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The response of eleven sweet potato (Ipomoeabatatas (L.)Lam) cultivars to Infection by Meloidogynespp in Jos, Nigeria.

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Abstract: *The response of elevensweet potato (Ipomoeabatatas (L.)Lam) cultivars to infection by Meloidogynespp was evaluated between August 2007 and December 2007. The susceptibility of eleven (11) sweet potato cultivars to root-knot nematode infection was investigated in the botanical nursery of the University of Jos, using steam sterilized soil in clay pots. The cultivars used were E10, CIP Mat 32, CIP Mat 31, CIP 440168, Wagabolige, TIS 86/0356, Ex-Igbariam, TIS 87/0087, E4, CIP Mat 3 and TIS 2532 Op.1.13. Each cultivar was replicated sixteen (16) times. Eight (8) replicates of each cultivar were inoculated with 3000 juveniles of root-knot nematodes and the remaining eight replicates served as control. Growth and yield parameters such as number of leaves, length of vines, number of tubers, weight of tubers and weight of vines per plant were monitored. The result showed that growth and yield parameters such as number of leaves, length of vines, number of tubers, weight of tubers and weight of vines were higher in the uninoculated (control) plants than the infected plants. Tuber yield was reduced by 12.5%, 13.89%, 13.17%, 5.23%, 12.71%, 10.12%, 1.6%, 7.4%, 6.23%, 19.66% and 15.42%. in infected E_{10}, CIP Mat 32, CIP Mat 31, Wafabolige, CIP 440168, TIS 86/0356, Ex-Igbariam, TIS 87/0087, E4, CIP Mat 3 and TIS 2532.OP.1.13 respectively. Varietal response to root-knot nematode infection differed significantly ($P<0.05$). None of the varieties was immuned to the infection. CIP 440168 and E4 were moderately resistant while CIP Mat 31, TIS 86/0356 and TIS 87/0087 were susceptible. All other varieties were moderately susceptible.The investigation has thus identified cultivars that holds promise for use as resistant variety against root-knot nematodes.*

I. Introduction

Sweet potato (Ipomoeabatatas (L) LAM) is believed to have originated in the tropical and subtropical areas of South America but is now cultivated in nearly all parts of the world (Onwueme, 1978).Sweet potato is an important food crop in Nigeria particularly in the northern part where it is mostly cultivated. Apart from its enormous potentials as food for man and animals, sweet potato is also a good source of industrial material, thus utilized in making cakes, biscuit, flour, starch, syrup and a host of other items (Mckell, 2006).

The production of sweet potato is hampered by a number of factors including pests and diseases; one of which is the root knot nematode disease caused by Meloidogyne species.The root-knot nematodes are known to parasitize at least 2000 plant species (Adesiyanet al., 1990). In Nigeria, it has been reported that about 140 plants are parasitized by the nematode. Its host include vegetables, tuber crops, tree crops and several weeds. Among the favourable hosts are tomato, cowpea, yam, tobacco, sugarcane, cotton, carrot, eggplant, sweet potato, and Irish potato (Adesiyanet al., 1990). Due to their frequency of occurrence, high level of infestations and possible interactions with other pathogens, the root-knot nematodes (Meloidogynespp) have been recognized as major limiting factor in food production, especially for vegetables.Gowenet al. (2005) reported that infection by root-knot nematodes causes poor root development, resulting in reduced nutrient and water uptake and weak support for the plant. Food produced by the plant is redirected to giant cells produced by the nematodes instead of leaves and fruits.Gaspasin (2005) said that aside from yield loss, cracking of tubers due to root-knot nematodes can make such tubers unmarketable.According to Trudgill and Philips (2004), the observed losses in plants due to root-knot nematodes may be as a result of impaired water relations in affected plant. This is probably because the developing giant cell systems interfere with and disrupt the development of xylem. The root-knot nematodes have been implicated in diseases and yield reduction of several crops in India. For instance, annual yield reduction of about 28.4% in chick pea has been attributed to Meloidogyne infection. Also, yield losses of 33.83% and 40.07% in nematodes have been reported (Sasser, 1989). Yield loss of about 25% in potato due to root-knot nematodes was reported by Ifenkweet al. (2005). The nematodes apart from causing rots on roots due to gall formations are known to block vascular tissues of susceptible host thereby resulting in wilting.Yield losses are largely influenced by the pathogenicity of the species of nematodes, the nematodes population density at planting and the susceptibility of the host plant (Trudgill and Philips, 2004).Sasser (1989) reported that nematodes cause economic losses amounting to about 100 billion dollars annually. He further stated that Meloidogyne species account for the bulk of these losses.

Philis (1995) reported that the national loss in yield of vegetables by root knot nematodes and citrus nematodes in Cyprus reaches around US$ 8million per year, while for Potato and bananas is around

US$1million per year. He also reported estimated annual yield loss of several crops due to Meloidogyne species. Among them are Banana, Carrot, Cowpea, Celery, Cucumber, Egg plant, Haricot Bean, Potato, Sweet melon, Tomato and Tobacco which have losses of 15, 20, 20, 20, 20, 25, 20, 10, 20, 20, and 20% respectively.

Varela (2011) reported that estimates of vegetable crop losses due to root knot nematodes in Kenya ranged from 17 to 20% for Solanummelongena, 18 to 33% for melon and 24 to 38% for tomato. He further reported that general crop losses due to Meloidogyne species in Kenya are estimated at 25% or more. In Nigeria, Ogunfowora (1976) reported that M. incognita at a population of 20,00015 liters of soil reduced yield of Ife 1, Ibadan Local, Pusa early, Dwarf Marzanino, Ronita, New Yorker and Rassol tomato by 89, 86, 84, 77, 74, 73 and 58% respectively. Nwauzor and Fawole (1982) reported that root knot nematodes accounted for a reduction of between 34 – 52% in market value of yam in eastern Nigeria. Ogbuji (1979) reported that yam cultivars infected with M. incognita deteriorated rapidly in storage.

Zafar (2001) observed that root-knot nematodes decreased potato tuber quality by causing brown spots on the surfaces, rending the tubers unacceptable for either processing or fresh tuber sale. A number of nematode control measures are available. The use of chemicals has been reported to be the most effective (Dropkin, 1989). However, current trends in plant disease control are tilted towards Integrated Pest Management (IPM). This is a recently developed approach to plant disease management that is aimed at achieving the desired control while reducing the use of chemicals. To accomplish this, various combinations of cultural, biological and physical control measures are employed. This approach has become necessary, largely due to the high cost of chemicals, its environmental toll and the fact that some plants retain these chemicals which become hazardous to man and animals when such plants are consumed (Gowenet al., 2005).

Gullino et al.(2000) reported that Integrated Pest Management (IPM) has been used to control soil-borne pests in Italy with great success. They also stated that IPM if properly and intensively employed might reduce pesticide use by as much as 50% while at the same time, improving pest control.

Some researchers have suggested that root-knot nematode disease is endemic in Plateau State (Wonang and Akueshi, 1998). The control of this disease poses a major problem because of the frequency of occurrence and the extensive host range of the causal organisms. Although root knot nematodes can be controlled to some extent by crop rotation and the use of nematicides, both have their limitations. The nematode affects a wide range of plants thereby making it difficult to get plants for rotation. Also, shortage of arable land is a limitation to the practice of crop rotation. Nematicides are chemicals and recent trend in plant disease control discourages the use of chemicals due to its environmental effect as well as cost. Therefore it has become necessary to investigate control measures that are cheap,environment friendly, readily available and with little or no expertise required yet effective. These, therefore, necessitated this research with the objective of screening different cultivars of sweet potato for susceptibility to root-knot nematode diseases.

II. Materials and methods

Eleven (11) cultivars of sweet potato were used for this research. These were Ex-Igbariam, CIP Mat 32, CIP Mat 31, Wagabolige, CIP 440168, TIS 86/0356,TIS 2532 OP. 1.13, TIS 87/0087, CIP Mat 3, E4 and E10.The cultivars were obtained from the National Root Crop Research Institute (NRCRI) Umudike, Abia State.

Source of inoculum

It has been reported that vegetables such as tomato, potato among others are susceptible to root– knot nematodes (Gowenet al, 2005). Tomato and potato varieties were therefore sampled from different farms within Jos and environs and examined for the presence of galls on their roots. Where galls were seen, the plants were then brought to the laboratory, the galls excised from the roots, placed in Petri dish containing small amount of distilled water to moisten the galls. The dish with the galls in them were placed under a dissecting binocular microscope and viewed under X40 objective. While viewing, the galls were teased apart using sharp needles in order to free the females of the nematodes from the galls (Southey, 1970). Care was taken in order not to puncture the nematodes. The females were seen as white saccate-shaped bodies under a black background. They were identified by observing their perineal pattern (i.e a distinct pattern of striations surrounding vulva and anus), which has marked differences (Taylor and Sasser, 1978).

Extraction of nematodes

The root samples and distilled water in the Petri dish were inverted into a funnel with a short piece of rubber tubing attached to the stem. A test-tube filled with water was then attached to the end of the rubber tube and made air tight at both the point of attachment with the funnel and the test-tube using masking tape. The funnel was then lined with a thin layer of cotton wool and supported in an upright position . This is modified Baermann funnel method of nematode extraction (Southey, 1970) and is one of the fastest methods of recovering nematodes from roots.

The root samples in the funnel were then watered to prevent them from drying and to allow for free movement of the nematodes. The set-up was allowed to stand for 48 hours. Nematode juveniles that hatch in the water being active swam through the cotton wool and were collected at the bottom of the test-tubes. This was done by carefully dislodging the test-tube, the water in the funnel and rubber tubing then allowed to run into a beaker. The content of the beaker was then centrifuged and poured away to the last 2 centimetres to concentrate the nematodes. Several sets of the set-up were used so as to obtain enough quantity of the inoculum.

Estimation of nematode population was done by counting the number of active juvenile in 1ml of homogenised suspension of the inoculum using a binocular research microscope at X40 magnifications.
The estimation was done as shown below:
1 ml of the suspension = 150 juveniles
Therefore, 20mls of suspension = 150 X 20 = 3000 juveniles.

Reaction of sweet potato cultivars to Meloidogynesppinfection

This was carried out in the Botanical nursery of the department of Plant Science and Technology, University of Jos between August 2007 and January 2008. Top garden soil was collected and mixed with well dried organic manure at a ratio 3:1. The soil-manure mixture was heat sterilized at 65˚C for 90 minutes using electric soil sterilizer and allowed to air dry. One hundred and seventy-six (176) 23cm by 23cm clay pots was filled with the heat sterilized soil-manure mixture after which the vine cuttings of the eleven (11) of sweet potato was planted with each cultivar replicated sixteen (16) times.

An inoculum containing 3000 juveniles of root-knot nematodes sourced from different vegetable farms around Jos was used to inoculate eight (8) replicates of each cultivar at four (4) weeks after planting. 20mls of freshly hatched nematodes juveniles' suspensions were inoculated into each pot. This was done by pipetting the inoculums into a hole made close to the growing points of the roots, as the juveniles have been found to penetrate roots at the growing tip or in the zone of elongation behind the tip of the root. The remaining eight (8) replicates of each cultivar were not inoculated, they served as control. The pots were then arranged in the open in a completely randomized experimental design. The pots were watered as required and weeding was done by handpicking.

At maturity, i.e after 120 days, number of leaves per plant were counted and recorded for both the nematode inoculated and their un-inoculated controls. Length of vines per plant were measured and recorded. Each plant was carefully uprooted, then, numbers of tubers per plant were determined. Afterwards, data on fresh weight of vines per plant, fresh weight of tubers per plant and number of galls per plant were collected.

Data generated were analysed using the one-way analysis of variance and the means separated using the least significance difference (LSD). Plants were rated for resistance/susceptibility based on gall index as described by Taylor and Sasser (1978). Also,theIpomoea batatas cultivars from the different treatments were rated for resistance based on tuber yield, gall index and nematode reproduction factor (Afolamietal., 2004).

III. Results

The investigation revealed that root-knot nematodes parasitized and reduced leaf production in all varieties of sweet potato used for the trial (Table 1)

Among inoculated plants, CIP mat 32 had the highest mean number of leaves, followed by CIP 440168, then Wagabolige while CIP Mat 2 had the least. Among plants that were not inoculated with nematodes (control plants) CIP 440168 had the highest mean number of leaves, followed by CIP mat 2 and Wagabolige while CIP mat 3 has the least (Table 1).

Statistical analysis showed that generally, leaf production was significantly reduced in inoculated plants as compared to their uninoculated controls at 0.05 level of probability.

Leaf production was also found to differ significantly ($P<0.05$) among cultivars. CIP Mat 32, CIP Mat 31, CIP 440168 and Wagabolige were found to have significantly higher mean number of leaves than Ex-Igbariam, E4, CIP Mat 3 and TIS 2532.OP.1.13 at 0.05 level of probability (Table 1).

Mean length of vines

The results revealed that root-knot nematodes parasitized and reduced vine production in all infected Ipomoea batatas(Table 2). Among infected plants, mean length of vines was highest in cultivar CIP Mat 31, followed by CIP 440168 then CIP Mat 32 while the least mean length of vine was recorded in cultivar CIP Mat 3. However, among uninoculated plants, the highest mean length of vines was recorded for CIP Mat 32 while the least was recorded for the cultivar E4. Plants inoculated with nematodes juveniles generally had lower mean length of vines when compared with their uninoculated controls (Table 2). Statistical analysis showed that all infected plants had significantly reduced vines as compared to their controls ($P < 0.05$) (Table2).

Mean number of tubers

Mean number of tubers were highest in cultivar CIP Mat 31, followed by CIP Mat 32 and Wagabolige while CIP Mat 3 had the least (Table 3).Generally, inoculated plants had lower mean number of tubers as compared to their uninoculated controls (Table 3). Statistical analysis showed that among infected plants CIP 440168, TIS 86/0356, TIS 87/0087, TIS 2532.OP.1.13, E4 and CIP MAT 3 had significantly lower mean number of tubers than their uninfected controls ($P < 0.05$) (Table 3).

Mean fresh weight of vines

Inoculated plants generally had lower mean fresh weight of vines as compared to their uninoculated controls. Statistical analysis showed that mean fresh weight of vines were significantly reduced in inoculated plants as compared to their uninoculated counterparts at 0.05 level of probability. However, for cultivars E10 and Wagabolige the infected plants did not differ from the control. ($P>0.05$).Among infected plants, CIP Mat 31 had significantly higher mean fresh weight of vines than cultivars E10, CIP 440168, E4, CIP Mat 3 and TIS 2532OP.1.13. All other cultivars did not differ from each other in mean fresh weight of vines at 0.05 level of probability (Table 4).

Mean fresh weight of tubers

Plant inoculated with root-knot nematode juveniles generally had lower mean fresh weight when compared to their un-inoculated controls. Inoculated plants were significantly reduced as compared to their un-inoculated counterparts in mean fresh weight of tubers ($P < 0.05$) (Table 5). Among the uninfected plants, cultivar TIS 87/0087 had the highest mean fresh weight of tubers, followed by CIP Mat 32 while CIP Mat 3 had the least. Statistical analysis showed that CIP Mat 32 had significantly higher mean fresh weight of tubers than all the other cultivars ($P < 0.05$) (Table 5).

Mean number of galls

Cultivar CIP Mat 31 had the highest mean number of galls (32), followed by TIS 87/0087, then TIS 86/0356 (31) while E4 (8.50) had the least mean number of galls per plant. Statistical analysis showed that E4 had significantly lower mean number of galls compared to all the other cultivars. Also, CIP mat 3, TIS 2532.OP.1.13 and Ex-igbariam did not differ from each other in number of galls($P>0.05$). CIP MAT 31 did not differ from TIS 87/0087 in number of galls but was found to have significantly higher number of galls than all other cultivars ($P<0.05$) (Table 6). All un-infected plants had no galls.

Root gall index

Gall Indices indicated variation in response of the eleven (11) sweet potato cultivars to root-knot nematode infection. Cultivars CIP Mat 31, TIS 86/0356 and the 87/0087 were susceptible while E4 was moderately resistant. All other cultivars were moderately susceptible (Table 7).

Percentage yield loss of potato tubers

The investigation revealed that the root-knot nematode parasitized and reduced tuber yield in all the sweet potato cultivars used for the trial. Cultivars CIP Mat 3 had the highest percentage yield loss (19.66%), followed by TIS 25132.OP.1.12 (15.42%) and CIP Mat 32 (13.89%) in that order while Ex-Igbariam had the least percentage yield loss (1.60%) (Table 8).

Resistance rating based on gall index, nematode reproduction and yield.

The initial nematode population (Pi) per 500g soil was 3000 juveniles introduced into the soil while the final nematode population (Pf) per 500g soil and roots was 2430, 1740, 3150, 1680, 1440, 3090, 1680, 3090, 1500, 1650 and 1620, for E_{10}, CIP Mat 32, CIP Mat 31, CIP 440168, Wagabolige, TIS 86/0356, Ex-Igbariam, TIS 87/0087, E_4, CIP Mat 3 andTIS2532.OP.1.13 varities respectively (Table 9).

Resistance rating based on gall index, nematode reproduction factor and yield revealed that TIS 86/0356, CIP MAT 31 and TIS 87/0087 were susceptible while all other varieties were hypersusceptible (Table 9).

IV. Discussion

The results of the investigation revealed that most growth and yield parameters of sweet potato monitored were significantly reduced ($P<0.05$) due to the infection by Meloidogyne species. These results are consistent with reports of earlier workers (Ogaraku and Akueshi, 2005). The stunting of plants, chlorosis and reduced yield suggests lack of physiological stability and may be as a result of reduced translocation, inadequate nutrient absorption and abnormal production of growth regulators as suggested by Melakeberhan (1986). Adesiyanet al.(1990) observed that Meloidogyne infection of plants caused reduced root efficiency due to

broken and deformed vascular elements resulting in impairment of translocations of water and mineral nutrients, thus reducing growth and yield of plants.

Macro elements such as Nitrogen, Potassium and Phosphorus are used in growth and chlorophyll synthesis. Deficiency of such elements can lead to reduced growth and chlorosis. Decrease in potassium concentration is particularly important because of its effects on photosynthesis, either by affecting carbon dioxide uptake or by altering other key physiological processes such as osmotic potential. The manifestation by mineral deficiency symptoms by sweet potato infected by Meloidogynespp can therefore be attributed to impaired translocation of these elements by the activities of root-knot nematodes which feed and block vascular tissues of their host (Dropkin, 1989). According to Adesiyanet al., (1990), root-knot nematode infection can result in reduced transport of growth regulators such as cytokinins and gibberellins, thus resulting in reduced growth and yield. Stunting and reduced yield can also be attributed to impaired differentiation of xylem and phloem tissues of the roots; this deters transport of materials from roots to top of the plants (Dropkin, 1989). The poor growth and yield of infected plants may be attributed to decrease photosynthesis as reported by Adesiyanet al. (1990), that infection by root-knot nematodes led to decrease in photosynthesis. Chlorosis is a result of reduced chlorophyll content; this may as well explain reduction in photosynthesis and yield.

Vegetative growth and yield of sweet potato were also found to differ among varieties. This may be as a result of genetic variation among cultivars. Doubrava and Blake (2000) observed that some varieties of okra develop less disease, disease develop slower or later in them than in other varieties of the same plant. This, they attributed to genetic modification of the variety. This may as well explain the observation in this study.

Roots of the eleven (11) varieties of sweet potato inoculated with Meloidogynespp showed galling to varying degrees and had higher weight than their controls. Agrios (1986) reported that formation of galls is the most characteristic symptom of root-knot nematode infection. The nematode is known to secrete growth regulator of the indole group, which reduces hypertrophy (cell enlargement) and hyperplasia (cell multiplication) at infection sites (Mehrotra and Aggarwal, 2003). These galls become nutrient sinks and cause a shift in the plants metabolism and transport of materials in favour of the roots (Adesiyanet al., 1990). This may be the reason for the observed weight increase. Giant cell formation are caused by enzymatic secretions from the root-knot nematodes in host plants which induce re-differentiation process that eventually leads to the formation of multinucleated feeding cells called the syncthia. Taylor and Sasser (1978), observed reduced root efficiency in galled plants. This will obviously affect the overall performance of such plants.

Adesiyanet al. (1990) reported reduction in transport of gibberellins and cytokinins in roots of galled plants. They further reported that there is qualitative difference in type of gibberellins transported out of galled roots. These observations go a long way to explain reduced growth and yield of infected plants. Root weight of galled plants generally averaged higher than those of their controls. This can be attributed to gall formation and proliferation of lateral roots. It may also be due to the redirection of nutrients from shoots to roots in galled plants

Reduction in the shoot weight in galled plants as compared to their uninoculated controls is consistent with earlier reports by Adesiyanet al. (1990). They reported that infection by root knot nematodes increased root weight and decreased shoot weight. This may be as a result of polyploid feeding cells and metabolic sinks in galled roots, which causes nutrients produced in shoots to be redirected to root (Melakerberhan 1986). Reduction in shoot weight may also be attributed to the effect of vascular wilt pathogens which Meloidogynespp infection might have predisposed sweet potato to.

Estimated percentage yield loss of sweet potato due to root knot infection in this study ranged from 16% to 19.16%. Higher losses have been reported by other workers, losses between 20% - 49% in cowpea by Ogaraku and Akueshi (2005).Susceptibility ratings of the sweet potato cultivars based on gall indices, tuber yield and nematode reproduction factor categorized three cultivars CIP MAT 31, TIS 86/0356 and TIS 87/0087 as susceptible while the remaining eight cultivars were hypersusceptible.

TIS 86/0356 and TIS 87/0087 though were susceptible to root knot nematodes but fared better than a number of the other cultivars in tuber yield. Only three varieties Ex Igbarian (1.6%), Wagabolige (5.23%) and E_4 (6.23%) had lower percentage yield loss than TIS 87/0087 (7.4%). Difference in susceptibility among the cultivars of sweet potato suggests that the cultivars differ in quality or in their ability to resist infection by root knot nematodes. The investigation has thus identified cultivars that holds promise for use as resistance variety against root-knot nematodes.

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Table 1: Effect of Root-Knot Nematodes on Mean Number of Leaves Per Plant of Sweet Potato Cultivars

Variety	Mean Number of leaves per plant. Inoculated	Un-inoculated
E10	24.75	47.00
CIP Mat 32	32.75	49.75
CIP Mat 31	26.75	45.25
CIP 440168	31.63	50.50
Wagabolige	29.50	49.75
TIS 86/0356	24.00	42.50
Ex-Igbariam	23.00	33.00
TIS 87/0087	26.00	44.00
E4	23.00	36.00
CIP Mat 3	16.00	30.00
TIS 2532.OP.1.13	18.00	31.00
LSD =	.450	

Pairs of means that differ by more than their LSD are significantly different (P<0.05).

Table 2: Effect of Root-Knot Nematodes on Mean Length of Vines per Plant of Sweet Potato Cultivars (in cm)

Variety	Length of vines per plant Inoculated	Un-inoculated
E_{10}	48.00	51.80
CIP Mat 32	50.30	60.50
CIP Mat 31	58.50	58.30
CIP 440168	50.50	54.50
Wagabolige	30.80	46.30
TIS 86/0356	28.00	30.80
Ex-Igbariam	31.00	35.10
TIS 87/0087	28.00	37.10
E_4	26.20	30.30
CIP Mat 3	24.50	31.00
TIS 2532.OP.1.13	28.00	32.10
LSD	.755	

Pairs of means that differ by more than their LSD are significantly different at 0.05 level of probability.

Table 3: Effect of Root-Knot Nematodes on Mean Numbers of Tubers per Plant of Sweet Potato Cultivars.

Variety	Mean Number of Tubers Inoculated	Plant Uninoculated
E_{10}	3.25	3.25
CIP Mat 32	3.50	3.50
CIP Mat 31	3.75	3.75
CIP 440168	2.50	2.75
Wagabolige	3.50	3.50
TIS 86/0356	2.25	2.50
Ex-Igbariam	2.63	2.75
TIS 87/0087	2.75	3.75
E_4	2.25	2.63
CIP Mat 3	1.75	2.38
TIS 2532.OP.1.13	2.00	2.25
LSD	.204	

Pairs of means that differ by more than their LSD are significantly different at 0.05 level of probability.

Table 4: Effect of Root-Knot Nematodes on Mean Fresh Weight of Vines per Sweet Potato Cultivars (in grams)

Variety	Mean Fresh Weight of vines Inoculated	Uninoculated
E_{10}	24.70	25.20
CIP Mat 32	39.20	41.00
CIP Mat 31	50.00	51.30
CIP 440168	24.20	32.90
Wagabolige	37.10	38.00
TIS 86/0356	35.60	37.40
Ex-Igbariam	29.40	30.50
TIS 87/0087	36.00	39.00
E_4	22.10	30.50
CIP Mat 3	18.20	24.10
TIS 2532.OP.1.13	19.50	25.50
LSD	.966	

Pairs of means that differ by more than their LSD are significantly different at 0.05 level of probability.

Table 5: Effect of Root-Knot Nematodes on Mean Fresh Weight of Tubers (g) per Sweet Potato Plant

Variety	Mean Fresh Weight of Tubers Inoculated	Uninoculated
E_{10}	105.00	120.00
CIP Mat 32	124.00	144.00
CIP Mat 31	122.00	140.50
CIP 440168	121.40	128.10
Wagabolige	98.20	112.10
TIS 86/0356	116.40	129.50
Ex-Igbariam	92.20	93.70
TIS 87/0087	136.20	147.10
E_4	81.30	86.70
CIP Mat 3	46.60	58.00
TIS 2532.OP.1.13	54.30	64.20
LSD	.967	

Pairs of means that differ by more than their LSD are significantly different at 0.05 level of probability.

Table 6: Mean Number of Galls Per Potato Cultivar Inoculated with Root-Knot Nematode Juvenile

Variety	Number of galls
E_{10}	28.50
CIP Mat 32	21.50
CIP Mat 31	32.00
CIP 440168	20.50
Wagabolige	21.50
TIS 86/0356	31.00
Ex-Igbariam	11.50
TIS 87/0087	31.50
E_4	8.50
CIP Mat 3	12.00
TIS 2532.OP.1.13	11.30
LSD	.925

Pairs of means that differ by more than their LSD are significantly different at 0.05 level of probability.

Table 7: Gall Indices of Inoculated Plants and their Root-knot Nematode Resistant Rating.

Variety	Gall Index	Resistant Ratings
E_{10}	3.00	Moderately susceptible
CIP Mat 32	2.80	Moderately susceptible
CIP Mat 31	3.70	Susceptible
CIP 440168	2.60	Moderately susceptible
Wagabolige	2.30	Moderately susceptible.
TIS 86/0356	3.50	Susceptible
Ex-Igbariam	2.50	Moderately susceptible
TIS 87/0087	3.60	Susceptible
E_4	2.40	Moderately resistant
CIP Mat 3	2.60	Moderately susceptible
TIS 2532.OP.1.13	2.50	Moderately susceptible

Table 8: Effect of Root-Knot Nematode on Tuber Yield (in grams)

Variety	Yield per cultivar Inoculated	Uninoculated	% yield loss
E_{10}	525.00	600.00	12.50
CIP Mat 32	620.00	720.00	13.89
CIP Mat 31	610.00	702.50	13.11
Wagabolige	607.00	640.50	5.23
CIP440168	491.00	562.50	12.71
TIS 86/0356	582.00	647.50	10.12
Ex-Igbariam	461.00	468.50	1.60
TIS 87/0087	681.00	735.50	7.41
E_4	406.50	433.50	6.23
CIP Mat 3	233.00	290.00	19.66
TIS 2532.OP.1.13	271.50	321.00	15.42

Table 9. Resistance Ratings Based on Crop Yield, Nematode Reproduction Factor and Gall Index.

Variety	Gall index	Pf.	Rf.	Comparison IPY& CPY	Resistance Category
E_{10}	3.00	2430	0.81	< Control	Hypersusceptible
CIP Mat 32	2.80	1740	0.58	< Control	Hypersusceptible
CIP Mat 31	3.70	3150	1.05	< Control	Susceptible
CIP 440168	2.60	1680	0.56	< Control	Hypersusceptible
Wagabolige	2.30	1440	0.48	< Control	Hypersusceptible
TIS 86/0356	3.50	3090	1.03	< Control	Susceptible
Ex-Igbariam	2.50	1680	0.56	< Control	Hypersusceptible
TIS 87/0087	3.60	3090	1.03	< Control	Susceptible
E_4	2.40	1500	0.50	< Control	Hypersusceptible
CIP Mat 3	2.60	1650	0.55	< Control	Hypersusceptible
TIS2532.OP.1.13	2.50	1620	0.54	< Control	Hypersusceptible

Key:
Pf. -Final nematode population
Rf. -Nematode reproduction factor
IPY.- Yield of infected plants
CPY.- Yield of control plants