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Effect of cucumber plant age on nematode multiplication and development of disease complex

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Abstract
Cucumber (*Cucumis sativum*) is a warm season vegetable grown throughout the world under tropical and subtropical condition in open fields. The climatic suitability of crops is also favorable for many diseases. Among them disease complex situation causes severe loss. The simultaneous penetration of nematode and fungus exhibited a synergistic effect on growth retardation of plants. In view of this, the experiment was conducted on effect of cucumber plant age on development of wilt complex caused by nematode and fungus interaction. The fungus and nematode (2 J_2 per gram soil) simultaneously inoculated in soil at the time of sowing, 7, 14, 21 and 28 days after sowing (DAS). Data showed that maximum plant growth parameters, minimum nematode reproduction and minimum PDI were recorded in inoculum after 28 days of sowing followed by 21 days and 14 days after sowing While, minimum plant growth parameters, maximum nematode reproduction and maximum PDI were recorded with inoculated at the time of sowing.

Keywords: Plant age, cucumber, root-knot nematode, fusarium

Introduction
Cucumber *(Cucumis sativum*) popularly known as khira is one of the important cucurbitaceous vegetables from nutritional as well as economic point of view. It is a warm season vegetable grown throughout the world under tropical and subtropical condition in open fields. It is cultivated in both kharif and summer seasons in northern part of country and round the year under mild temperature condition in tropical regions (Nagar, 2013) [5]. Cucumber is a warm season crop but it is also grown in summer and rainy season. It requires 18 ºC minimum temperature for seed germination and 20-30ºC for growth and development of plant. It requires sandy to loam soil for early and good crop. Cucumber fruits become ready for first harvesting in about 60-70 days after sowing.

The *Fusarium oxysporum f. sp. cucumerinum* is the most common and harmful pathogen on cucumber plants causing *fusarium* wilt and reduced the yield (Ogura, 1992) [7]. The damage caused by root knot nematode is much higher in tropical and subtropical countries (Taylor and Sasser, 1978) [11] and they reduce crop yields considerably both qualitatively and quantitatively (Sasser and Freckman, 1986, Anwar and Mckenry, 2012) [9, 1]. Disease complex situation in agricultural crops systems is very common in nature. It has long been shown that fungal pathogens of crop plants interact with plant parasitic nematodes leading to increased disease severity (Atkinson, 1892). These have been number of reports of disease complexes involving many crops where in plant nematodes were found interacting with fungal or bacterial pathogens. However, root-knot nematode and *Fusarium* wilt is a major complex disease which cause heavy loss in cucumber production, though this disease not recognize easily with complex. The complex is highly destructive to cucumber plants and characterized by enhanced wilt symptoms on infected plant wilt suppressed growth and yield (Prasad, 1995) [8]. The simultaneous penetration of nematode and fungus exhibited a synergistic effect on growth retardation of plants. In view of this the present investigation was undertaken on effect of plant age on development of wilt complex caused by nematode and fungus interaction.

Material and Methods
The experiment on effect of plant age on development of wilt complex caused by nematode and fungus interaction was conducted in pot condition during October to December, 2020 at SKN College of Agriculture, Jobner, and Jaipur. The region falls under agro- climatic zone semi-arid eastern plain of Rajasthan.

Earthen pots were washed, cleaned and disinfected before use by rinsing them with 4 per cent formalin solution. The formalin was allowed to evaporate before their use for experimentation. Earthen pots were taken and filled with 500 cm^3 sterilized soil.

Sandy loam soil was thoroughly washed with 3-4 changes of water so as to remove the soluble leachates and air dried. This soil was then mixed with well decomposed FYM (3:1), to prepare soil composite. The composite soil was disinfested with four per cent commercial formaldehyde (E. Merck) by sealing the heap corners with polyethylene sheet for 15 days and later exposed to direct sunlight after spreading in a thin layer to allow complete evaporation of remnants of formaldehyde. Sterilized soil composite was stored in a clean aluminium tray, well covered with polyethylene sheet and was utilized whenever required for the experimental purpose.

Cucumber seeds were sown at 2-3 cm depth @ 2 seed /pot and at the time of two leaf stage one plant in each pot was maintained.

The fungus was multiplied on pre - soaked sterilized sorghum grain in flask by inoculating with 7 days old culture of *Fusarium oxysporum* and incubated at 25± 1º C temperature for 7 days.

Egg masses of root-knot nematode, *Meloidogyne* spp. collected from the infected roots were kept in distilled water in watch glasses at room temperature for hatching. Freshly hatched 2nd stage juvenile was then inoculated on one month old cucumber plants already grown and maintained in pots filled with steam sterilized soil to obtained adequate pure population of *Meloidogyne* spp. on the plants and in soil to carry out further experiments.

The cucumber (variety NS-4136) of five age groups *viz.* at the time of sowing, 7, 14, 21 and 28 days were inoculated with 1000 freshly hatched second stage juveniles of *Meloidogyne* spp and fungus culture. An un-inoculated control was also maintained. The experiment was laid out in poly house under CRD manner with four replications. The pots were irrigated with 100 ml tap water as and when required. Observations on vine length (cm), root length (cm), vine weight, and root weight (g), number of galls per plant, number of egg masses per plant, number of eggs per egg masses, PDI and nematode juveniles per 200cc soil were recorded 60 DAS.

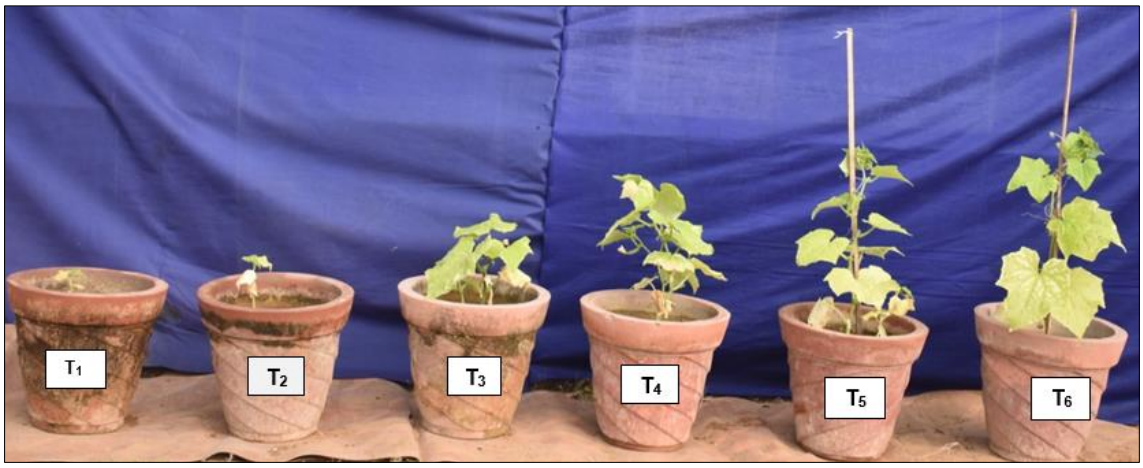
Result and Discussion

The data presented on plant growth parameters showed that maximum plant growth parameters were recorded in inoculum after 28 days of sowing followed by 21 days and 14 days after sowing and the minimum plant growth parameters were recorded in inoculum at the time of sowing. The plant growth parameters were significantly increased with increase the fungus and nematode inoculum interval after sowing. The nematode reproduction and PDI were significantly decreased with increase the fungus and nematode inoculum interval after sowing. Among all the age group of plants, the maximum nematode reproduction and PDI were recorded with inoculated at the time of sowing followed by 7 days and 14 days after sowing. While, minimum nematode reproduction and PDI were recorded in inoculum after 28 days after sowing. Findings of Nayga and Slares (1990) [6] showed decreased root-knot nematode population and lower percent yield loss in *Momordica charantia* when nematode inoculation after six to eight weeks of planting. Mukhtar *et al.* (2013) [4] recorded that those plants inoculated after 2nd week of emergence were heavily damaged. Kumar *et al.* (2018) [3] observed that one week old black gram plants were more susceptible to root-knot nematode. Siengchin *et al.* (2020) [10] observed the sizes of root galls and giant cells of young mung bean plants infected with root knot nematode were larger than for older plants parameters. However, with the increase in plant age at the time of inoculation, the damaging effects lowered significantly. With an increase in plant age there was a corresponding decrease in the reproduction factor being inversely proportional to plant ages.

Table 1: Effect of plant age on multiplication of *Meloidogyne* spp. and per cent wilt disease incidence

Treatments	Plant growth characters				Nematode reproduction				PDI
	Vine length	Vine weight	Root length	Root weight	No. of galls/ plant	No. of egg masses/ plant	No. of eggs/egg mass	Nematode population / 200 cc soil	
At the time of sowing	8.03	2.08	7.20	0.35	148.00	121.50	277.00	898.75	72.50
7 DAS	11.90	2.19	8.85	0.42	97.50	72.50	261.50	796.00	60.50
14 DAS	13.38	20.65	8.98	2.30	74.75	55.50	256.25	711.75	39.50
21 DAS	25.68	24.40	10.35	2.45	36.50	26.50	253.50	407.50	35.25
28 DAS	36.65	29.42	11.10	3.21	22.25	9.50	250.50	358.50	9.00
Un-inoculated	38.10	36.88	12.07	4.43	0.00	0.00	0.00	0.00	0.00
S.Em ±	0.24	0.279	0.235	0.14	1.299	0.589	0.797	4.630	0.598
CD 5%	0.73	0.83	0.698	0.43	3.860	1.751	2.37	13.757	1.777

Average of four replications
DAS* = Day after sowing



T1 = At the time of sowing, T2 = 7 Days after sowing, T3 = 14 Days after sowing, T4 = 21 Days after sowing, T5 = 28 Days after sowing, T6 = Un- inoculated

Plate 1: Effect of plant age on multiplication of *Meloidogyne* spp. and wilt incidence

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