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Response of Masakwa Cultivars of Sorghum (Sorghum Bicolor) To Root Knot Nematode (*Meloidogynejavanica*) in the Nursery

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Abstract: *This work examined response of Masakwa cultivars of Sorghum (Sorghum bicolor) to root knot nematode (Meloidogynejavanica) in the screen house of Crop Protection Department, ModibboAdama University of Technology, Yola. It was to find out the effect of M. javanica on growth and transplanting age of the Masakwa cultivars. Six cultivars of Masakwa were collected from Borno and Adamawa States farmers and they are named as Ex-bama1, Ex-bama2 and Ex-bama3 in Borno State while Ex-Damare1, Ex-Damare2 and Ex-Damare3 in Adamawa State. All the six cultivars were planted in 15cm diameter pots containing sterilized soil. Each cultivar was planted in two pots (i.e 12 pots) and one of each was inoculated with M. javanica and the other left uninoculated. This was replicated three times giving 36 pots arranged in a complete randomized design. Data were collected on plant growth parameters, M. javanica J_2 count/100g of soil and root gall index, then analysed statistically. The results indicated that all the six cultivars were susceptible to M. javanica infection. There was no significant difference (P= 0.05) among the cultivars in number of J_2/100gm of soil and galling index. However, the number of juveniles/1gm of roots had significant difference (P=0.05) with Ex-Damare 1 having 1195 J_2/1gm of roots being significantly higher than that of Ex-Bama 1 which recorded 343 j_2/1gm of roots.*

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I. Introduction

Masakwa variety of sorghum (*Sorghum bicolor*) is a type of sorghum that is cultivated on vertisol soils that has residual moisture in dry season. It is usually cultivated in those areas after the rain have ceased as from September –February the following year (Njomaha, 2004). In Nigeria, this variety is mainly cultivated in North Eastern region thus in Yola (Adamawa State) around the Benue valley and in Borno state from Bama up to the Chad basin proper where the vertisol soils are found (Ogunlela and Obilana, 1982; Djonneiva and Dangi, 1999). They also reported that in Northern Cameroon around the Chad Basin, this variety of sorghum is cultivated in dry season and it constitutes 25-30% of total sorghum produced in that country. In Northern Cameroon about 46% of households cultivate dry season sorghum as sole crop on farms averaging 1.4ha (Njomaha, 2004).Similarly, it is cultivated around the Chad Basin in Chad and Niger Republics. Those areas where it is cultivated, the Fulanis call it *Muskuwari* while Kanuri and Shuwa call it Firgi/*Muskuwa*and they are the major cultivators of that variety of sorghum. This variety of sorghum is used as food in different forms, industrially to produce starch and other products as well as feed for livestock just like the other common sorghum varieties (ICRISAT, 1990).

Farmers traditionally grow the crop at low plant density thus 10, 000-14, 000 plants/ha (Njomaha and Kamuanga, 1991; Carskey, 1993). The yield is usually low from 300kg to 800kg/ha depending on the season and cultivar used (Whitehead, *et al*., 1980; Djonneiva and Dangi, 1999). They also observed that it escapes insect pests attack and disease infection because it is cultivated in dry season. However, since the seeds are broadcasted in small marginal areas after ploughing towards the end of rainy season to raise the seedling for transplanting, there is the need to look at seedling diseases.

Therefore, this work was conducted to find out:
i) Whether Masakwa is susceptible to root knot nematode (*M. javanica*), ii).The effect of root knot nematode on Masakwa growth in the nursery and iii).Effect of root knot nematodes on transplanting age of Masakwa variety of sorghum.

II. Materials and Methods

The experiment was conducted in the screen house and laboratory of Department of Crop Protection, ModibboAdama University of Technology, Yola.

Source and Description of Seeds

The three types of cultivars obtained from Borno state were obtained from local farmers in Bama and were named Ex-Bama 1, Ex-Bama 2 and Ex-Bama 3. The three cultivars from Adamawa State were sourced from the local farmers in Yola and named Ex-Damare 1, Ex-Damare 2 and Ex-Damare 3. A brief description of the cultivars seeds is given below.

Ex-Bama 1: The seeds are Whitish in colour relatively flat and a little bigger than the other 2.
Ex-Bama 2: The seeds have ash like colour, medium in size.
Ex-Bama 3: The seeds are milky in colour and medium in size.
Ex-Damare 1: Seeds are ash in colour relatively bigger and flat.
Ex-Damare 2: The seeds are milky to light brown and medium in size.
Ex-Damare 3: The seeds are white and medium in size.

Preparation of Growing Media

Soil was obtained from the marginal end of a sorghum farm at the University Teaching and Research farm. It was a sandy loam soil, then filled into a half drum where steam was used to sterile the soil. It was allowed to cool and filled into all the 36 plastic buckets at ¾ level. The soil in the buckets were watered for three days before planting.

Planting of Masakwa Seeds

In each of the 36 buckets containing sterilized soil prepared above, 3-5 seeds of Masakwa were planted at a depth of 2-3cm. each cultivar was planted in 2 buckets, giving twelve buckets for the six cultivars. This was then replicated to give 3 replicates and arranged in a complete randomized design in the screen house on screen house concrete benches. The set up was irrigated regularly to the end of the experiment.

Inoculation of *Meloidogynejavanica* juveniles into the buckets of Masakwa cultivars:

One week after germination, the seedlings were thinned to one per bucket. In each replicate, one bucket of each cultivar was inoculated with 1000 *M. javanica* juveniles using 20cm needle and syringe. It was done by creating a small furrow 3cm away from the seedling to a depth of 3-4cm. The juveniles were hatched from eggs obtained from a culture maintained on Tomato in the screen house. The second bucket for each cultivarin each replicated was left uninoculated.

Data Collected

At 4 and 6 weeks old plant height and seedlings stem diameter were taken for each. At 7 weeks old the experiment was terminated and the seedlings were gently uprooted with less injury to the roots. Each bucket was gently placed in a big bucket of water in a slanting position allowing the soil to runoff into the bucket freeing the roots of the seedlings. The roots of each seedling was weighted using a sensitive weighing balance. The fresh vegetative parts were weighed and dried under shade inside the laboratory then weighed.At 7 weeks old before uprooting the seedlings as described above soil sample from each inoculated pot was collected. Using table spoon at 5cm away from the seedling 100g of soil was collected to a depth of 8-10cm in four different locations around the seedling and stored at room temperature in the laboratory. The *M. javanica* juveniles were extracted using a modified Baerman tray method (Whitehead and Hemming, 1965). The extracted J_2 were then counted under the microscope (x40). From roots of each seedling 1gm of roots were weighed and cut into pieces of 1-2cm length, then j_2 were extracted from the roots using Hussey and Baker (1973) method. In each the juveniles were counted under the stereo microscope (X40).

Root Gall Index

From the uprooted seedlings before taking the earlier measurements and drying of the roots, number of galls on each root were counted. A scale of 0-5 for galling index rating was used according to Taylor and Sasser (1978). All the data collected above were analysed according to complete randomized design and means separated using least significant difference. Using the least host efficiency ($R=\frac{P_f}{P_i}$) Cantosaenz's host suitability Designation (Sasser*et al.*, 1984) described in Table 1, trial assessment of the various Masakwa cultivars were made.

Table 1: Quantitative Scheme for Assignment of Canto-Saenz's Host Suitability (Resistance) Designation.

Plant damage (Galling Index)	Host efficiency (R-Factor)	Degree of resistance (DR) Designation
≤ 2	≤ 1	Resistant
≤ 2	> 1	Hyper-susceptible
>2	≤ 1	Susceptible
>2	>1	Susceptible

Source: Sasser*et al.* (1984)

III. Results

Table 2: Effect of *Meloidogynejavanica* on fresh and Dry Weight of Vegetative Parts of Masakwa cultivars Infected with *M. javanica*

Cultivars	Infected fresh vegetative weight (g)	Uninfected fresh vegetative weight (g)	Infected dry vegetative weight (g)	Uninfected dry vegetative weight (g)
Ex-Bama 1	6.6	22.7	1.4	3.1
Ex-Bama 2	9.1	17.2	2.0	2.7
Ex-Bama 3	6.3	15.5	1.9	2.8
Ex-Damare1	7.2	12.3	1.6	3.0
Ex-Damare2	8.2	19.5	1.7	2.4
Ex-Damare3	7.8	15.9	1.8	2.1
S.E	0.63	1.7	0.08	0.17
L.S.D	4.79^{NS}	12.53^{NS}	0.63^{NS}	1.30^{NS}

The results in Table 2 showed that there was no significant difference (P=0.05) between all the infected Masakwa cultivars in fresh and dry vegetative weight. The highest fresh vegetative weight of 9.1g in infected Masakwa cultivars was recorded by Ex-Bama 2 and the least with 6.3g was recorded by Ex-Bama 3. However, it could be observed that the root knot nematodes (*M. javanica*) had tremendous effect on the vegetative weight of all the cultivars, since the infected. Ex-Bama 1 was weighing 6.6g which is about 1/3 of the uninfected cultivar that weighed 22.7g. All the other infected cultivars were weighing just ½ of their uninfected counterparts.

Table 3: Effect of *Meloidogynejavanica* on root weight and stem diameter of infected Masakwa cultivars

Cultivars	Infected fresh root weight (g)	Uninfected fresh root weight (g)	Infected dry stemdrain (cm)	Uninfected dry stem drain (cm)
Ex-Bama 1	3.6	2.9	5.3	7.0
Ex-Bama 2	2.2	2.4	5.8	8.0
Ex-Bama 3	1.7	2.5	6.0	7.4
Ex-Damare1	1.1	2.5	5.3	7.2
Ex-Damare2	1.8	3.7	6.7	8.7
Ex-Damare3	1.3	1.2	5.3	8.0
S.E	0.21	0.34	0.21	0.37
L.S.D	1.63^{*}	2.62^{*}	1.62^{*}	2.79^{*}

Note: * Significant difference (P=0.05)
NS = Not significant (P = 0.05)
S.E = Standard error
LSD = Least significant Difference

Fresh root weight of infected Masakwa cultivars indicated significant difference (P=0.05) between the cultivars (Table 3). The highest root weight of 3.6g was observed in Ex-Bama 1, while the lowest was recorded by Ex-Damare 1 that weighed 1.1g. However, all the cultivars of the infected plants recorded lower root weight when compared with their uninfected counterparts except that of Ex-Bama 1. This indicates that the root-knot nematodes (*M. javanica*) caused stunted root growth for all the cultivars. In the case of Ex-Bama 1 the higher number of galls might be responsible for the increase in weight. The infected Masakwa cultivars showed no significant difference (P=0.05) in stem diameter, the thickest was that of ex-Damare 2 with 6-7mm. However, all of them were thinner than their uninfected counterparts. This indicates that *M. javanica* had effect on thickness of stem on all the Masakwa cultivars.

Table 4: Effect of *Meloidogynejavanica* on Masakwa cultivars height at 4 and 6 weeks of age

Cultivars	Height at 4 weeks infected	Height at 4 weeks uninfected	Height at 6 weeks infected	Height at 6 weeks uninfected
Ex-Bama 1	17.2	13.9	23.0	26.3
Ex-Bama 2	14.9	15.5	24.2	24.8
Ex-Bama 3	13.6	16.0	23.3	25.0
Ex-Damare1	13.8	14.5	22.2	22.5
Ex-Damare2	13.5	14.8	22.6	23.3
Ex-Damare3	13.0	14.0	23.3	23.1
S.E	0.65	0.23	0.41	0.41
L.S.D	4.91^{*}	1.79^{*}	3.10^{NS}	5.43^{NS}

Note: * Significant difference (P=0.05)
NS = Not significant (P = 0.05)
S.E = Standard error
LSD = Least significant Difference

At 4 weeks after planting all the infected Masakwa cultivars showed no significant difference (P=0.05) in terms of height. The tallest among them was that of Ex-Bama 1 which measured 17.3cm and Ex-Damare 3 recorded 13.0cm height. However, the uninfected cultivars showed significant difference (P=0.05) between them in terms of height. At 6WAP all the cultivars in infected and uninfected Masakwa cultivars showed no significant difference (P=0.05) in height among them. It could be observed when the infected and uninfected cultivars each were compared they were almost of the same height.

Table 5: Host Suitability of Masakwa Cultivars of sorghum (Sorghum bicolor) tested for Root Knot Nematode (*Meloidogynejavanica*) in screen house.

Cultivars	No. of *M. javanica*, juvenile/1g of root	No. of *M. javanica*, juvenile/1g of soil	Galling index	Host effic. Repri. Fact. (R-factor)	Suitability design.
Ex-Bama 1	343	1900	3.0	1.90	S
Ex-Bama 2	646	2493	2.7	2.49	S
Ex-Bama 3	656	2019	3.0	2.02	S
Ex-Damare1	1195	1813	2.7	1.81	S
Ex-Damare2	672	2232	3.0	2.23	S
Ex-Damare3	774	2466	2.7	2.47	S
S.E	86.8	139.6	0.09		
L.S.D	654.56^{*}	1052.7^{NS}	0.72^{NS}		

Note: * Significant difference (P=0.05) S = Susceptible
NS = Not significant (P = 0.05)
S.E = Standard error
LSD = Least significant Difference

For host suitability, all the cultivars were infected and root-knot nematode reproduction took place. The number of *M. javanica*juveniles in 1g, of roots had significant difference (P=0.05) among the cultivars. The highest juveniles count of 1195 in 1gm of roots was recorded in Ex-Damare 1, while the lowest recorded in Ex-Bama 1. The number of *M. javanica* juveniles in 100g of soil, showed no significant difference (P=0.05) in all the soils of the six cultivars. The highest number of *M. javanica* juveniles /100g of soil of 2493 was recorded in soil of Ex-Bama 2. Galling index for all the cultivars rangedbetween 2.7-3.0. The host efficiency (R-factor) for all the cultivars was more than 1 and the highest of 2.49 was observed in Ex-Bama 2. Suitability designation indicated that all the six Masakwa cultivars were susceptible to *M. javanica* infection.

IV. Discussion

All the Masakwa cultivars of sorghum tested had their vegetative weight reduced because of the *M. javanica* infection with most of them being 1/3 or ½ of their uninfected counterparts. They also showed yellowing of leaves,Chlorosis of sorghum leaves due to *M. incognita* was earlier reported by Orr and McSorley (1978). The testedMasakwa cultivars also recorded thinner stem diameter when compared to their uninfected counterparts. Even though the infected cultivars had no significant difference (P=0.05) in plant height among them, they were all shorter by 1-2cm less than their uninfected counterparts. Kollo (2002) reported stunted growth of sorghum as one of the symptoms of *M. incognita* on sorghum. The performance of the seedlings in terms of height irrespective of the infection is an indication that the Masakwa cultivars of sorghum are not good host of *M.javanica*. Dover, *et al*. (2015) observed that many sorghum cultivars are not good host of root knot nematodes. They also observed that sorghum has high seedling vigor.Using the quantitative scheme for assignment of Canto-saenz's host suitability designation all the Masakwa cultivars tested against *M. javanica*were susceptible. However Ex-Bama 1 supported less *M. javanica* reproduction with only 343 j_2/1gm of roots and 1900j_2/100gm of soil. Even the remaining cultivars did not produce up to 2500 j_2/100g of soil indicating the poor host status of the cultivars. Earlier on Mesorley*et al*. (1994) reported that in Florida SX-17 sorghum cultivar sudan grass did not support reproduction of *M. javanica*. This result is also supported by the findings of Kirkpatrick and Thomas (2016) where they reported that sorghum could support low reproduction of root-knot nematodes when compared with corn and soybean having only 1000j_2/250cm of soil in May to 3500j_2/250cm^3 of soil in September as compared to those in Corn (106012/24cm^3 of soil in May to 7, 800J_2/250cm^3 of soil in September) and Soybeans (800J_2/250cm^3 of soil in May to 10,000J_2/250cm^3 of soil in September). It could also be observed that with thinner, yellowing and relatively shorter cultivars of the infected Masakwa cultivars when transplanted to field the yield may be reduced. This could be as a result of late

establishment of the Masakwa Cultivars due to the *M.* javanica attack causing effect on the transplanting date. Transplanting date of Masakwa sorghum is an important factor contributing to yield obtained (Mvendo-Awono*et al.*, 2013). Earlier on yield loss due to root knot nematodes on sorghum cultivars were reported (Page, 1985; Kollo, 2003). However it could be observed that when transplanted into the field the root-knot nematodes survival may not continue since the Masakwa cultivars are growing on residual moisture that cannot support the root-knot nematode multiplication and migration. Russel (1980) and Carsky*et al.*, (1995) observed that soil moisture may be adequate in lower layers of the vertisol soil but the Masakwa plants may not be able to extract it due to low root density in those layers.

V. Conclusion

From the study it could be concluded that all the Masakwa cultivars tested against *M. javanica*were susceptible to the root-knot nematode. That the *M. javanica*affected the seedling growth even though not much in terms of height. The Masakwa farmers are therefore advised not to establish Masakwa nurseries in areas already infested by root-knot nematode (*Meloidogynejavanica*) or they should apply nematode control measures in the nursery beds. This will give stronger and healthier seedlings of Masakwa for better yield in the field. This findings is important more especially now that all the areas under Masakwa cultivation in all the four countries (Nigeria, Cameroun, Chad and Niger) is being recovered from Boko-Haram occupation.

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