dihystera* were recovered from the field. In the August sown crop there were more *M. incognita* (2164) than the July crop (480), but the yields of the two crops were similar.

For 30 day interval of weeding and hoeing also, the fluctuations in the population of *H. dihystera* and *M. incognita* were similar to the previous two treatments, as their populations were zero and maximum (4176) in the month of August, respectively, while in May and June populations were highest for *H. dihystera* (423-460) and lowest for *M. incognita* (49-64). Yield was lowest in June (1 Kg), followed by May (2.3 Kg), when there was a considerable population of *H. dihystera* (423-460). In July and August, the yields were 3.3 and 5.1 Kg, respectively, and the field was free from *H. dihystera.* However, there was considerable population of *M. incognita* (360-4176).

Vigour of the crop was found to be reduced with increase in weeding and hoeing intervals. However, the reduction was minimum in August sown crop. *Helicotylenchus dihystera* and *M. incognita* were the major nematodes encountered. Although, the mean monthly temperature from May to August varied little (28.7-31 °C), the population of both these nematodes varied considerably (Table II). The maximum temperature range of May and June (32-34.5 °C) appeared to favour the multiplication of *H. dihystera* more than that of July and August, when it was 29-30 °C. The low temperature range in July and August appeared to favour *M. incognita.* Similarly, high relative humidity (79-80%) appeared to favour *M. incognita*, while for *H. dihystera a* relative humidity more than 57.7 per cent appeared to be adverse (Table II). The results also suggest that *H. dihystera* is more damaging to the crop than is *M. incognita*.

Correlation calculations showed that of the three nematodes species prevalent in the field only *H. dihystera* caused a significant negative impact (r = -0.7715) on crop yield (Table III). There was significant negative correlation between the populations of *H. dihystera* and *M. incognita* (r = -0.5392) and a positive correlation between yield and M *incognita* infestation (r = 0.4493; P>0.05).

Table II. Effect of different sowing times (with overall impact of all the weeding and hoeing intervals) on the nematode populations and crop yield, in relation to soil temperature and relative humidity.

Sowing time	Nematode pulation*		Yield (Kg/plot)	Temp. (°C)**	% relative humidity**
	H. dihystera	*M. incognita*			
May	349 (18.61) a	66 (8.10) b	3.66 b	21.9 (27.3-31.9)	46.3 (32.9-59.8)
June	369 (19.07) a	285 (15.10) b	1.76 c	31.4 (28.4-34.5)	57.5 (48.6-66.4)
July	0 (1.00) b	433 (20.80) b	4.36 ab	29.1 (28.2-30.0)	80.0 (74.6-86.3)
August	14 (2.85) b	2382 (46.54) a	5.31 a	28.7 (28.4-29.0)	79.0 (71-80)
CD (0.05)	5.58	23.16	1.08	-	-

* Figures with same letters on the columns do not statistically differ; ** Figures in parentheses represent the range values.

Table III. Correlation between nematode populations and crop yield.

-	*H. dihystera*	*M. incognita*	*Q. indicus*	Total pop.	Yield
H. dihystera	1.000	-	-	-	-
M. incognita	-0.5392*	1.000	-	-	-
Q. indicus	0.3538	-0.2544	1.000	-	-
Total pop.	-0.4002	0.9874*	-0.1947	1.000	-
Yield	0.7715*	0.4493	0.4661	0.3381	1.000

* (P≤0.05).

DISCUSSION

The increase in weeding and hoeing intervals in May and June was accompanied by increase and decrease in the populations of *H. dihystera* and *M. incognita*, respectively. However, this change in the population densities of these two nematodes in relation te weeding and hoeing may be explained by *H. dihystera* being an ectoparasite, so that the frequent weeding and hoeing caused disturbanee to its feeding and multiplication, resulting in population decline. *M. incognita* being an endoparatsite, remained unaffected by the frequeney of weeding and hoeing. In fact, frequent weeding and hoeing improved plant growth, which in tum allowed better multiplication of *M. incognita*.

Yield decreased, as weeding and hoeing intervals increased; such effect may be due to: reduction in the population of *H. dihystera*; reduced competition for nutrition; improved structure of soil, which in tum may improve aeration and water absorption Capacity etc; interruption of multiplication and establishment of other harmful biotic factors.

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