Floralinfestationof tuberose (*Aphelenchoides*) ~~anditsand~~ itsmanagement~~.withtreatment modules.~~

Abstract

In the field experiment conducted on cv. Culcatta Double~~, to observe~~the symptoms of floral malady and~~ also~~ efficacy of ~~the~~ treatment modules on foliar nematode population, percent infestation~~ of plant~~ and resulting yields of the crop~~s~~has been observed. The symptoms appear~~starts~~on the~~with~~ leave~~sf~~ and progress until~~till~~ flowering. T~~he t~~ypical symptoms observed were browning of leaves and flowers. In serious condition, the plant becomes stunted along with prickles on the stalks and flowers. The flowers become brittle~~ were easily breakable and hard~~. The results of the present ~~experiment~~study showed that the percent infestation~~edplant~~ was directly proportional to~~correlated with~~ the nematode population. T~~ and it was also observed that t~~he percent infestation and as well as the population was higher in untreated plot (M7) as compared to all treated plots. T~~It was observed that t~~he treatment module (M4) involving ~~consisting of the treatments like,~~ overnight drenching of bulb in water followed by dipping in monocrotophos 36SL @750ppm for 4 hrs + Spraying of monocrotophos 36SL @360g a.i./ha alternated with cartap hydrochloride 50SP @375g a.i./ha at 15 days interval after onset of foliar nematode infestation in the 1st year and succeeding year crop was the most economical (ICBR 1: 8) and ~~most~~ effective means of managing~~restraining~~*Aphelenchoidesbesseyi* population. It also yielded higher~~greatest~~ number of marketable flower stalks viz. ~~,~~4, 43,908.19 ~~numbers of stalks~~ per hectare.

Keywords: *Aphelenchoidesbesseyi,* Browning of leaves and flowers, Floral malady, Tuberose.

Introduction

Tuberose(*Polianthes tuberosa* L.)is one of the most important tropical, ornamental, bulbous, flowering plants cultivated for production of long-lasting flower spikes. It is popularly known as Rajanigandha. It belongs to the family Amaryllidaceae and is native of Mexico. It is commercially cultivated in many countries of the world like Vietnam, China, Brazil, Italy, Iran, UK, USA, etc. including India.Tuberose is ~~one of the~~ famous among ~~the~~ cut flowers. M~~Usually tuberose is quite hardy plant and m~~any pests have been reported to attack this crop. The plant parasitic nematode (PPN) is one of the most important pests attacking tuberose and reducing~~is causing barrier to~~ quality and quantity of flower production. Among the PPN, the most important are foliar~~ nematode~~and Root Knot nematode ~~infecting the tuberose crop.Mukhopadhyay (1997) reported that the n~~Nematodes~~ to~~ cause serious problem in tuberose by reducing almost 50% of earnings of the flower growers of the stateMukhopadhyay (1997). As a result of severe infestation by nematode, the flower stalks become stunted, ~~and~~ reduced in weight, ~~and~~ epidermis becomes irregular and rugged, with aging pricked and~~on~~ tough (Kadam,*et al*., 2019). Diagnosis of symptoms ~~has been considered the most~~ is important ~~part~~ in consideringtaking ~~any~~ strategies~~y~~ for managementcontrolling ~~the nematodes pest~~. A ~~Therefore, a~~ management programme with variable treatment modules was~~eretaken up~~designed to manage~~d~~ the nematode population as well as invent ~~and to further observed~~the economically feasible ~~economically best~~ treatment.

Material~~s~~ and Methods~~:~~

A field experiment was carried out using~~on~~ cv. Culcatta Double for observation~~vigilance~~ of symptom~~s~~ development ~~right~~ from emergence to mature plant and then managing the foliar nematodes. Progressive manifestation of symptoms in infested tuberose stalks and flowers was closely monitored~~observed continuously,right~~ from emergence of the stalk head to harvesting of flowers.I~~The i~~nfected bulbs (2.0-2.5 cm diameter)~~ of tuberose~~ were collected from ~~farmers~~ fields (Ranaghat, West Bengal) and soaked overnight in plain water. The plants were taggedfor observation of the~~ emerging~~ symptoms and the plants were observed meticulously~~ in~~ every week after emergence. The developed

symptoms were recorded along with the increase in age of the plant. In the next phase, ~~Again the collected~~infected bulbs ~~(2.0-2.5 cm diameter) of tuberose from farmers field (Ranaghat, West Bengal)~~ were soaked overnight in plain water, ~~and~~ followed by soaking in nematicides at different doses and duration~~s~~ according to the treatment schedule ~~of the experiment~~. *Paecilomyceslilacinus* and NSKP (Neem Seed Kernel Powder) were also used as treatment before planting and treatment after sprouting of bulbs respectively. The infected bulbs were planted inthe plot (3×1.5)m^2 at a spacing of 50 × 37.5 cm^2. There were 7 treatment modules; each replicated 4 times in a Randomized Block Design. Details of the module~~s~~ are as follow~~s:~~:

M_1-

a)Overnight drenching of bulb in water followed by dipping in Carbosulfan 25 EC @ 1000ppm for 4 hrs. b) Spraying of chlorfenapyr 10SC @75g a.i./ha alternated with cartap hydrochloride 50SP @375g a.i./ha at 15 days interval after onset of foliar nematode infestation in the 1st year and succeeding year crop.

M_2-

a) Overnight drenching of bulb in water followed by dipping in carbosulfan 25 EC @1000ppm for 4 hrs. b) Spraying of cartap hydrochloride 50SP @375g a.i./ha alternated with carbosulfan 25 EC @500g a.i./ha at 15 days interval after onset of foliar nematode infestation in the 1st year and succeeding year crop.

M_3-

a) overnightdrenching of bulb in water followed by dipping in monocrotophos 36SL @750ppm for 4 hrs. b) Spraying of cartap hydrochloride 50SP @375g a.i./ha alternated with chlorfenapyr 10SC @75g a.i./ha at 15 days interval after onset of foliar nematode infestation in the 1st year and succeeding year crop.

M_4-

a) overnightdrenching of bulb in water followed by dipping in monocrotophos 36SL @750ppm for 4 hrs. b) Spraying of monocrotophos 36SL @360g a.i./ha alternated with cartap hydrochloride 50SP @375g a.i./ha at 15 days interval after onset of foliar nematode infestation in the 1st year and succeeding year crop.

M_5-

a) Overnight drenching of bulb in water followed by dipping in *Paecilomyceslilacinus* (spore load 24×10^7) spore suspension.

b) Prophylactic spraying with NSKP @ 50g/l of water at 15 days interval after onset of foliar nematode infestation in the 1st year and succeeding year crop.

M_6-

a) Overnight dipping of bulbs in water.

b)Spraying of water along with sticker at 15 days interval after onset of foliar nematode infestation in the 1st year and succeeding year crop.

M_7- Control, DAS-Days after sowing

Sticker along with water was added during all nematicides application. Initial nematode population, nematode population per 20g of flowers from each treatment at the time of blooming, percent infested plant and yield were observed during the programme and incremental cost benefit ratio were also calculated.Initial nematode population of foliar nematode was carefully examined in 49 bulbs (7 bulbs for each treatment).The initial nematode population ~~from infected bulb before treatments~~ was estimated by counting the population under stereoscopic binocular microscope. The initial nematode population was extracted from the slash bulb keeping in wire gauge assembly followed by killing and fixing of the nematodes (Seinhorst, 1962). In case of population study, infested 20g of flowers were chopped into small pieces with the help of a sharp knife. Then, the chopped flowers were placed on wire gauge fitted over a petri plate containing clean water just touching the bottom of the wire gauge assembly. The assembly was covered with another petridish to prevent the water loss and was kept undisturbed for 12 hours. During the period, the nematode came out from the chopped flower materials and migrated freely in the water. Then, the prepared suspension was passed through 20 and 400 mesh sieves serially under tap water for cleaning the remaining plant toxic substances released and nematodes were collected in a beaker from the residues and subsequently killing and fixing of the nematodes (Seinhorst, 1962)were done. Estimation of nematodes was done ~~counted~~ with the help of multi chambered counting disc under stereoscopic binocular microscope.For the observation of percent infested plants the total number of plants were taken per plot and then out of that total plants , the nematode infested plants showing the symptoms were taken and accordingly it was calculated by using the following formula Percent Infested Plants = (numbers of nematode infested plants per plot / Total number of plants per plot) X100.The yields were taken in terms of

flower stalk by harvesting the stalk and incremental cost benefit ratio was then calculated to observe the best results in terms of cost.

Results and Discussion:

Progressive manifestation of symptoms in infested tuberose stalks and flowers was closely observed continuously right from emergence of the stalk head to harvesting of flowers. After planting the bulb, the growthing appearances of the tuberose crops were found changing with the infestation by the nematode (*A. besseyi*), the changed on growth attributes directly affect the market value of the tuberose plant due to its unthrifty appearance comparing to the healthy tuberose crops. The symptoms on leaves were initially marked by emergence of yellowish green or pale green or pale green leaves from base to tip of the leaves and later it started turning brown. Formation of prickle like structures was a very first visible morphological changes as a result of nematode infection. The prickle could be observed both on stalk as well as on flowerssimiliarwhich is parallel to the findings by Kadam,*et al*. (,2019). The nematodes while feeding entered in developed flower head and also fed on the epidermal layer of the newly formed stalk. Due to their profuse feeding on the stalk epidermis, the stalk became irregular and rugged. In the infested plant, symptom occurs just after the emergence of the stalk head. In addition to this symptoms, there is twisting in the stalk and , the bracts were often found crinkled. The plants thus infested at early stage, suffered seriously from retardation of growth and remain stunted. ultimately, Sometimes spike developed but the flowers did not bloom whereas, development of apparently normal spike with partial blooming of either lower most or the top most few flowers was also observed. In a few cases the flower stalks emerged with a blind flower head where no spike developed. But both the quality as well as quantity of the important growth attribute was better in treated plots over the untreated ones in both the years of experiment (Kadam,*et al.,* 2020). Therefore, the treatments in modules were aimed towards managing foliar nematode in tuberose and it was found that incorporation of different formulations significantly reduced nematode attack as compared to untreated plots. The infestations caused by foliar nematode (*Aphelenchoidesbesseyi*) in tuberose (cv. Calcutta double) were found to be more in flowers.Percent Infested Plants (P.I.P) were restricted within 9.84-34.44 during the period from August, 1st flowering – February, 2nd year flowering (Table no 2-6) where populations of nematodes remained restricted within 500 excepting a single instance and assumed 1000 or more value in Februaryonly. L That low population of nematodes as well as PIP might be due to the initial stage of the experiment at experimental location accompanied by the effect of nematode management activities and gradual reduction in atmospheric moisture and temperature from November onwards. However, in relation to both the mentioned parameters, the treatment modules had immense positive impact in general and particularly the treatment module M_4 was recorded almost the best one during this period.From March to June, 2nd year of floweringPIP in all the plots including the untreated ones showed a steady growth which was clearly observed with a sharp rise in nematode populations too. Since July onwards there was gradual declination in nematode populations consequent to which PIP in the plots from September onwards declined. This might be the reason behind of July as a rainy seasonan impact on nematode activity gets obstruct resulting sudden fall in PIP and nematode populations in that month. Interestingly, during this period under discussion, *i.e*., March to November, 2nd year flowering, the treatment module M_4 was more or less the best performer among the allies.In most of the cases during the management programme, it was recorded that the nematodes population were directly correlated with the infestation. The yield results were found to be best in the treatment modules M_4 with 4,43,908.19 numbers of stalks per hactre (Table no. 7). Whereas in untreated plot, the yield obtained was very less i.e 65938.56 numbers of stalks per hactre in M_7 which showed that the treatment module were found to be effective and increased the yield of the crops. Considering incremental cost benefit ratio (ICBR), the combinations module of monocrotophos 36SL and cartap hydrochloride 50SP (M_4) proved most economical (ICBR ranged from 1: 8 to 1: 1for all treatment modules) i.e M_4 (1:8.44) and this was followed by M_2 (1:6.40), M_3 (1:5.19), M_1 (1:5.07), M_5 (1:1.56) and M_6 (1:1.05). Results of two season's experiments clearly showed that despite having high nematode infestation, all the treatments in combined formed as module were quite effective and economic to improve the yield over untreated plots.From the above results regarding the percent plant infestation, we could also find that the treatments modules significantly decreased the infestation percentage as the infestation was highest in untreated plot (M_7) in almost all the months. The progresses of nematode infestation during both the season in untreated plots ranged from 9% to 74%. From this, we can also conclude that the infestation percentage increased in 2nd year crops as compared to 1st year crops which supported the observation of Khan *et al*., 2006 where he concluded that the disease incidence was found low (3-34%) in the treated plots whereas in the untreated plots, it was ranging between 10% and 58% in first year crop, however, it was more in second year crop. Here, the conclusion can also be made that the treatment module M_4 was found to be the most

effective in almost all the months during the programme to reduce the infestation caused by foliar nematode *Aphelenchoidesbesseyi* with nematode infestation ranged from 0% to 61% all together in both the year which was more or less similar with the findings of Khan *et al.,* (2005) who recorded that pre-soaking of bulbs for overnight followed by hot water treatment at 50ºC for 30 minutes+dipping of bulbs in monocrotophos 36SL in 500 ppm for 6 hours+two sprayings with monocrotophos 36SL at 500 ppm in first, second and third year crop with three sprayings with monocrotophos 36SL at 500 ppm at 15 days interval (T_5) was found to be superior in terms of reduction of foliar disease with PDI value in the treated plots recorded from 2% to 66%. Khan and Ghosh, (2011) reported that among synthetic pesticides tested, monocrotophos 36 SL showed killing to the extent of 41% nematodes while cartap hydrochloride 50WP and carbosulfan 25EC had 14% killing effect at relatively higher concentration (0.2%) after 2 hrs of exposure. Kadam et al., (2020) also recorded that module cobined treatment with monocrotophos 36SL @ 750, carbosulfan 25EC @ 250g and cartap hydrochloride 50SP @ 375g were found very effective in growth attribute of the crop. William and Robert, (2005) recorded that Chlorfenapyr was a foliar treatment that could be used to manage foliar (*Aphelenchoides*spp.) nematodes whereas Rajvanshi, (2012) recorded that NSKP; Neem seed kernel powder- 10%) could gave significantly better results as compared to untreated check for controlling the nematodes. In another finding, Nagesh *et al.,* 1998 revealed that split application of *P. lilacinus* in combination with oil cakes significantly reduced multiplication rate of nematodes, compared to the single application of *P. lilacinus*, oil cakes and their combinations at planting. The augmentation of nematodes population was found to be more in untreated plot as compare to treated plot (Khan *et al.,* 2006). The appearance of nematode was also found to be more during the month May, June, July and August due to high relative humidity and temperature in the atmosphere (Khan, 2004). It is further to be mentioned that performances of the treatment modules were assessed based on their comparative performance only and there was no such treatment module to check the growth of the nematode populations completely particularly during the periods of high humidity and temperature.

Conclusion:

Aphelenchoides, ~~being~~ one of the most important ornamental nematode pest is ~~also~~ hard to manage using single method ~~of management~~. The~~i~~s nematodes survives in bulbs of the tuberose and can remain alive for many years in inactive mode. When~~but once the~~ bulbs are~~is~~ s~~h~~own in the field, they ~~will get~~ become active ~~again with~~due to the moisture ~~present in the field~~ and start~~ted~~ feeding upon the plant tissues. ~~Since, t~~The ~~man~~infestation ~~can be~~ found from the very early stages till the flowering ~~stages and which~~ leads to drastic economic losses. Therefore, the management were planned in modules so that it can be managed right from the sprouting till harvest of the cut or loose flowers. Many ~~The hidden nature of~~ nematodes ~~make them stay safe from farmers eyes and many has been~~ escape~~alread~~, and ~~y as the peak infection~~ can be found during~~in~~ flowering stages with highest population in flowers. Such infected f~~The unwanted vision in the f~~lowers ~~along with stalk made it unmarketable conditions~~ lead~~ing~~ to huge~~big~~ losses ~~of the farmers~~. T~~So, t~~he module M_4- consisting of ~~a) O~~overnight presoaking of bulbs in water followed by dipping in monocrotophos 36SL @750ppm for 4 hrs. ~~and b) S~~spraying of monocrotophos 36SL @360g a.i./ha alternated with cartap hydrochloride 50SP @375g a.i./ha at 15 days interval after onset of foliar nematode infestation in the 1st year and succeeding year crop was the best for managing the foliar nematode in tuberose and economizing the farmers earning.

Table no. 1: Initial nematode population (INP) ~~i.e~~ before bulb treatment ~~of tuberose~~ (cv. Calcutta Double)

Treatment ~~in~~ modules*	~~Initial~~ nematode population / 7 bulbs
M1	**44.96**
M2	**62.67**
M3	**68.78**
M4	**53.44**
M5	**66.78**
M6	**62.00**
M7	**67.67**
SEm±	**4.18**
CD (5%)	**12.87 (S)**

*In each nematocidal application sticker along with water was added

**Figure marked by common letter are not significantly different according to Duncan's Multiple Range Test at P<0.05. Figures in the parenthesis indicate angular transformed values

Table 2: Effect of ~~the~~treatment modules on Percent Infested Plants (P.I.P) and population of foliar nematodes per 20g of tuberose flower<u>s</u> (cv. Calcutta Double) during 1st year of flowering.

Treatment in modules*	P.I of flower stalk <u>during</u>~~on~~ August ~~1~~st ~~year~~	Population of nematodes/20g flower <u>during</u>~~on~~ August ~~1~~st ~~year~~	P.I of flower stalk <u>during</u>~~on~~ September ~~1~~st ~~year~~	Population of nematodes/20g flower <u>during</u>~~on~~ September ~~1~~st ~~year~~	P.I of flower stalk <u>during</u>~~on~~ October ~~1~~st ~~year~~	Population of nematodes/20g flower <u>during</u>~~on~~ October ~~1~~st ~~year~~
M1	18.75 (**25.89**)^{a**}	69.37 (8.28)^{bcd}	27.65 (**31.88**) ^{a}	57.65 (7.42)^{ab}	31.14 (**34.15**)^{ab}	142.31 (11.93)^{abc}
M2	29.07 (**31.94**)^{a}	38.38 (6.17)^{ab}	26.25 (**30.21**) ^{a}	118.00 (10.59)^{bc}	24.34(**29.77**)^{a}	159.38 (12.38)^{bc}
M3	15.94 (**23.70**)^{a}	51.49 (7.20)^{abc}	25.52 (**30.24**) ^{a}	32.74 (5.67)^{a}	24.89(**30.20**)^{a}	178.85 (13.07)^{bc}
M4	14.93 (**22.71**) ^{a}	34.76 (4.46)^{a}	16.91 (**24.15**) ^{a}	91.45 (9.24)^{bc}	23.43 (**29.21**)^{a}	67.25 (7.18)^{a}
M5	22.06 (**28.18**) ^{a}	97.71 (9.81)^{cd}	28.71 (**32.62**) ^{a}	100.08 (9.72)^{bc}	27.38(**31.78**)^{a}	91.67 (9.39)^{ab}
M6	16.96 (**24.53**) ^{a}	99.20 (9.95)^{cd}	34.44 (**36.06**) ^{a}	152.31 (12.32)^{c}	31.39(**34.05**)^{ab}	215.63 (14.52)^{c}
M7	45.48 (**42.67**)^{b}	110.58 (10.52)^{d}	65.51 (**55.29**)^{b}	136.14 (11.65)^{c}	40.64 (**39.89**)^{b}	255.54 (15.74)^{c}
SEm±	3.88	1.06	4.50	1.12	2.23	1.65
CD (5%)	11.54	3.14	13.38	3.32	6.61	4.90

*In each nematocidal application sticker along with water was added. **Figure marked by common letter are not significantly different according to Duncan's Multiple Range Test at P<0.05. Figures in the parenthesis indicate angular transformed values.

Table 3: Effect of ~~the~~ treatment modules on Percent Infested Plants (P.I.P) and population of foliar nematodes per 20g of tuberose flowers (cv. Calcutta Double) during 1st and 2nd year of flowering.

Treatments in module*	P.I of flower stalk on November 1st year	Population of nematodes/20g flower on November 1st year	P.I of flower stalk on January 2nd year	Population of nematodes/20g flower on January 2nd year	P.I of flower stalk on February 2nd year	Population of nematodes/20g flower on February 2nd year
M1	13.14 (**21.21**)^{a**}	243.00 (14.86)^{abc}	15.29 (**23.35**)^{ab}	227.75 (15.02)^{ab}	30.80 (**33.90**)^{cd}	845.25 (28.73)^{abc}
M2	11.65 (**19.94**)^{a}	328.50 (17.85)^{bc}	22.02 (**28.13**)^{abc}	151.06 (10.82)^{ab}	22.20 (**28.37**)^{c}	1109.94 (32.67)^{abc}
M3	12.25 (**20.80**)^{a}	214.50 (14.61)^{abc}	19.79 (**26.30**)^{ab}	158.38 (12.29)^{ab}	13.00 (**21.12**)^{ab}	472.28 (20.85)^{a}
M4	09.84 (**18.58**)^{a}	132.00 (11.35)^{ab}	12.14 (**20.31**)^{a}	110.31 (10.08)^{a}	10.44 (**19.09**)^{a}	688.19 (26.20)^{ab}
M5	15.50 (**23.48**)^{a}	79.88 (7.86)^{a}	25.33 (**30.47**)^{bc}	271.69 (15.93)^{ab}	20.81 (**27.03**)^{bc}	1092.75 (30.42)^{abc}
M6	10.44 (**19.17**)^{a}	154.00 (10.81)^{a}	32.00 (**34.64**)^{cd}	282.88 (16.77)^{b}	28.01 (**32.18**)^{cd}	1625.00 (39.98)^{bc}
M7	26.91 (**31.56**)^{b}	363.00 (18.98)^{c}	41.48 (**40.28**)^{d}	585.00 (23.98)^{c}	36.13 (**37.22**)^{d}	1944.67 (42.81)^{c}
SEm±	1.87	2.25	2.74	2.1	1.90	4.56
CD (5%)	5.56	6.68	8.13	6.33	5.63	13.54

*In each nematocidal application sticker along with water was added. **Figure marked by common letter are not significantly different according to Duncan's Multiple Range Test at P<0.05. Figures in the parenthesis indicate angular transformed values.

Table 4: Effect of ~~the~~ treatment modules on Percent Infested Plants (P.I.P)and population of foliar nematodes per 20g of tuberose flowers (cv. Calcutta Double) during 2nd year of flowering.

Treatments in module*	P.I of flower stalk on March 2nd year	Population of nematodes/20g flower on March 2nd year	P.I of flower stalk on April 2nd year	Population of nematodes/20g flower on April 2nd year	P.I of flower stalk on May 2nd year	Population of nematodes/20g flower on May 2nd year
M1	35.53 (**36.76**)^{a**}	1602.33 (39.88)^{ab}	48.70 (**44.54**)^{a}	1879.75 (43.28)^{a}	60.33 (**51.31**)^{b}	6489.83 (80.52)^{b}
M2	38.65 (**38.71**)^{a}	2369.25 (48.52)^{c}	49.67 (**45.10**)^{a}	1779.69 (41.85)^{a}	56.78 (**49.23**)^{ab}	4352.25 (65.94)^{a}
M3	32.38 (**34.94**)^{a}	2210.88 (46.85)^{bc}	50.64 (**45.65**)^{a}	1631.25 (39.29)^{a}	51.09 (**45.90**)^{ab}	6243.96 (78.91)^{b}
M4	29.77 (**33.26**)^{a}	1422.75 (37.59)^{a}	52.40 (**46.69**)^{a}	1201.38 (34.56)^{a}	44.74 (**42.26**)^{a}	4154.75 (64.46)^{a}
M5	32.66 (**34.96**)^{a}	1672.96 (40.75)^{ab}	53.56 (**47.34**)^{a}	1885.88 (43.01)^{a}	60.15 (**51.29**)^{b}	8050.04 (89.30)^{c}
M6	32.95 (**35.24**)^{a}	2576.54 (50.29)^{c}	54.87 (**48.15**)^{a}	1978.38 (44.29)^{a}	61.24 (**51.81**)^{b}	8482.83 (92.03)^{c}
M7	52.03 (**46.45**)^{b}	2621.79 (51.18)^{c}	66.24 (**54.80**)^{b}	2849.69 (53.38)^{b}	61.86 (**52.27**)^{b}	12612.96 (112.15)^{d}
SEm±	1.53	2.35	1.75	2.94	2.03	2.54
CD (5%)	4.53	6.99	5.21	8.73	6.02	7.55

*In each nematocidal application sticker along with water was added. **Figure marked by common letter are not significantly different according to Duncan's Multiple Range Test at P<0.05. Figures in the parenthesis indicate angular transformed values

Table 5: Effect of ~~the~~ treatment modules on Percent Infested Plants (P.I.P) and population of foliar nematodes per 20g of tuberose flowers (cv. Calcutta Double) 2nd year of flowering.

Treatment in modules*	P.I of flower stalk on June 2nd year	Population of nematodes/20g flower on June 2nd year	P.I of flower stalk on July 2nd year	Population of nematodes/20g flower on July 2nd year	P.I of flower stalk on August 2nd year	Population of nematodes/20g flower on August 2nd year
M1	54.99 (**48.16**)^{ab**}	20468.44 (143.04)^{c}	44.72 (**42.24**)^{a}	13387.33 (115.67)^{b}	61.00 (**51.69**)^{ab}	9330.13 (96.35)^{b}
M2	59.05 (**50.54**)^{abc}	13545.94 (115.91)^{b}	52.69 (**46.83**)^{b}	16028.33 (126.57)^{c}	58.86 (**50.45**)^{a}	9503.75 (97.39)^{bc}
M3	56.18 (**48.87**)^{ab}	11113.44 (105.33)^{ab}	49.13 (**44.79**)^{ab}	9987.88 (99.76)^{a}	56.45 (**49.05**)^{a}	7221.31 (84.55)^{b}
M4	47.34 (**43.74**)^{a}	10365.00 (101.68)^{a}	44.86 (**42.34**)^{a}	10757.33 (103.67)^{a}	56.02 (**48.78**)^{a}	5710.75 (75.29)^{a}
M5	57.33 (**49.55**)^{ab}	13489.75 (116.10)^{b}	46.66 (**43.37**)^{ab}	11395.08 (106.73)^{a}	59.66 (**51.01**)^{a}	11775.94 (108.49)^{c}
M6	61.92 (**52.26**)^{bc}	18869.50 (136.88)^{c}	50.07 (**45.33**)^{ab}	19634.92 (140.09)^{d}	66.91 (**55.33**)^{ab}	27165.31 (164.67)^{d}
M7	69.02 (**56.56**)^{c}	20731.63 (143.88)^{c}	67.94 (**55.82**)^{c}	27528.25 (165.82)^{e}	73.55 (**59.49**)^{b}	28732.31 (169.29)^{d}
SEm±	1.42	3.94	1.18	2.26	2.32	3.85
CD (5%)	4.21	11.70	3.52	6.72	6.91	11.43

*In each nematocidal application sticker along with water was added. **Figure marked by common letter are not significantly different according to Duncan's Multiple Range Test at P<0.05. Figures in the parenthesis indicate angular transformed values

Table 6: Effect of the treatment modules on Percent Infested Plants (P.I.P) and population of foliar nematodes per 20g of tuberose flower (cv. Calcutta Double) 2nd year of flowering.

Treatment in modules*	P.I of flower stalk on September2nd year	Population of nematodes/20g flower on September 2nd year	P.I of flower stalk on October 2nd year	Population of nematodes/20g flower on October 2nd year	P.I of flower stalk on November 2nd year	Population of nematodes/20g flower on November 2nd year
M1	55.26(**48.34**) ^{ab**}	9659.44 (98.10)^{b}	44.00(**41.82**)^{a}	8498.13 (91.69)^{ab}	38.41(**38.55**)^{b}	4710.50 (67.71)^{b}
M2	53.42(**47.30**)^{ab}	4449.88 (66.54)^{a}	41.37(**40.31**) ^{a}	7375.00 (85.54)^{a}	43.09(**41.31**)^{bc}	4221.96 (64.48)^{ab}
M3	45.69(**42.81**)^{a}	3884.06 (61.97)^{a}	44.40(**42.07**) ^{a}	8456.92 (91.85)^{ab}	29.25(**33.00**)^{a}	3636.81 (60.28)^{ab}
M4	42.87(**41.13**)^{a}	9431.56 (96.84)^{b}	49.25(**44.87**) ^{a}	6275.71 (78.58)^{a}	43.49(**41.52**)^{bc}	2252.38 (47.43)^{a}
M5	54.18(**47.69**)^{ab}	10953.75 (104.65)^{b}	59.49(**50.79**)^{b}	10642.38 (102.92)^{b}	50.28(**45.45**)^{c}	3748.13 (60.26)^{ab}
M6	63.51(**53.17**)^{bc}	27448.50 (165.60)^{c}	59.94(**51.03**)^{b}	14969.50 (121.71)^{c}	48.19(**44.24**)^{bc}	5462.06 (73.47)^{b}
M7	70.23(**57.37**)^{c}	30310.13 (173.59)^{c}	65.98(**54.72**)^{b}	32159.75 (179.23)^{d}	61.00(**51.71**)^{d}	5391.44 (71.66)^{b}
SEM	2.41	4.02	1.93	4.51	1.55	4.75
CD (5%)	7.17	11.93	5.75	13.40	4.60	14.12

*In each nematocidal application sticker along with water was added. **Figure marked by common letter are not significantly different according to Duncan's Multiple Range Test at P<0.05. Figures in the parenthesis indicate angular transformed values

Table 7: Incremental cost benefit ratio recorded under the nematode management programme during 1st and 2nd flowering season.

Treatment in modules*	Total Nematicide cost/ ha (Rs.)	Total labour cost/ha (Rs)	Total cost (Rs)	Yield/ ha (Nos. of stalk)	Incremental yield/ha (Nos. of stalk)	Incremental gross income/ha	Incremental net income/ ha	ICBR
M1	76968.54	40404	117372.5	421879.14	355940.58	711881.16	594508.62	1:5.07
M2	49368.55	40404	89772.55	397899.45	331960.89	663921.78	574149.23	1:6.40
M3	71545.65	40404	111949.7	412319.10	346380.54	692761.08	580811.43	1:5.19
M4	39695.66	40404	80099.66	443908.19	377969.63	755939.26	675839.60	1:8.44
M5	243111.1	40404	283515.1	428937.19	362998.63	725997.26	442482.16	1:1.56
M6	25197.30	40404	65601.3	133091.23	67152.67	134305.34	68704.04	1:1.05
M7	**-**	-	-	65938.56				

*In each nematocidal application sticker along with water was added. Labour charges- Rs.222 per day per man and price of tuberose per stalk – Rs.2/stalk

Plate Nos. (1) Prickles on stalks (2) Prickles and ruggedd on stalks. (3). Hard, prickled and stunted plant with flowers partially bloom. (4). Distorted and bending in plant. (5) Comparison between nematode infested and healthy tuberose plant. (6) Yellowing and browning of leaves of tuberose plant.

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