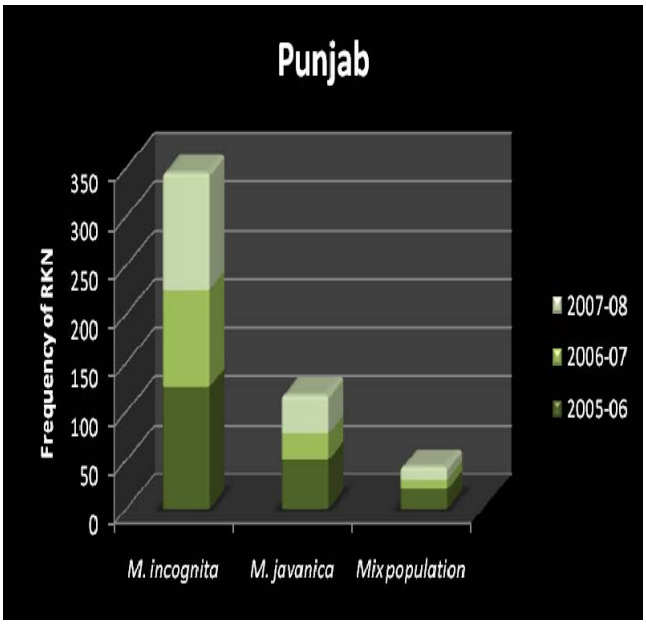
Table 1.2: Incidence of root-knot nematodes from rice and soybean localities

No. of fields sampled (A)	*Direct examination of plant roots (B)*	*Total incidence after bioassay (C)*	*D/F in incidence (C-B)*	*% incidence (C/A) × 100*
48	28	15	13	31.2
39	19	13	06	33.3
32	14	10	04	31.2
20	21	08	13	40.0
18	09	10	01	53.5
20	14	06	08	30.0
36	25	07	18	13.4
14	06	07	01	50.0
25	27	08	19	52.0
25	26	04	22	16.0
277	189	88	105	31.7

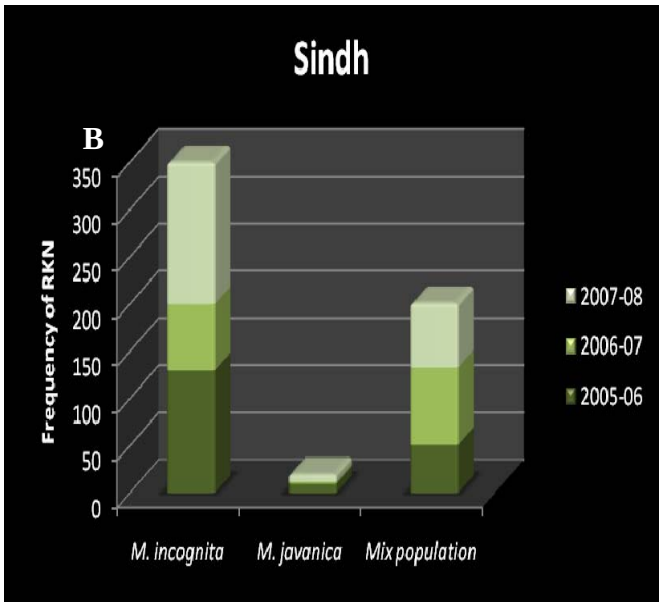
6. Percentage Occurrence of Root-Knot Nematode (Meloidogyne) Species in Pakistan

Out of 1500 samples of rice, over all percentage of *M. incognita* was 46.3 % while *M.javanica* was recovered in 9.1 %. Whereas in 39.7% samples mixed population of *M. incognita* and *M. javanica* was encountered. Prevalence of *M. incognita* was 52.5 % out of 600 samples of soybean, *M. javanica* 11.6 % and *M. hapla* was recovered in 20 % whereas *M. graminicola* has not encountered during the present study (Fig. 1.3 - 1.4). Province wise percentage occurrence of *M. incognita* was 31.3% from Punjab and 33.7% from Sindh whereas *M. javanica* was found with 21.3% from Punjab and 25% from Sindh. In case of soybean the highest percentage of occurrence of *M. incognita* was 80% from KPK followed by 72.7% from Sindh and 68% from Punjab. Whereas *M. javanica* was found with 62.5% in Punjab and 44.7% in Sindh, while the least percentage occurrence of *M. hapla* was 20% from KPK only.

A combination of factors is likely to have contributed towards the change in distribution of *Meloidogyne* spp., in Pakistan. Over a period of time, movement of plant materials from root-knot infected fields could have led to spread of *Meloidogyne* spp., to new areas. Natural causes such as flooding and soil erosion also assist in the spread of root-knot nematodes.

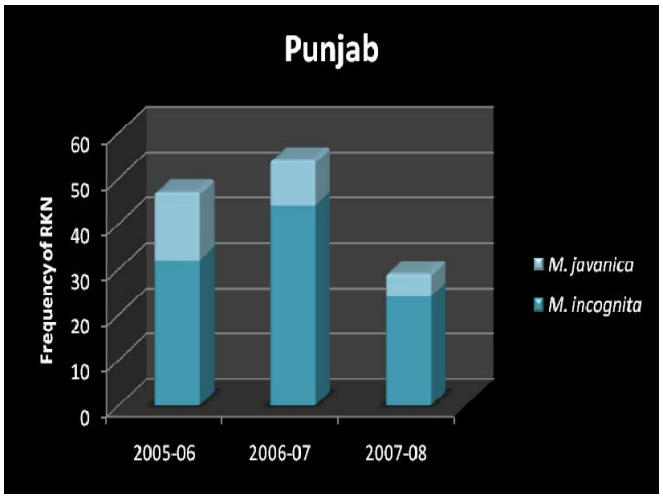


A



B

Figure 1.3: (A-B). % occurrence of root-knot nematode species in rice cultivated areas during 2005-2008. A. Punjab; B. Sindh, Pakistan



A

B

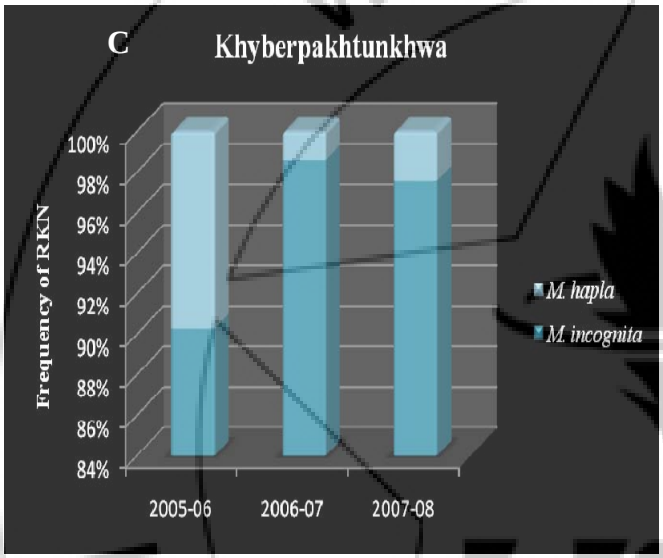


Figure 1.4: (A-C). % occurrence of root-knot nematode species in soybean cultivated areas during 2005-2008. A.Punjab; B. Sindh; C. KP, Pakistan

Table 1.3: Distribution, % occurrence and intensity of root-knot nematode species in rice fields of Pakistan

Locality	*No. of samples collected*	*No. of positive samples*	*Occurrence % of RKN*	*RK I on root system*	*Meloidogyne species and sub species*
Punjab					
Faisalabad	45	10	22.2	< 25	*M. incognita*
Gujranwala	55	28	50.9	26-50	*M. incognita*
Hafizabad	22	3	13.6	1-10	*M. javanica*
Jhang	40	18	45	50-75	*M. i and M. j*
Kasur	65	13	20	< 25	*M. javanica*
Narowal	35	5	14.2	1-25	*M. incognita*
Okara	30	9	30.0	< 25	*M. javanica*
Pakpattan	10	2	20	< 25	*M. incognita*
Rahimyar	33	-	-	-	
Sahiwal	50	12	24	< 25	*M. incognita*
Sheikhupur	150	51	34.0	26-50	*M. incognita*
Sialkot	46	25	54.3	>75	*M. i and M. j*
Vehari	19	-	-	-	-
Sindh					
Badin	50	30	60	50-75	*M. i and M. j*
Dadu	60	30	50	26-50	*M. i and M. j*
Gharo	30	2	6.6	1-10	*M. i and M. j*
Hyderabad	10	3	30.0	<25	*M. javanica*
Jaccobabad	50	21	42.0	26-50	*M. incognita*
Khairpur	10	-	-	-	-
Larkana	300	109	36.33	< 25	*M. i and M. j*
Nasirabad	200	44	22.0	1-10	*M. incognita*
Nawabshah	25	8	32.0	< 25	*M. incognita*
Sanghar	10	-	-	-	-
Shikarpur	70	30	42.8	26-50	*M. i and M. j*
Sukkur	10	2	20	1-10	*M. javanica*
Thatta	75	45	60.0	26-50	*M. incognita*

7. Distribution and Percentage Occurrence of RKN Species in the Surveyed Areas

Detail analysis of the samples, collected from rice and soybean fields, revealed the presence of RKN. These nematodes were identified on the basis of RKN taxonomy (including perineal pattern and morphology of juvenile and male) [14] and [15]. Two species of root-knot nematodes viz., *M. incognita* and *M. javanica* were more frequently recovered from rice and soybean studied areas. From seven localities of rice viz., Sialkot, Jhang (Punjab), Badin, Dadu, Larkana, Shikarpur and Gharo (Sindh) mixed population of two species viz., *M. incognita* and *M. javanica* were encountered. Ten rice localities viz., Gujranwala, Sheikhupura, Narowal, Pakpattan, Sahiwal, Faisalabad (Punjab), Thatta, Jaccobabad, Nawabshah and Nasirabad (Sindh) reproduced only one species *M. incognita*. Whereas from five regions viz., Okara, Kasur, Hafizabad (Punjab), Hyderabad and Sukkur (Sindh) only one species *M. javanica* was isolated. However, from four regions of rice viz., Vehari, Rahimyar Khan (Punjab), Sangharh and Khairpur (Sindh) no RKN species was recovered (Table 1.3).

In the present study root-knot nematode was found infecting both rice and soybean plants, however, the root-knot disease intensity was found low in rice than soybean plantations. Because of stagnant water root-knot nematodes did not produce at high rate of recurrence in rice plantations. In this study out of 26 localities, Sialkot showed the highest disease incidence of root-knot nematodes (>75) on rice root systems followed by two locations viz., Jhung (Punjab) and Badin (Sindh) who shared the same RKI (50-75). However, low index of root-knot was recorded in rest of the localities. During the survey *M. incognita* was found in the highest frequency in rice fields of Badin and Thatta having the same frequency (60 %) in Sindh, while Sialkot (54.3 %) and Gujranwala (50 %) of Punjab showed lower frequency than Sindh (Table 1.3).

Among root-knot nematodes *M. incognita* had been ranked first with respect to geographical distribution and host range. The rate of infection of *M. incognita* has increased as compared to other root-knot species on soybean in Khyber Pakhtunkhwa (KP). However, [6] reported the wide spread occurrence of root-knot species *M. javanica* in a survey of NWFP. So we can say after 16-17 years *M. incognita* has

dominated in KP including soybean crop plants as compared to rice crop according to the scale used by [16].

8. Discussion

During this research many nematodes were encountered from rice and soybean plants, but very little information is available on the importance of these host associated nematodes [6], [1],[17] and [2]. *Meloidogyne* is the most important nematode genus that may cause damage in the production of both crops in the country. As observed the fields of soybean were found damaged by *Meloidogyne* spp., with heavy galling on the roots. While in rice fields less infestation of RKN was found. The reports are similar to those reported earlier for soybean and rice [18] and [19].

In the present study varying degree of frequency of root-knot nematodes in rice and soybean crops was recorded from different localities of Pakistan. In soybean crop variation in incidence may be due to many factors, which contribute to the infection and reproduction of the nematodes in field [20] , [21], as well as climate variation at the localities [22],[23], type of soil [24], [25] and sequence of cropping [26], [27] while in rice field it may be due to the stagnant water in the field.

However, present findings are in confirmation of the results of previous surveys carried out by many researchers that worked on similar objectives viz., [28],[5]-[6], [29]-[33].

During the present study over all occurrence of root-knot nematodes (*M.incognita*) were found 33.3 % in rice and 67.1 % in soybean. These results are also in accordance with the following workers: [34]-[38]. [39] reported occurrence of root-knot (35 %) of the fields and can cause losses in upland rice. [40] reported that the root-knot nematode infect and establish in all the rice ecosystems and cause severe damage to deepwater rice in Asam. [41] observed that transplantation of infected seedlings may results in greater infection and damage to rice plants in the field. Yield losses associated with *M. incognita* on soybean were suppressed up to 90 % in Florida [42]-[44]. [45] and Maung and Jenkins (1959) noted the effect of root-knot nematodes on the yield in soybean. Sinclair and Backman (1989) reported the greatest yield losses of soybean by *M. incognita*. While 10-30 % yield losses was reported by the [46].

9. Future Scope or Recommendations

The present study provides important information to extension specialists, which can be used to create alertness among growers.

i. It should aware the plant scientists to consider nematodes major damaging pests of crops and start searching for resistant cultivars as an option in plant parasitic nematode management.
ii. Awareness campaigns about RKN disease launched on a large scale to disseminate the knowledge among the farmers or growers community.

1) Continue surveys with pathogenic races, e.g. of *M. incognita.*
2) More investigations into pathogenic capabilities and economic threshold infestation levels.
3) Extended nematology consultancies, both international and local level.
4) Emphasis should also be specified to the control of nematodes by biological means and the use of resistant cultivars.

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