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Population dynamics of *Hirschmanniella mucronata* and *H. oryzae* on *Sesbania rostrata*, *Aeschynomene afraspera* and rice cv. IR 58 [1]

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Summary — Studies on the population dynamics of *Hirschmanniella oryzae* and *H. mucronata* on *Sesbania rostrata*, *Aeschynomene afraspera*, and rice cv. IR 58 were conducted under greenhouse and field conditions. The greenhouse experiment was conducted in pots with initial inocula of 500, 5000, and 10 000 nematodes per plant. Root and soil nematode populations were estimated at 15, 30, 45, 60, and 75 days after transplanting (DAT). Field experiments were conducted on two irrigated rice fields naturally infested with either *H. oryzae* or *H. mucronata*. Root and soil nematode populations were estimated at 0, 15, 30, 45, 60, 75, 90 and 120 days after transplanting (DAT). In rice, nematode populations in the roots gradually increased to a maximum at 30-45 DAT and then decreased until harvest. Simultaneously, the number of nematodes detected in soil progressively decreased until 30-45 DAT and then increased again. In *S. rostrata* and *A. afraspera*, the nematode root populations increased progressively from transplanting to 60 DAT under field conditions and 45 DAT under greenhouse conditions. During the same period the nematode soil populations decreased to less than 1/dm^3 of soil. Between 45-60 DAT and 90 DAT the nematode root population decreased to less than 1/g of root, whereas the nematode soil populations did not increase and remained at less than 1/dm^3 of soil. These results indicate that *S. rostrata* and *A. afraspera* can effectively control *H. oryzae* and *H. mucronata* populations in field and greenhouse conditions.

Résumé — ***Dynamiques de populations de* Hirschmanniella oryzae *et* H. mucronata *sur* Sesbania rostrata, Aeschynomene afraspera *et riz cv. IR 58*** — Les dynamiques de populations de *Hirschmanniella oryzae* et *H. mucronata* sur *Sesbania rostrata*, *Aeschynomene afraspera* et riz cv. IR 58 ont été étudiées en serre et au champ. L'expérience en serre a été conduite avec des inoculums initiaux de 500, 5000 et 10 000 nématodes par plante. Les populations de nématodes ont été estimées dans le sol et dans les racines 15, 30, 45, 60 et 75 jours après inoculation. Les expériences au champ ont été conduites sur deux rizières irriguées naturellement infestées l'une par *H. oryzae*, l'autre par *H. mucronata*. Les populations de nématodes ont été estimées dans le sol et dans les racines 0, 15, 30, 45, 60, 75, 90 et 120 jours après repiquage. Des résultats similaires ont été obtenus en serre et au champ. Sur riz, les populations de nématodes observées dans les racines ont augmenté à partir du repiquage pour atteindre un maximum 30 jours (en serre) et 45 jours (au champ) après le repiquage. Ensuite, ces populations ont décru jusqu'à la récolte. Simultanément, les nombres de nématodes détectés dans le sol ont diminué progressivement jusqu'à 30-45 jours après repiquage puis augmenté jusqu'à la récolte. Avec *S. rostrata* et *A. afraspera*, les populations de nématodes observées dans les racines se sont accrues progressivement jusqu'à 45 jours et 60 jours après le repiquage respectivement en serre et au champ. Dans le même temps, les populations observées dans le sol ont fortement diminué pour atteindre moins de un nématode par décimètre cube. Entre 45-60 jours après repiquage et la récolte, les populations de nématodes observées dans les racines ont diminué pour atteindre moins de un nématode par gramme de racine; dans le même intervalle de temps, les densités de population dans le sol sont restées inférieures à un nématode par décimètre cube. Ces résultats indiquent que *S. rostrata* et *A. afraspera* peuvent efficacement contrôler les populations d'*H. oryzae* et d'*H. mucronata* dans les conditions du champ aussi bien qu'en serre.

Key-words : *Hirschmanniella*, populations, *Sesbania*, *Aeschynomene*, rice.

Hirschmanniella oryzae (Van Breda de Haan, 1902) Luc & Goodey 1963 and *Hirschmanniella mucronata* (Das, 1960) Luc & Goodey, 1963, rice root nematodes, are present in high population densities in most irrigated rice fields throughout Asia (Sher, 1968; Sato & Kosyhyhara, 1970; Fortuner & Merny, 1979; Madamba *et al.*, 1981; Subramanian & Velayuthan, 1983; Ichinohe, 1988) and are known to cause severe damage to rice crops (Panda & Rao, 1971; Mathur & Prasad, 1972; Fortuner, 1977). Chemical control of nematodes in irrigated rice fields while effective, may have undesirable side effects such as persisting in grains (Visalakshi *et al.*,

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1979), piscidal effects (Argente *et al.*, 1977), and poisoning of wild birds (Flickinger *et al.*, 1980, 1986). Crop rotation with resistant or trap crops may be an alternative to chemical treatments.

Sesbania rostrata (Brem.) and *Aeschynomene afraspera*, legumes capable of fixing nitrogen in flooded soil, are potential green manure crops for rotation with irrigated rice (Rinaudo *et al.*, 1983; Rinaudo & Moudiongui, 1985; Becker *et al.*, 1989). In pot and microplot experiments, the population density of *H. oryzae* was reduced by a crop of *S. rostrata* acting as a trap crop for the nematode (Germani *et al.*, 1983; Pariselle, 1987; Pariselle & Rinaudo, 1988).

In our research, population dynamics of *H. oryzae* and *H. mucronata* on *S. rostrata*, *A. afraspera*, and rice cv. IR 58 were studied under field and greenhouse conditions. Objectives of our research were to compare and estimate the potential of *S. rostrata* and *A. afraspera* in controlling *H. oryzae* and *H. mucronata*.

Materials and methods

Greenhouse experiments

Two experiments were conducted simultaneously under greenhouse conditions, the first with *H. oryzae* and the second with *H. mucronata*.

Hot water treatments were applied to seeds of rice cv. IR 58 (57 °C for 15 min) and seeds of *A. afraspera* (100 °C for 5 s). Seeds of *S. rostrata* were scarified in H_2SO_4 for 10 min. Nurseries were prepared in pots containing 1 dm^3 of autoclaved soil (80 °C for 6 h).

One week old seedlings of *S. rostrata*, *A. afraspera*, and rice cv. IR 58 were transplanted separately to clay pots containing 500 cm^3 of autoclaved soil (80 °C for 6 h). Fertilizer (14-14-14) was applied to all pots (1.5 g/pot) at transplanting and 45 days after transplanting. Plants were watered daily in order to maintain a permanent layer of 2 to 3 cm of water on the top of the soil.

Nematodes were derived from cultures maintained on rice cv. IR 58 in the greenhouse. Seedlings were inoculated at transplantation with 500, 5000 or 10 000 nematodes per plant by introducing the nematodes in the soil.

Nematode population densities were estimated in the soil and the roots at 15, 30, 45, 60, and 75 days after inoculation. Nematodes were extracted from the 500 cm^3 of soil by sieving (using a 45 µm aperture sieve) and Baermann funnel (48 h extraction time). Nematodes were extracted from the totality of each root system, roots were macerated for 10 s in an electric blender, and then placed on a Baermann funnel for 48 h.

Pots were arranged on benches in a three factor, completely randomized design replicated three times. The factors were : plant species, inoculum level, and sampling time.

Field experiments

The two field experiments were conducted on the IRRI experimental farm on two fields naturally infested with either *H. oryzae* or *H. mucronata*.

Seeds of *A. afraspera*, *S. rostrata*, and rice cv. IR 58 were treated or scarified as described for the greenhouse experiment. Nurseries were seeded on May 18 for rice and May 25 for the two legumes.

Plots of 4 m × 5 m enclosed in bounds were established, each of them was irrigated separately. The three crops were transplanted on June 9 in a randomized complete block design with six replications on the field infested with *H. oryzae* and seven replications on the field infested with *H. mucronata*. The rice crop was grown for 90 days until harvest and the two legumes for 120 days. Irrigation was applied as needed to maintain the two fields permanently flooded. No fertilizer and no insecticide treatment were applied during these experiments.

Nematode population densities were estimated in the soil and the roots at 15, 30, 45, 60, 75, 90 and 120 days after transplanting. Four soil and root samples were collected at random from each plot at each sampling time. Nematodes were extracted from 200 cm^3 of soil and 3 g of roots using the same techniques as for the greenhouse experiments.

Results

Greenhouse experiments

Similar results were observed with the two nematodes and with all initial inoculum levels. Figures 1 and 2 show the results obtained with *H. mucronata* and *H. oryzae*, respectively.

On rice, the root nematode populations increased from transplanting until a maximum was reached at 30 DAT and then decreased until harvest. Simultaneously, the number of nematodes detected in the soil progressively decreased until 30 DAT and then increased again to reach a number of nematodes approximately equal to the initial population when the initial inoculum was 500 nematodes per plant and average total numbers of nematodes inferior to the initial population when initial inocula were 5000 and 10 000 nematodes per plant.

On *S. rostrata* and *A. afraspera*, the nematode root populations increased progressively from transplanting to 45 DAT. During the same period of time the nematode soil populations decreased. Between 45 DAT and 75 DAT the nematode root population decreased to less than 10 nematodes per root system, whereas the nematode soil populations continued to decrease and only a few nematodes were detected in the soil at 75 DAT.

Irregardless of the initial inoculum, at 60 and 75 DAT numbers of nematodes observed in the soil cultivated with rice and in the rice roots were significantly higher

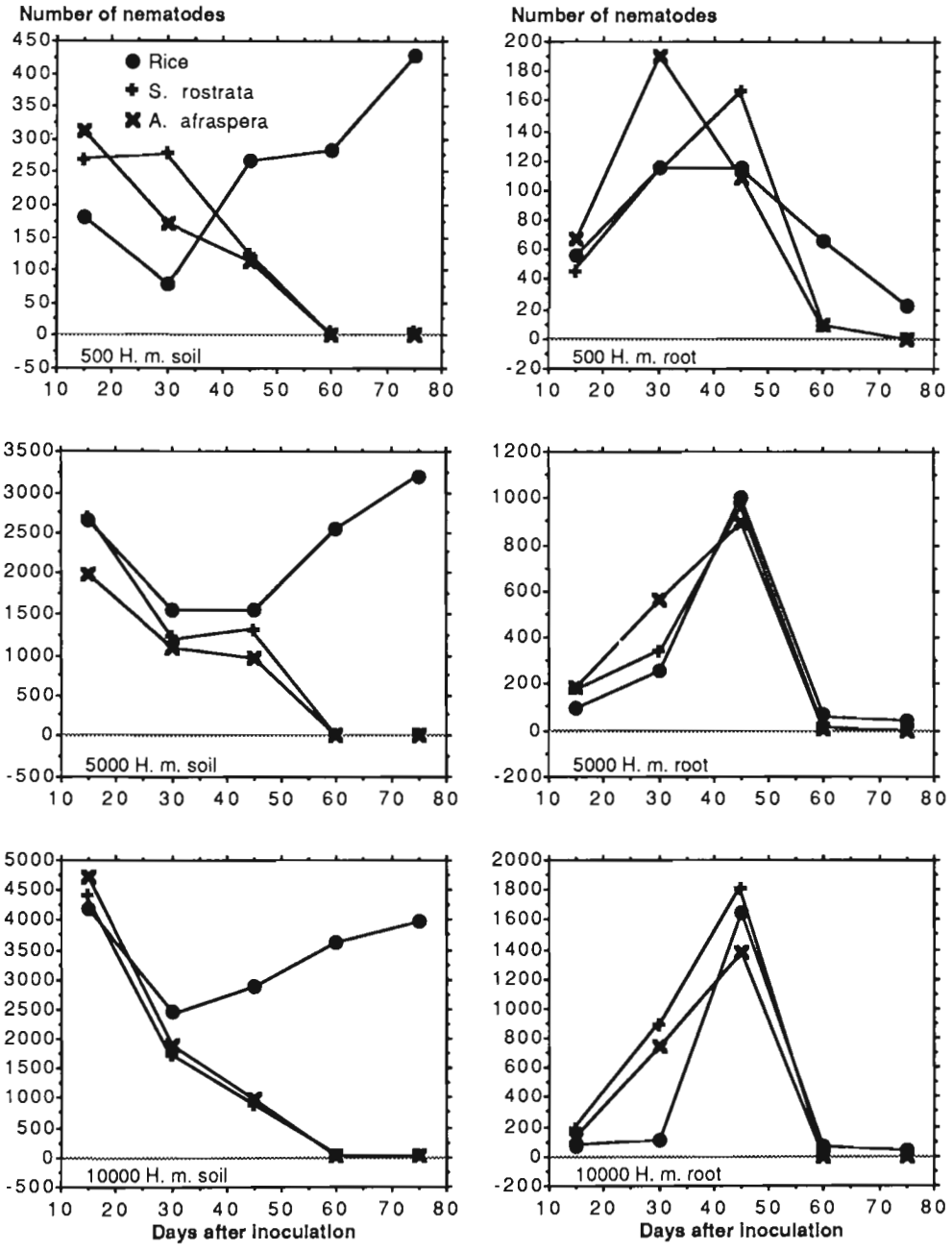

Fig. 1 : Average (3 replications) total numbers of *Hirschmanniella mucronata* observed in the soil and the root system of rice cv. IR 58, *Sesbania rostrata* and *Aeschynomene afraspera* plants inoculated with 500, 5000, and 10 000 nematodes and grown for 75 days in a greenhouse.

than those observed with *S. rostrata* and *A. afraspera* by Mann-Whitney test at the 5 % level.

FIELD EXPERIMENTS

Results observed were similar in the two rice fields naturally infested with *H. mucronata* and *H. oryzae*. These results are shown on Figure 3.

In the rice field plots, the average root nematode populations gradually increased until a maximum of approximately 35 nematodes/g of root was reached at 45 DAT and then decreased until harvest. Simultaneously, the average numbers of nematodes detected in

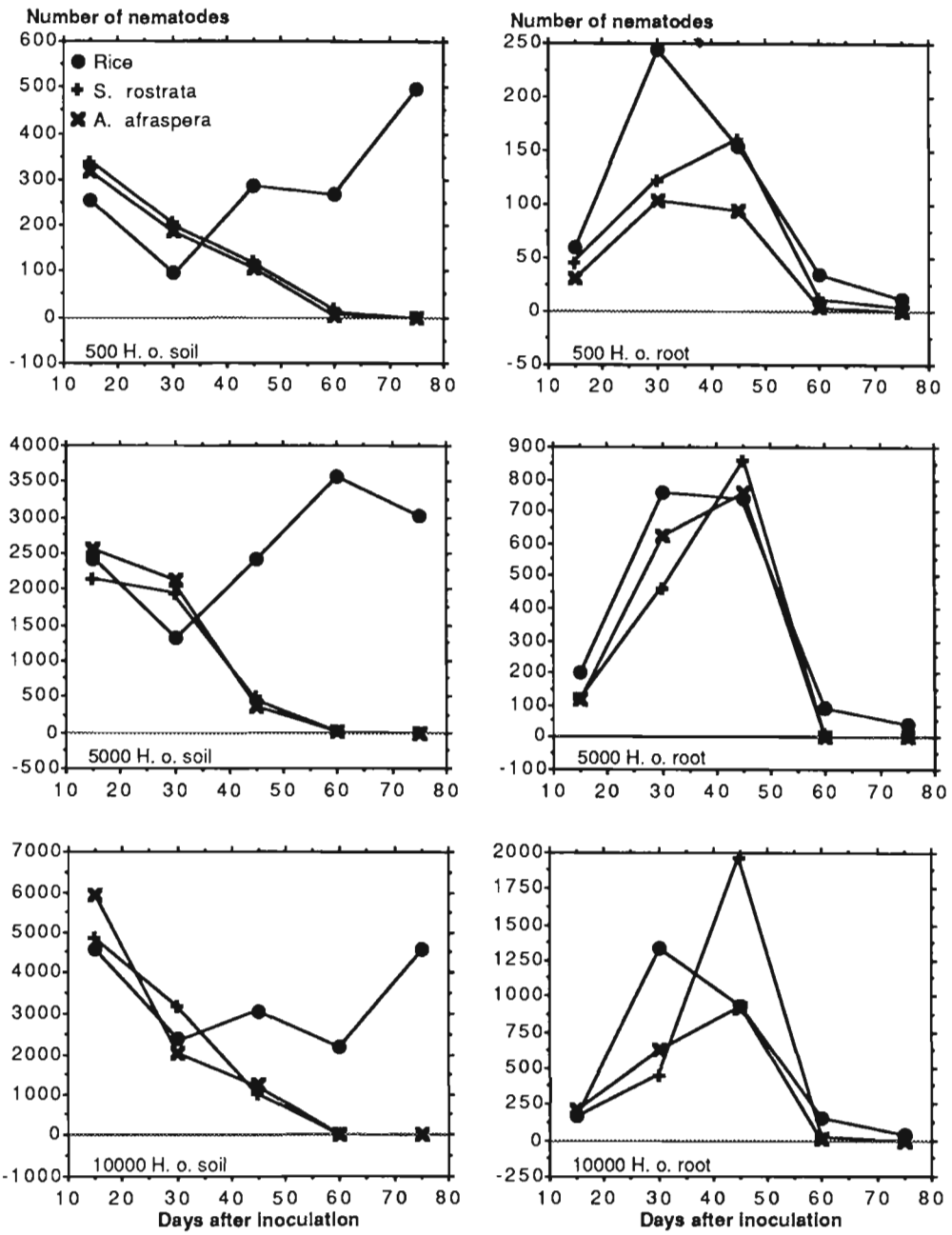

Fig. 2 : Average (3 replications) total numbers of *Hirschmanniella oryzae* observed in the soil and the root system of rice cv. IR 58, *Sesbania rostrata* and *Aeschynomene afraspera* plants inoculated with 500, 5000, and 10 000 nematodes and grown for 75 days in a greenhouse.

the soil progressively decreased until 45 DAT and then increased again to reach population densities approximately equal to the initial population densities.

In *S. rostrata* and *A. afraspera* field plots, the nematode root populations increased progressively from transplanting to 60 DAT when the average number of nematodes reached a maximum of 5 to 10/g of root. Between 60 DAT and 120 DAT the nematode root population decreased to less than 1/g of root. The nematode soil populations decreased constantly from

transplanting to 120 DAT to reach undetectable levels at the end of the experiments. A two-way analysis of variance has shown that, at the 5 % level, in both fields : *i)* the average initial population of nematodes observed in the different treatments were not significantly different; *ii)* the factor block did not affect significantly the numbers of nematodes observed in the soil and the roots of the three crops; *iii)* the number of nematodes detected per g of root were significantly higher in rice than in the two legume crops at all sampling times; *iv)* the numbers of *H. oryzae* observed in the soil of the rice plots were significantly lower at 15, 30, and 45 DAT and significantly higher at 60, 75, and 90 DAT than those observed in plots cultivated with the legume crops; *v)* the numbers of *H. mucronata* observed in the soil of the rice plots were significantly lower at 45 DAT and significantly higher at 60, 75, and 90 DAT than those observed in plots cultivated with the legume crops.

Discussion

The results obtained on rice under greenhouse and field conditions confirm the observations that the maximum population present in the roots is reached between tillering and heading (Fortuner, 1976), and that the soil population is rebuilt at the end of the rice crop when the nematodes are leaving the roots (Merny, 1972). When initial inoculum of 5000 and 10 000 nematodes were used in the greenhouse experiment the average number of nematodes recovered from rice pots at 75 DAT was less than the initial inoculum. This indicates that a rice plant grown in a pot with only 500 cm^3 of soil can not sustain these high numbers of nematodes.

The results obtained with *S. rostrata* under greenhouse and field conditions confirmed the previous observation made in microplots (Germani *et al.*, 1983, Pariselle, 1987) and pot (Pariselle & Rinaudo, 1988)

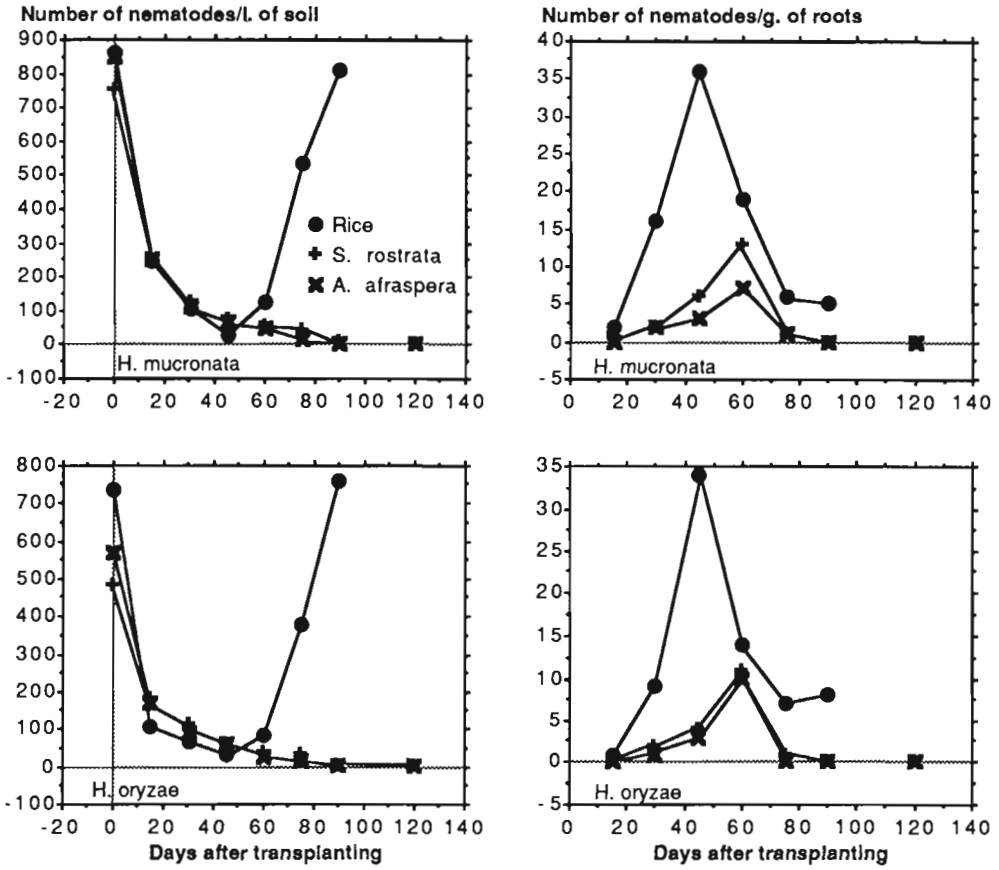

Fig. 3 : Average numbers of *Hirschmanniella mucronata* (7 replications) and *Hirschmanniella oryzae* (6 replications) observed, at 15 days intervals for 120 days, in the soil and the root system of rice cv. IR 58, *Sesbania rostrata* and *Aeschynomene afraspera* in two fields naturally infested.

experiments that *S. rostrata* may be a trap-plant for *H. oryzae*. They also confirmed observations by Pariselle (1987) that the nematodes were able to exit from the root of *S. rostrata* until 60 days after planting. In our experiments the nematode root exit inhibition began at 75 days after planting and was concomitant with flowering of the plant. Similar results were observed with *A. afraspera*. This may indicate that the destruction or the inhibition of the nematodes, inside the roots of the two leguminous crops, may result from a modification of the physiology of these plants.

The results obtained in the field experiments indicate that *S. rostrata* can be used in irrigated rice fields to effectively control the rice root nematodes *H. oryzae* and *H. mucronata*. These results also indicate that *A. afraspera*, another potential greenmanure crop, has the same effect as *S. rostrata* on the rice root nematodes and may also be used to effectively control these nematodes under field conditions. However, to be effective in controling nematodes, these two legumes crops have to be cultivated for at least 75 days and preferably 90 to 120 days. Notwithstanding a necessary study of the economics of the control of rice root nematodes by using greenmanure crops, their cropping for 90 to 120 days in order to control these nematodes will be a limitation to their utilization for this purpose. This is because small farmers can not afford to keep their land out of production for such a period of time.

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