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Screening of Cucumber varieties for their Reaction to Root-knot Nematode, *Meloidogyne incognita*

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ABSTRACT: The *Meloidogyne incognita* has detrimental effect on the sustainable production of cucumber production. It is a significant pest that significantly reduces cucumber plant growth and causes yield losses of 66.23 percent. Aim of this study is to draw systematic and comprehensive picture of resistant reaction of different cultivars of cucumber against root knot nematode, *Meloidogyne incognita* which can be used by farmers for more production. A pot culture experiment was conducted in the department of nematology, OUAT, Bhubaneswar 2021-2022 to examine how 34 cucumber cultivars responded to *Meloidogyne incognita.* The experimental setup was designed on CRD having 3 replications. The roots of all the cucumber cultivars were examined 45 days after the inoculation to calculate their gall indices, which ranged from 0 to 5. Data were collected based on nematode reproduction after 45 days. None of the 34 cucumber cultivars tested positive for immunity to root-knot nematode. Present data revealed that out of Thirty-four (34) varieties none was found immune against root-knot nematode. Two varieties Green long and Topper F1 were categorised as resistant against *M. incognita* while nine (9) varieties summer queen, Malini, Crystal-21, Super Queen 45, Encounter 962 F1, Kareena, Padma -51, JK Manali, Krish were categorised as moderately resistant and eighteen varieties (18) Rajmata, sukumal, supriya, Simran, Clara, Glossy, NS-415, Padmini, KSP-1302 Bhavana, Hercules New, ZCU-126, KSP-142 Hansa, Kumud, Natalia-74, Suruchi, AZCU-30, Hind, cucumber sweet long were found susceptible against root knot nematode and remaining five (5) varieties Basumati, 12-Patra, Adimata, Kumulika, Radhika were found highly susceptible reaction to nematode.

Keywords: Cucumber varieties, *Meloidogyne incognita*, gall index, resistance.

INTRODUCTION

The cucumber, scientifically known as *Cucumis sativus* L., is the member of the family Cucurbitaceae that is considered to be the most significant and widely consumed. The family consists of about 118 genera and 825 species (Rai *et al*., 2008). According to the FAO estimate, there were 4,290,000 ha of cucurbit cultivation, yielding 10.52 t/ha, or around 5.6% of India's total vegetable production. Globally, cucurbits are grown on an area of 8.5 million hectares with production of 17.9 million tons (Akbar *et al*., 2015). Cucumber plant is susceptible to different plant parasitic nematodes among which the root-knot nematode *Meloidogyne incognita* is known to occur throughout the world. Plantparasitic nematode represent an important constraint on the delivery of global food security. Damage caused by PPN has been estimated at US $ 80 billion per year (Nicol *et al*., 2011). It is generally documented that the four major speices (*M. incognita*, *M. javanica*, *M. arenaria* and *M. hapla*) as well as few emerging species such as *M. enterolobii* and *M. chitwoodi*, cause damage on a vast majority of crops (Moens *et al*., 2009). They are considered among the top five major plant pathogens and the first among the ten most important genera of plant parasitic nematodes in the World (Mukhtar *et al.* 2013). The root-knot nematode was first discovered in England in a green house on cucumber (Berkeley, 1855) and are worldwide in distribution and attack many economically important crops (Sasser, 1979) and more than 3000 plants including cucurbits have been recorded as hosts (Sasser, 1977). *Meloidogyne* spp. were considered to be the most important parasites of cucumber and caused yellow foliage, unthrifty growth, small slow growing fruits, poor yield, heavy root galling, root decay and reduced root system (Krishnaveni and Subramanian 2005). Hence for sustaining good production, it becomes important to know incidence and severity of root knot nematode in cucumber. Therefore, the present investigation was undertaken to screen the locally available cucumber cultivars for resistance against *Meloidogyne incognita* (Kofoid and White/Chitwood).

The varieties were categorized into highly resistant (HR), resistant (R), moderately resistant (MR), susceptible (S) and highly susceptible (HS) types on the basis of presence of egg masses, root knot indices following 1-5 scale (Taylor and Sasser 1978).

Gall Index	Observations	Reactions
1	No egg mass/galls/plant	Highly resistant (HR)
2	1-10 egg masses/galls/plant	Resistant (R)
3	11-30 egg masses/galls/plant	Moderately resistant (MR)
4	31-100 egg masses/galls/plant	Susceptible (S)
5	> 100 egg masses/galls/plant	Highly susceptible (HS)

Data on the number of galls, egg masses, and reproductive factors were collected after the allotted time. After being rinsed with tap water, the egg mass-stained roots were counted at a 25x stereomicroscope. The ultimate nematode population was calculated by adding the nematode samples taken from the soil and the eggs taken from the infected roots (Hussey and Barker 1973; Whitehead and Hemming 1965).

MATERIAL AND METHODS

After being manually removed from the infected cucumber roots, a single egg mass of *M. incognita* was surface sterilised in a 1:500 (V/V) aqueous solution of "chlorax" (Sodium hypochlorite) for 5 min. (Hussey and Barker 1973). The egg mass was then transferred to a small coarse sieve that was placed inside a Petri plate with enough water to cover the bottom of the sieve. The petri dish was cultured for 5 days at room temperature (27 °C) (Den Ouden, 1958). To ensure a steady supply of inoculum for the experiment, seedlings of the tested cultivars were infected with the offspring of a single egg mass and cultivated in autoclaved soil (Sharma *et al*., 2006). After being surface sterilised with formaldehyde solution (1.0%) cucumber seeds were planted in an earthen pot with a diameter of 10 cm and a volume of 500 cm^3 of sterilised soil (Fig. 1). Seedlings were trimmed to one seedling per pot ten days after germination and injected with *M. incognita* at 1.1 g/g soil (Fig. 2). Each entry has three replications that were kept. After 45 days (Fig. 3) of being inoculated, the plants were carefully plucked, the roots were separated, washed, and then fixed in 4% formalin. The roots were then dyed with lactophenol-acid fuchsin, cleared in pure lactophenol, and the number of egg masses and galls on each plant were counted using a stereo-zoom microscope (Devi *et al*., 2014). It was decided to score the root-knot gall index and responses using the conventional methodology.

Statistical analysis. To find out the significant difference in the different cucumber cultivars, the all data were statistically analysed at 5 per cent level.

RESULTS AND DISCUSSION

A. Length of the vine and Root length (cm)

The data recorded for vine length revealed significant differences among different cucumber cultivars (Table 1). Length of the vine ranged from 80.90cm to 41.30 cm. The highest vine length was recorded in cultivars green long (80.90cm) and topper F1 (79.59cm). In moderately resistant varieties highest vine length is found in Malini i.e., 77.66cm and lowest vine length is seen in Encounter 962 F1 is 54.59cm. Among susceptible varieties highest vine height is found in NS- 415 i.e., 67.21cm and lowest vine height is found in Sukumal is 55.37cm. The vine length in highly susceptible varieties is lowest in 12 Patra *i.e.,* 41.30cm. Generally, more vigorous the vines, more is the yield in cucumber. Similar estimates were also reported earlier (Shukla *et al.* 2010; Veena *et al.*, 2012). It has been reported that the highest length of vine was observed in Kathmandu local (203cm) and the lowest plant height in kasinda (148.70) with average plant height 177.45cm (Maharjan *et al*., 2015).

The highest root length was observed in Basumati (29.07cm), followed by Adimata (28.76), Kumulika (27.64cm), Crystal 21(27.31cm), NS- 415 (26.55cm), Natalia- 74 (26.16cm). Lowest root length of cucumber cultivars was found in topper F1 (14.59cm) followed by Green Long (16.23cm) Encounter 962 F1 (16.26cm), Malini (18.66cm), Summer queen (19.16cm). There was a nonsignificant difference among different varieties on length of the vine and root. Similar screening for vine length was done by Sudheer *et al*. (2022) with different varieties of cucumber.

B. Fresh vine weight and root weight (g)

Among thirty-four varieties the range of fresh vine weight is 9.90cm to 6.40cm and highest fresh vine weight is observed in green long (9.90cm) followed by topper F1 (9.26cm), malini (8.99cm), JK Manali (8.84cm), Kareena (8.72cm). Among susceptible varieties highest fresh vine weight is found in kumud i.e., (7.84g), followed by Natalia- 74 (7.82g), Suruchi (7.77g), KSP- 1302 Bhavana (7.67g). The lowest fresh vine weight is observed in highly susceptible varieties like Kumulikai.e., 6.34g followed by 12 Patra and basumati (6.40g), Adimata (6.56g), Radhika (6.61g).

It has been reported that highest fresh root weight was found in green long (1.31g) followed by topper F1 (1.24g), malini and Kareena (0.85), Encounter 962 F1(0.83), Summer queen (0.82). Among susceptible varieties mentioned in Table 1 the fresh root weight ranged from 0.61g to 0.68g. Lowest fresh root weight is found in Cucumber sweet long, AZCU- 126, Sukumal (0.61g) followed by Hercules new, Supriya, Rajmata (0.62g), Glossy (0.63g). There was a nonsignificant difference among different varieties on fresh root and shoot weight. Possible reason of reduction of shoot and root weight in highly susceptible varieties may be due to improper supply of nutrients resulting from the nematode infection.

Table 1: Variations in plant growth parameters of cucumber cultivars infected by root-knot nematode *M. incognita*.

Sr. No.	Varieties	Fresh Vine wt.(g)	Fresh root wt.(g)	Vine length (cm)	Root length (cm)	Dry Vine wt.(g)	Dry root wt.(g)
1.	Rajmata	7.67	0.62	58.57	22.57	0.77	0.18
2.	Basumati	6.40	0.47	43.97	29.07	0.57	0.11
3.	Sukumal	7.37	0.61	55.37	21.03	0.70	0.14
4.	Summer queen	8.16	0.82	71.49	19.16	0.83	0.21
5.	12- patra	6.40	0.43	41.30	25.63	0.52	0.08
6.	Adimata	6.56	0.45	42.43	28.76	0.59	0.09
7.	Supriya	7.25	0.62	58.35	22.35	0.67	0.16
8.	Green Long	9.90	1.31	80.90	16.23	0.92	0.27
9.	Malini	8.99	0.85	77.66	18.66	0.86	0.22
10.	Simran	7.44	0.68	65.49	24.27	0.66	0.20
11.	Crystal 21	8.41	0.77	68.31	27.31	0.72	0.19
12.	Clara	7.13	0.68	65.87	25.87	0.74	0.20
13.	Glossy	6.71	0.63	60.40	24.31	0.63	0.15
14.	Super queen 45	7.96	0.81	66.00	25.66	0.75	0.18
15.	NS- 415	7.35	0.68	67.21	26.55	0.73	0.19
16.	Padmini	7.57	0.65	62.80	23.80	0.63	0.17
17.	Encounter 962 F1	8.36	0.83	54.59	16.26	0.68	0.21
18.	KSP- 1302 Bhavana	7.67	0.71	62.67	21.34	0.62	0.15
19.	Topper F1	9.26	1.24	79.59	14.59	0.89	0.25
20.	Hercules new	7.62	0.62	63.92	21.25	0.62	0.12
21.	AZCU- 126	7.38	0.61	58.77	20.10	0.72	0.11
22.	KSP- 142 Hansa	6.78	0.65	63.75	24.08	0.63	0.17
23.	Kumulika	6.34	0.41	45.64	27.64	0.52	0.10
24.	Kumud	7.84	0.60	64.30	22.64	0.61	0.13
25.	Radhika	6.61	0.44	44.01	24.01	0.51	0.08
26.	Natalia- 74	7.82	0.67	67.16	26.16	0.68	0.18
27.	Suruchi	7.71	0.71	65.71	23.71	0.73	0.16
28.	Kareena	8.72	0.85	57.79	19.79	0.71	0.20
29.	AZCU- 30	7.59	0.66	63.76	23.76	0.64	0.14
30.	Padma- 51	8.40	0.76	66.10	25.10	0.68	0.20
31.	JK Manali	8.84	0.74	61.68	21.68	0.58	0.19
32.	Hind	7.56	0.67	62.71	24.26	0.65	0.16
33.	Cucumber sweet long	7.16	0.61	63.09	20.76	0.58	0.15
34.	Krish	7.82	0.57	54.69	22.85	0.61	0.13
	SE(m)±	**0.26**	**0.01**	**1.90**	**1.07**	**0.02**	**0.003**
	CD (0.05)	**0.72**	**0.03**	**5.35**	**3.03**	**0.06**	**0.009**

C. Dry vine weight and root weight (g)

The data recorded for dry vine and root weight revealed significant differences among different cucumber cultivars (Table 1). Weight of dry vine ranged from 0.51 to 0.91g. The highest vine dry weight is found in green long (0.92g) followed by topper F1 (0.89g), malini (0.86g), summer queen (0.83g), rajmata (0.77g), Super queen 45(0.75g). Lowest vine dry weight is found in radhika (0.51g), 12 patra and kumulika (0.52g), basumati (0.57g), Adimata (0.59g), cucumber sweet long and JK Manali (0.58g).

Highest dry root weight is found in green long (0.27g), topper F1 (0.25g), malini (0.22g), summer queen (0.21g), Simran, clara, padma-51 and Kareena (0.20g). Lowest dry root weight is found in 12-Patra and Radhika (0.08g), adimata (0.09g), Kumulika (0.10g), AZCU- 126 and basumati (0.11g), Hercules new (0.12g). There was a nonsignificant difference among different varieties on dry root and shoot weight. A plant response to nematode parasitism causes a morphological and physiological change that affects photosynthetic process.

D. No. of Galls/root system

Highest number of galls was found in 12 Patra (114.43) followed by Kumulika (113.97), Basumati (107.30), Radhika (96.01), Adimata (94.63), Simran (65.49) (Table 2). Lowest number of galls was found in green long (10.90) followed by topper F1 (13.59), Padma-51 (21.68), Crystal-21 (22.98), Kareena (25.46), krish (26.35). There was a nonsignificant difference among different varieties on number of galls. Highest number of galls can significantly reduce due to poor translocation of water and nutrients for growth of plant, thus there will be decrease in yield of cucumber crops. Root knot nematode causes giant cells in the roots and this disrupts the root vascular system, reducing the uptake of water and nutrients and their transport from the roots to the shoots (Abad *et al.,* 2003).

E. Nematode population (J2/200cc soil)

Highest nematode population was found in highly susceptible variety 12 patra (1468.00), followed by adimata (1433.00), basumati (1366.33), Radhika (1269.67), kumulika (1081.67) (Table 2). Lowest nematode population is found in resistant variety green long (224.67) followed by topper F1 (243.67), summer queen (294.00), Kareena (294.67), malini (329.33). Basing on nematode population, root gall index and susceptibility, the effect of varietal difference on root gall numbers per root system was also observed to be significant (Hunter, 1958).

The outcomes showed that the various cucumber varieties evaluated reacted to *M. incognita* in a variety of ways. Host plant genetics and other environmental factors may have an impact on this variation in root knot nematode tolerance. The presence of nematode resistance genes reduces the appeal of the plant root to invading worms. Plant effects on the nematode's ability to reproduce are reflected in the nematode's resistance and susceptibility to parasitic plant nematodes (Sharma *et al.*, 2006). The ability of a cultivar to reproduce or multiply is one of the most important criteria for cultivar selection. The host is said to as susceptible when it allows the nematode to reproduce on it and results in yield losses, whereas the host is referred to as tolerant when there are no yield losses. However, the host will be resistant if it prevents the nematode from reproducing and as a result there is no yield loss (Seinhorst, 1967). Juveniles had the greatest potential to fully develop in Susceptible hosts when compared to resistant and moderately resistant cultivars, the juvenile's development was either slowed down or delayed (Nelson *et al.*, 1990).

Table 2: Screening of cucumber cultivars against root-knot nematode (*Meloidogyne incognita*).

Sr. No.	Varieties	No. of galls/root system	Root Knot Index (1-5 scale)	Nematode population (J2/200cc soil)	Response
1.	Rajmata	36.24	4.36	685.00(26.17)	S
2.	Basumati	107.30	4.91	1366.33(36.96)	HS
3.	Sukamal	35.37	4.65	720.33 (26.84)	S
4.	Summer Queen	26.16	3.72	294.00 (17.15)	MR
5.	12-patra	114.43	4.98	1468.00(38.31)	HS
6.	Adimata	94.63	4.90	1433.00(37.85)	HS
7.	Supriya	44.68	4.57	737.00 (27.15)	S
8.	Green Long	10.90	2.52	224.67 (14.99)	R
9.	Malini	26.32	3.74	329 .33 (18.14)	MR
10.	Simran	65.49	4.75	844.33 (21.74)	S
11.	Crystal-21	22.98	3.68	347.33 (25.59)	MR
12.	Clara	64.20	4.71	865 .33 (29.42)	S
13.	Glossy	57.06	4.62	785.00(28.02)	S
14.	Super Gueen-45	31.66	4.10	349.67 (18.70)	MR
15.	NS-415	46.21	4.67	543.00 (23.30)	S
16.	Padmini	36.14	4.69	792.00(28.14)	S
17.	Encounter 962F1	33.93	4.45	436.67 (20.89)	MR
18.	KSP 1302 Bhavna	42.67	4.47	820.00 (28.63)	S
19.	Topper F1	13.59	3.46	243.67 (15.61)	R
20.	Hercules New	45.92	4.81	924.00 (30.40)	S
21.	AZCU-126	35.77	4.67	820.33 (28.64)	S
22.	KSP 142 Hansa	55.08	4.58	912.33 (30.20)	S
23.	Kumulika	113.97	4.90	1081.67(32.88)	HS
24.	Kumud	56.97	4.61	775.33 (27.84)	S
25.	Radhika	96.01	4.91	1269.67(35.63)	HS
26.	Natalia-74	59.16	4.78	772 .00 (27.78)	S
27.	Suruchi	55.04	4.54	783.00 (27.98)	S
28.	Kareena	25.46	3.76	294.67 (17.17)	MR
29.	AZCU-30(Bajrangi)	65.26	4.75	838.00 (28.95)	S
30.	Padma-51	21.68	3.48	374.33 (19.34)	MR
31.	Jkmanali	26.49	3.82	402.67 (20.07)	MR
32.	Hind	61.00	4.70	892.67 (29.88)	S
33.	Cucumber sweet long	91.76	4.89	888.00 (29.80)	S
34.	krish	26.35	3.80	426.00 (20.64)	MR
	SEM	**2.05**		**0.88**	
	CD 5%	**5.78**		**2.50**	

Fig. 1. Sowing of seeds

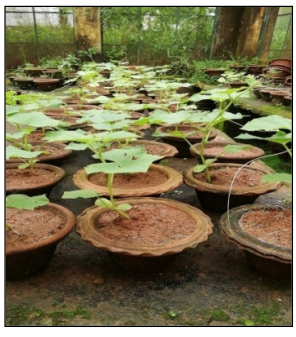

Fig. 2. 10 Days after sowing.

Fig. 3. 45 Days after sowing.

CONCLUSIONS

The residual nematode population density in the field is directly impacted by resistant and moderately resistant germplasm that inhibits nematode reproduction. It would be desirable to choose resistant genotypes based on root knot index during preliminary assessments, followed by selection based on nematode reproduction during advanced evaluations, for breeding programmes for resistance to plant parasitic nematodes. Therefore, using resistant genetic material can be a key strategy for controlling the root knot nematode population in the pulse ecosystem. On resistant and moderately resistant germplasm, it was revealed that *Meloidogyne incognita* reproductive capacity was drastically low. These cultivars are advised for cultivation in *M. incognita* infested fields because they are expected to experience less nematode damage than susceptible ones with the highest rate of nematode multiplication.

FUTURE SCOPE

This study will help to draw attention of farmers to get acquainted with different cucumber varieties which will be useful in selection for further cultivation. This will also facilitate to know about the resistant and susceptible varieties and change their genetic variation according to the desired characters.

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Conflict of Interest. None.

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