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Plant growth and yield of cowpea as affected by population density of root knot nematode, *Meloidogyne incognita*

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Abstract: Under screen house conditions, cowpea plant was inoculated with root knot nematode, *Meloidogyne incognita* at different population levels viz., 0,10,100,1000,2000 and 4000 at planting time. Results indicated that as initial population increased, the final nematode population gradually increased, but this population tended to decrease at higher nematode densities 2,000 and 4,000 levels. The rate of nematode build up tended to decrease with increasing initial nematode inocula. Negative correlation coefficient (r) was found between initial and final population and cowpea plant yield or growth criteria averages (plant vigor index). Coefficient of determination (r^2) was calculated to determine the percentages reduction in yield and plant growth criteria caused by nematodes only.
Key words: Cowpea, plant growth, pod yield, population densities, *Meloidogyne incognita*.

Introduction

Cowpea (*Vigna unguiculata* (L.) Walp) is a plant belonging to the family Fabaceae. It is the most important grain legume providing a source of profitable revenue between 23 and 29% of the selling price in some countries [1]. It is also valued as the cheapest dietary and high quality vegetable protein of about 25-43%[2]. Root knot nematodes, *Meloidogyne* spp. are major pests of cowpeas in the most crop growing regions of the world[3]. They have a wide host range and their damage potential to different crops including vegetables can reach up to 100% [4,5]. Losses on cowpeas are due to *Meloidogyne* species in some countries, which have been ranged from10% to 89% [6]. However, there is little information about the relationship between population density of root knot nematode, *M. incognita* and cowpea plant growth and yield criteria all over the growing season. Therefore, this research aimed at evaluating of different inoculums of *M. incognita* on final nematode population and subsequently cowpea plant growth and yield vigor.

Material and Methods

For this experiment, Cowpea cv. Baladi seeds were sown in 25-cm.diam pots filled with solarized sandy loam soil (1:1) under screen house conditions. Fifteen days after emergence, plants were thinned to one plant/pot. Then, six different initial population densities (Pi) viz., 0, 10, 100, 1,000, 2,000 and 4,000 of root knot nematode, *Meloidogyne incognita* juveniles were used. Nematode inocula were done by pouring each inoculum in the holes around the roots in six replicates for each treatment. Temperature was 30±5c^o during the present study. The pots were regularily watered. All treatments were distributed in a completely randomized block design. Ninety days after nematode inoculation, nematodes in soil were extracted by sieving and decanting method[7]. Each root system of each replicate was divided into two halves, the first one was incubated in distilled water for egg hatching[8] and another half was examined for number of galls and egg masses. Rate of

nematode build up was calculated by dividing final nematode population (Pf)/ initial nematode population (Pi). Plant growth criteria including fresh weights of shoots and roots, length and dry weight of shoots were recorded. Plant yield criteria including number and weight of pods, number and dry weight of seeds/pod and dry weight of 100 seeds were estimated at harvest stage. Plant vigor was calculated for each treatment as an average of plant growth or yield criteria. The percentage vigor reduction was calculated for each treatment (nematode level) by dividing reduction in plant vigor index for each treatment/The highest plant vigor for control×100. Correlation coefficient(r) and coefficient of determination (r^2) were calculated to describe the relation between plant yield or growth vigor and initial and final nematode populations.

Statistical Analysis:

Data analysis was depended upon the least significant differences (LSD) and Duncan's Multiple's Range Test was performed to differentiate means among treatments by using COSTAT programme.

Results

Effect of initial nematode population on final population:

From Table 1, it was observed that as initial nematode population increased, there was a corresponding significant ($p \leq 0.05$) increase in the final nematode population, but this population tended to decrease at higher nematode densities of 2,000 and 4,000 levels. The rate of nematode build up tended to decrease with increasing initial nematode inocula.

Effect of initial nematode population on plant growth or yield criteria:

Table 2 illustrated that plant growth criteria and their plant vigor index- in general- decreased with increasing initial nematode population densities. When calculating plant growth vigor index reduction%, it is clearly noticed that the highest population density (4000 individuals/pot) reduced plant growth vigor index by 29.8% compared to that occurred in control treatment. Whilst the highest percentages reduction (33.9 and 32.7%) occurred at 100 and 1,000 levels, respectively. Also, plant yield criteria and their plant vigor index followed the same trend. When calculating pod yield index vigor reduction%, the highest nematode population density (4,000) caused the highest percentage reduction (24.7%) in yield vigor compared to that occurred in control treatment followed by the other treatments. (Table 3).

The relationship between initial and final nematode populations and plant growth or yield criteria:

When using statistical analysis, Table 4 indicates that plant growth or yield vigor index of cowpea negatively correlated with the initial population of root knot nematode, *M. incognita* as correlation coefficients (r) were -0.27 and -0.90, respectively.. In other words, when initial population of root knot nematode increased, there was corresponding decreases in plant growth and yield vigor index of cowpea. Determination coefficients (r^2) were 0.07 and 0.80, respectively. In Table 5, when statistically analyzed, the previous criteria i.e. plant growth or yield vigor index in relation to total final nematode population were negatively correlated as the correlation coefficients (r) were -0.75 and -0.56 and determination coefficients (r^2) were 0.57 and 0.32, respectively(Table 5).

Table (1): Final population and rate of build-up of *Meloidogyne incognita* infecting cowpea under green house conditions.

Nematode levels (Initial population (Pi))	No. J_2 in soil /pot	No. J_2 in roots/plant	No. of galls/plant	No. of egg-masses/plant	Total final population (Pf)	Rate of build-up (Pf/Pi)*
0(control)	0e	0f	0e	0e	0e	0
10	2840d	197e	22d	15d	3052d	305.2
100	2704d	365b	35c	26c	3095d	30.95
1000	7384a	327c	43c	27c	7738a	7.74
2000	3120c	270d	67b	49b	3439c	1.72
4000	4056b	517a	90a	60a	4633b	1.16

-Values are averages of 5 replicates. Similar letter(s) indicate significant differences among means according to Duncan's Multiple Range Test at level 0.05.

*Pf= Final population (No. of J_2 in soil+ no. of J_2 in roots + no. of eggmasses in roots, Pi= initial population

Table (2); Plant growth criteria of cowpea against initial inoculum levels of *Meloidogyne incognita* under screen house conditions.

Nematode levels	Plant length (cm)	Fresh weight of shoots (g)	Dry weight of shoots (g)	Fresh weight of roots (g)	Plant growth vigor index*	%Plant growth vigor index reduction
0(control)	93.0a	117.7a	29.8a	14.3a	63.7	-
10	72.6b	75.6de	21.5b	10.8a	45.1	29,2
100	67.0bc	70.2e	21.0b	10.2a	42.1	33.9
1000	56.7de	80.2cd	22.5b	12.0a	42.9	32.7
2000	62.3cd	88.1b	27.9a	13.0a	47.8	25.0
4000	54.8e	86.5bc	25.0b	12.5a	44.7	29.8

-Values are averages of 5 replicates. Similar letter(s) indicate significant differences among means according to Duncan's Multiple Range Test at level

*Plant growth vigor index was calculated as an average of plant growth criteria.

Table (3): Yield criteria of cowpea against initial inoculum levels of *Meloidogyne incognita* under screen house conditions.

Nematode levels	No. of pods/plant	Weight of pod /plant (g)	No. of seeds /pod	Dry weight of seeds/ pod(g)	Dry weight of 100 seeds(g)	Plant yield vigor index*	% Plant yield vigor index reduction
0(control)	14a	1.06a	8a	0.99a	11.10b	7.04	-
10	11ab	1.14a	8a	0.84a	10.21c	6.24	11.4
100	10ab	1.28a	9a	0.99a	11.95a	6.64	6.7
1000	9ab	1.20a	8a	0.95a	11.70a	6.18	14.2
2000	8ab	1.26a	8a	0.97a	11.65a	5.98	15.3
4000	7b	1.13a	7a	0.83a	10.52c	5.30	24.9

-Values are averages of 5 replicates. Similar letter(s) indicate significant differences among means according to Duncan's Multiple Range Test at level 0.05.

*Plant yield vigor index was calculated as an average of plant yield criteria.

Table (4): The relationship between initial inoculum levels of *Meloidogyne incognita* and plant growth or yield vigor index of cowpea

Nematode levels	Plant growth vigor index*	r	r^2	Plant yield vigor index*	r	r^2
0(control)	63.7	- 0.27	0.07	7.04	- 0.90	0.81
10	45.1			6.24		
100	42.1			6.64		
1000	42.9			6.18		
2000	47.8			5.98		
4000	44.7			5.30		

-Values are averages of 5 replicates. Similar letter(s) indicate significant differences among means according to Duncan's Multiple Range Test at level 0.05.
*Plant growth or yield vigor was calculated as an average of plant growth or yield criteria.
r= Correlation coefficient, r^2= Coefficient of determination.

Table (5): The relationship between total final nematode populations of *Meloidogyne incognita* and plant growth or yield vigor index of cowpea

Nematode levels	Total final nematode population (Pf)	Plant growth vigor index*	Correlation coefficient (r)	Determination coefficient (r^2|	Plant yield vigor index*	Correlation coefficient (r)	Determination coefficient (r^2|
0(control)	0e	63.7	-0.75	0.56	7.04	-0.57	0.32
10	3052d	45.1			6.24		
100	3095d	42.1			6.64		
1000	7738a	42.9			6.18		
2000	3439c	47.8			5.98		
4000	4633b	44.7			5.30		

-Values are averages of 5 replicates. Similar letter(s) indicate significant differences among means according to Duncan's Multiple Range Test at level 0.05.

Plant growth or yield vigor index was calculated as an average of plant growth or yield criteria.

Discussion

Conclusive results from the experiment showed that final nematode population tended to increase as initial population gradually increased, but at higher population levels, 2,000 and 4,000, it tended to decrease. Accordingly,rate of nematode build up decreased with increasing initial population which may be due to infra-specific competition among parasites for feeding. From the present study, it is obvious that there were negative correlations between plant growth or yield vigor index and the tested population density levels of *M. incognita* inoculated to plants at the beginning of the experiment. Another negative correlation was found between the total final population and plant growth or yield vigor index which ensured that the effect of root knot nematode infecting cowpea was based on both the initial and the total final nematode populations. In other words, the effect of initial population levels continued all over the growing season which finally reflected on plant growth and yield criteria at the termination of the experiment. The coefficients of determination, in the first case, were 0.07 and 0.81 for the respective criteria and 0.56 and 0.32, in the second case ,which means that 7 and 81 %, for the former, and 56 and 32%, for the later, of the variation in the above mentioned criteria caused by root knot nematode only could be explained by linear regression. These results agree with those obtained by other investigators [9,10,11,12,13]. On this basis, root knot nematode infecting cowpea should be controlled at the planting time to avoid damage reflecting on plants at maturity stage.

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