

Calcium Nitrate Fertilization Effect on Anthracnose Caused by *Colletotrichum Gloeosporioides* Penz. Tuber Rot by *Rhizopus Stolonifer* Ehrenb. And Yield In *Dioscorea Alata* Variety Agbodo after Fallow

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Abstract

TCalcium nitrate fertilization after fallow was investigated on anthracnose caused by *Colletotrichum gloeosporioides*, tuber rot by *Rhizopus stolonifer* and yield in *Dioscorea alata* var. Agbodo. The field plot soil had 33.17 cmol kg⁻¹ Calcium and 0.79% Nitrogen, which are above and below respectively, the critical levels determined for optimum yam production (South West Nigeria). The field plot design was RCBD, of three treatments of 0, 2 and 4 kg ha⁻¹ of Calcium from Calcium nitrate applied by soil amendment at 3 MAP (months after planting) and 3 replicates. At 4 MAP, increase in emergence of 100% in 2 kg ha⁻¹ treatment and increase of 119.29% in shoot length in 4 kg ha⁻¹ treatment, were significantly higher respectively than in the two other treatments. Tubers sampled at 5 MAP and incubated with *Rhizopus stolonifer* (for 2 weeks) were similar or comparable in infection, but 5.9% weight loss in the 4 kg ha⁻¹ was significantly lower than the control. Anthracnose severity score was 4, in the susceptible category in the control, but 3 in the moderately susceptible category in the calcium-fertilized treatments. Soil amendment levels of 1 to 2 kg ha⁻¹ Ca(NO₃)₂ plus one or at most two Ca(NO₃)₂ foliar sprays of 750 mg l⁻¹ are suggested for anthracnose control in future trials. Each field plot replicate in this study had 30 plants and a total of 90 in the plot. There were 6 rows of 5 plants each in a replicate, spaced 1 meter from one another. Alternate rows, to the calcium nitrate treatment rows were planted to the same variety without fertilizer and are referred to as border plants. Above-ground plant weight at 8 MAP in the treatment rows were 29.57%, 20.92% and 33.68% higher than their border plants. Shoot number per plant in the treatment rows, was 12.92%, 2336.92% and 24.74% higher than their border plants. Tuber number per plant was 29.71%, 138% and 41.67% higher in the treatment rows than their border plants. Tuber weight per plant (at 8 MAP) was 51.95%, 87.23% and 50.5% higher in treatment rows than in their border plants. Yield equivalent per hectare in this study are 23.4 tons ha⁻¹ (control), 42.5 tons ha⁻¹ (2 kg ha⁻¹) and 30.4 tons ha⁻¹ (4 kg ha⁻¹), for 486.7 grams of calcium nitrate application per hectare, which is cost effective compared to the recommended (ICS-Nigeria), 8 bags or 400 kg NPK 15-15-15 per hectare. Yield in tons per hectare of the 2 kg ha⁻¹ and 4 kg ha⁻¹ treatments in this study fall in the 30 to 75 tons per hectare potential for water yam.

Introduction

Yams are an important staple food in humid and sub-humid areas of the world. Nigeria produced 38 million metric tons in 2012 which represents 65% of the world total [1]. Despite this increased production is demanded as export is below 1%. Constraints to production include the field disease called Anthracnose caused by *Colletotrichum gloeosporioides* Penz. Losses of tubers, which are the most important part of the crop plant, of 50% and 30% to 60% at three to six months in storage prevail. Such losses are majorly due to fungal pathogens [2]. *Rhizopus stolonifer* is the second most important pathogen of stored yams [3]. Management methods to control/manage losses include chemicals or chemotherapeutants, biological control and use of resistant varieties. Calcium fertilization has been reported to increase resistance of *Solanum tuberosum* (Irish potato) tubers to bacterial rot [4]. Calcium fertilization has also been reported to

reduce infection and weight loss by *A. niger* and *B. theobromae* in long term storage in two improved varieties of *Dioscorea alata* and *D. rotundata* [5]. Calcium nitrate soil amendment was investigated in this study in relation to tuber rot caused by the rot pathogen *R. stolonifer*, as well as yield and to anthracnose disease caused by *C. gloeosporioides* in a popular local water yam variety *D. alata* var. Agbodo in South West Nigeria.

Materials and Methods

Sourcing of Tubers

Tubers of *Dioscorea alata* var. Agbodo were sourced from the yam farmers market in Lafenwa, a commercial area of Abeokuta City, capital of Ogun State Nigeria.

Field layout

A farm plot which had been left fallow for 3 years at the

Teaching and Research Farms of the Directorate of University Farms (DUFARMS), FUNAAB (Federal University of Agriculture), Abeokuta, was cleared manually with hoes and matchetes, A 31 m by 13 m area was cleared and divided into 3 replications (of 13 m by 9 m each). At this point soil sampling was done as described in section 2.3. The field plot design was RCBD (randomized complete block design), with three treatments, that are the soil amendment treatments to be applied at 3 months after planting. 1 m by 1 m mounds of 80 cm height were made and a 2 meter stake established per mound. A total of 90 mounds (30 per replicate) were made in the field plot. Inter-row and intra-row distance was 1 m and 0.5 m respectively. 1 m distance separated replicates from one another, and 1 m clear field border was maintained on each of the four sides of the plot. There were three treatment rows of 5 pounds each, as well as three border rows of 5 mounds each per replicate. The 6 rows were each separated from the other by 1 m space. Thus each treatment row where fertilizer was to be applied was followed by a border row where no fertilizer was to be applied. 30 mounds were thus established per replicate and 90 mounds for the whole plot.

Soil Sampling and Analysis

Soil sampling was done in the early hours, after clearing and marking out of the replicates for the field plot had been done. Soil samples were taken by replicate. Twenty (20) soil samples were taken in a zigzag pattern from each replicate with a soil auger. The auger was dug into the soil at 20 cm depth, slanting it so as to lift upper and lower soil [6]. Collection was in new labeled polythene bags. Samples were later air-dried, sieved with a 2 mm sieve and bulked together by replicate for analysis. Analysis of cations calcium, potassium, and magnesium as well as the mineral nitrogen were done according to routine methods of the Association of Official Analytical Chemists [7] in the Soil Science Laboratory, COLPLANT FUNAAB, and Abeokuta.

Planting

Seed yams of mean 0.55 kg size were planted in each mound, and mulching was with dried grass. After planting regular weeding was carried out throughout the growth cycle as at when due.

Emergence, shoot number and shoot length assessment at 3MAP (months after planting)

Emergence was assessed in each replicate by counting number of plants that had emerged at 3MAP, this was one day before fertilizer was applied. Shoots emerged from the growing plant were also counted above the top of the mound and their number per mound recorded. Shoot length per plant for a labeled shoot per mound was measured from the base or top of the mound to the shoot tip with twine and a meter ruler. Emergence, shoot number and shoot length were determined for treatment plants and border plants. Emergence, shoot number per plant and shoot length per plant were determined also at 4 MAP.

Fertilization at 3MAP

Fertilization by soil amendment at 3MAP was carried out

only in the treatment rows in each replicate. Fertilizer applied was calcium nitrate at the rate of 0 kg ha⁻¹, 2 kg ha⁻¹ and 4 kg ha⁻¹. Application was by sprinkling evenly in a 20cm deep furrow made at 25 cm radius around the root [8]. The furrow was covered up well with soil after application of the calcium nitrate.

Tuber sampling and infection/weight loss experiment at 5MAP and 6MAP

Early morning (7.00am) sampling of tubers at 5MAP and 6MAP was carried out for the infection and weight loss experiments. Sampling was done along a diagonal transect across the field plot for a random sampling of treatments, at 5MAP and across the second diagonal transect at 6MAP. Smooth wooden spoons specially made for yam harvest was used for the sampling. Soil was pushed away from the roots to expose tubers in the mound carefully to avoid bruising. A tuber was cut away from the shoot with a sharp knife or twisted clockwise until it snapped free from the shoot. Tubers were left to dry for about one hour beside the mound, and then cleared of soil with a soft cloth, and transferred to the COLPLANT (College of Plant Science and Crop Production) Screen house, FUNAAB. They were kept in ventilated wooden structures in the Screen house for 3 days to become physiologically stable before the infection and weight loss experiment was carried out in an Inoculation Hood structure inside the Crop Protection Laboratory of the Department of Crop Protection, COLPLANT FUNAAB. Tuber weights were measured with a top loading mettle balance before and after the experiment.

A 5-day old pure culture of *Rhizopus stolonifer* which had been isolated earlier from a rotting tuber of *Dioscorea alata* was used for the experiment. Tubers were each surface-sterilized at the inoculation site by swabbing with cotton wool dipped in 80% ethanol. After this, 2 cork borers (of 6 mm and 4 mm diameter), a scalpel and a pair of forceps were surface sterilized by dipping into 80% ethanol and flaming till red-hot over a lighted spirit flame bottle. They were then left to cool slanted against another cork borer. Thereafter, 10 to 15 mm deep incisions were made through the inoculation site of each tuber with the sterilized 6 mm cork borer. The cut tissue was lifted out with the scalpel and forceps and a 4 mm agar (potato dextrose agar) disc of the 5-day old pure culture of *R. stolonifer* was put inside the incision with the sterilized 4 mm cork borer. The cut out tissue was then replaced and the incision sealed with Vaseline (petroleum jelly). The inoculated tubers were transferred into a raised wooden netted/ventilated 3 m (length), 2 m (height) and 100 cm (width) yam storage structure which had doors (lockable) made to open and close, placed inside the main COLPLANT Screen house. Incubation period was 2 weeks. After this period, tubers were again weighed before they were cut open through the inoculation site with a sharp steel knife. Infected tissue was cut away with a scalpel into a pre-weighed petri-dish. Measurement of infected tissue was with an electronic balance. Weight loss was calculated with the formula: % Weight loss (Y) = ((A-B)/A)100, Where A and B are the weight of the tuber at the beginning and at the end of the experiment.

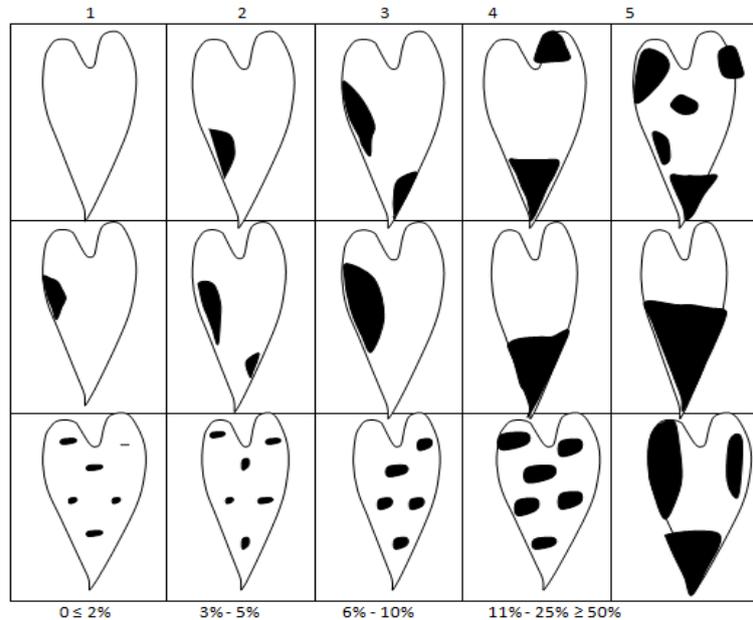
Percent infection was calculated with the formula: %

Infection=(C/A)100, where C and A are corrected weight of infected tissue and weight of tuber at the beginning of the experiment, respectively [11].

Where X and Y are weight of infected tissue and percent weight loss respectively.

Assessment of Anthracnose Severity at 8MAP

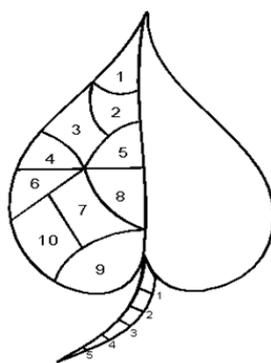
Severity of Anthracnose disease was assessed at 8MAP with the Anthracnose disease severity assessment scale of [10], (Figures 1 to 3). With the scale, severity was determined on a grade of 1 as resistant to a grade of 5 as susceptible.



- 1- No symptom/0 ≤ 2% severity/resistant/highly resistant
- 2 - Necrotic spots 1.00 mm – 2.00 mm/3-5% severity/moderately resistant (tolerant)
- 3 - Necrotic spots 2.01 mm – 3.00 mm/6-10% severity/moderately susceptible
- 4 - Necrotic spots 3.01 mm – 4.00 mm/11-25% severity/susceptible
- 5 - Necrotic spots > 4.00 mm/50% severity/very susceptible

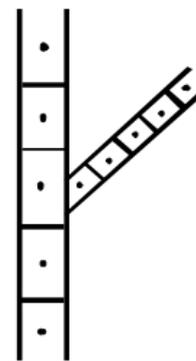
Modified from Green (1994)

Figure 1: Yam leaf anthracnose disease assessment diagram + lesions on petiole and stem



Petiole 1/5 x 100 = 20%
 Leaf BLADE 1/10 = 5%
 2/10 = 10% ETC.
 10 Leaves UPPER PORTION (young = tender/lighter texture)
 10 Leaves MIDDLE PORTION (maturing = green/expanded/big)
 10 Leaves LOWER PORTION (fully expanded + well-formed Cuticle/texture leathery)

Figure 2: Leaf anthracnose assessment



5 SECTIONS - 2 VINES ONLY
 PETIOLE - 1 TDA
 1 VINE ONLY
 TDR
 2 VINES ONLY
 TDA (Local) Estimated % area scored per Vine/Petiole (5 sections)

Figure 3: Vine and Petiole anthracnose assessment

Plant weight (above the ground), shoot number and yield determination at 8MAP

Number of shoots per plant were counted and recorded at 8MAP. Plant weight or weight of the plant above the mound was determined at 8MAP by cutting the shoots of the plant just above the mound into smaller sections with a sharp machete into a pre-weighed raffia basket. Weights were measured with a top loading field mettle balance. Tubers in each mound were then harvested with yam harvest smooth wooden spoons. Soil was pushed carefully away from the mound to expose the tubers. Tubers per mound/plant were counted and recorded. Harvested tubers per plant (or mound) were weighed with the field mettle scale. Plant weight, shoot number, tuber number and tuber weight per plant were also recorded for the border plants.

Data Analysis

Data were subjected to Analysis of Variance, and percent data were transformed appropriately before analysis. Means were separated using Tukey's Studentized Range (HSD) test.

Results

Soil Analysis

Soil Analysis results are presented in (Table 1). Calcium, Magnesium and Potassium in the soil site were 33.17 cmol kg⁻¹, 2.54 cmol kg⁻¹ and 0.51 cmol kg⁻¹ respectively. Nitrogen was 0.79%. The pH of the site was 6.49.

Agronomic characters assessment

Calcium nitrate soil amendment for *Dioscorea* species after fallow has not been reported before in literature. Therefore its effect after 3MAP when it was applied was assessed on emergence in the 3 treatments. Emergence was 60%, 40% and 60% for the 0, 2 and 4 kg ha⁻¹ calcium-fertilized treatments respectively at 3MAP that was one day before fertilizer application (Table 2). Four weeks after at 4MAP, emergence had increased by 11.11%, 100% and 22.24% in the treatments respectively, and the 2 kg ha⁻¹ fertilized plants had significantly higher emergence than the control as well as the 4 kg ha⁻¹ treatment (Table 2). There was no difference in emergence between the control and the 4 kg ha⁻¹ treatment. Shoot number at 3MAP was 3.14, 2.79 and 3.10 for the 0 kg ha⁻¹, 2 kg ha⁻¹ and 4 kg ha⁻¹ treatments respectively. At 4MAP increase of 60.19% (control), 94.75% (2kg ha⁻¹) and 113.55% (4 kg ha⁻¹) were not significantly different from one another. Shoot length was 1.57m, 1.49m and 0.70m in the 0 kg ha⁻¹, 2 kg ha⁻¹ and 4 kg ha⁻¹ calcium-fertilized plants respectively. At 4MAP increase in the 3 treatments were 15.98% (0 kg ha⁻¹) 45.73% (2 kg ha⁻¹) and 119.29% (4 kg ha⁻¹). The 4 kg ha⁻¹ treatment was significantly higher in the four weeks after fertilization in shoot length than the control as well as the 2 kg ha⁻¹ treatment (Table 2).

Table 1: Mean values of soil properties of the experimental site

pH (in water)	6.49 ± 0.20
Ca (cmol k ⁻¹)	33.17 ± 0.40
Mg (cmol k ⁻¹)	2.54 ± 0.03
K (cmol k ⁻¹)	0.51 ± 0.003
N (%)	0.79 ± 0.005

Table 2: Emergence and shoot growth at 3MAP and at 4 weeks after fertilization (4MAP) in *Dioscorea alata* variety AGBODO.

TRT ¹ kg ha ⁻¹ CALCIUM	%EM ¹ 3MAP	% EM ¹ 4MAP	% INC in EM	SN-3MAP ¹	SN-4MAP ¹	% INC in SN	SL-MAP ¹	SL-MAP ¹	% INC in SL
0	60	66.67	11.11	3.14	5.03	60.19	1.57	1.82	15.98
2	40	80	100	2.79	5.43	94.75	1.49	2.09	45.73
4	60	73.34	22.24	3.1	6.62	113.55	0.7	1.54	119.29
LSD (5%)			62.3			58.18			71.2

TRT = Treatment (kg ha⁻¹ of calcium)

3MAP = 3 months after planting

% EM = Percentage emergence

% INC = Percentage increase

4MAP = 4 months after planting

SN = Shoot number

SL = Shoot length (meter)

Infection/weight loss in inoculated tubers (5MAP and 6MAP)

Weight loss in the inoculated (with *R. stolonifer*) tubers sampled at 5MAP was 19.07% (control), 13.78% (2 kg ha⁻¹) and 5.90% (4 kg ha⁻¹) indicating that weight loss was significantly lower at the higher calcium-fertilized treatment (4 kg ha⁻¹), than the control, but was not different from the 2 kg ha⁻¹ treatment. Infection in the tubers at 5MAP, of 0.93% (control), 0.70% (2 kg ha⁻¹) and 0.28% (4 kg ha⁻¹) were not significantly different from one another. Tubers sampled at 6MAP and inoculated with the pathogen *Rhizopus stolonifer* were not significantly different in infection or weight loss from one another (Table 3). The values were 6.70%, 2.6% and 3.7% for weight loss in the 0 kg ha⁻¹, 2 kg

ha⁻¹, 4 kg ha⁻¹ treatments respectively. The values for infection were 1.11%, 1.46% and 3.55% in the 0 kg ha⁻¹, 2 kg ha⁻¹ and 4 kg ha⁻¹ respectively (Table 3).

Anthracnose disease severity at 8MAP

Anthracnose severity of 3.92 (susceptible) for the control, 2.86 (moderately susceptible) for the 2 kg ha⁻¹ treatment and 2.87 (moderately susceptible) for the 4 kg ha⁻¹ treatment were recorded at 8MAP (Table 4). Statistically the least significant difference indicates that there are no significant differences between them, but measurement of severity (on the severity scale – Otusanya et al., 2017) indicates that the severity on the calcium-fertilized plants was on a lower scale than that of the control plants.

Table 3: Infection and weight loss in calcium-fertilized *Dioscorea alata* var Agbodo inoculated with *Rhizopus stolonifer* for 2 weeks

Treatment kg ha ⁻¹ Calcium	Tubers harvested at 5 MAP ¹		Tubers harvested at 6MAP	
	% INFECTION	% WL	% INFECTION	% WL
0	0.93	19.07	1.11	6.7
2	0.7	13.78	1.46	2.6
4	0.28	5.9	3.35	3.7
LSD (P = 5%)	1.39	10.65	4.02	8.51
Overall mean	0.64	12.92	2.04	4.33

MAP = Months after planting
WL = Weight loss
LSD = Least significant difference

Table 4: Severity of Anthracnose disease caused by *Colletotrichum gloeosporioides* in calcium-fertilized *Dioscorea alata* var. Agbodod at 8 MAP

TRT ¹ kg ha ⁻¹ CALCIUM	Anthracnose Disease Severity Score
0	3.92 (susceptible)
2	2.86 (moderately susceptible)
4	2.87 (moderately susceptible)
LSD (P = 0.05)	1.87

MAP= Months after planting
LSD = Least significant difference

Yield at 8MAP

Yield in the calcium-fertilized plants and border plants (1m distance away) are presented in (Table 5). There was need to compare plant height in the calcium-fertilized plants and those of unfertilized border plants 1 meter away from each treatment row. This assessment was taken as fresh weight at 8MAP because plants would have become senescent at physiological maturity of 9 months. Mean weights of the plants above the ground were 1.49 kg (control), 1.85 kg (2 kg ha⁻¹) and 1.27 (4 kg ha⁻¹). These weights were 29.57%, 20.92% and 33.68% higher respectively than that of the border plants. Plant weight of the calcium-fertilized plants was not significantly different from one another at 8MAP.

Shoot number per plant was 3.67 (control), 6.47 (2 kg ha⁻¹) and 3.53 (4 kg ha⁻¹) and were not significantly different from one another. Shoot numbers were however 12.92%, 236.98% and 24.74% higher than that of border plants. Tuber number per

plant was 7.14 in the 2 kg ha⁻¹ calcium-fertilized plants and was significantly higher than tuber number of the control (4.54), and that of the 4 kg ha⁻¹ calcium-fertilized plants (5.27), as shown in Table 5. Tuber number per plant were 29.71% (control), 138% (2 kg ha⁻¹) and 41.67% (4 kg ha⁻¹), higher than that of the border plants.

Tuber weight per plant were 2.34 kg, 4.25 kg and 3.04 kg in the 0, 2 and 4 kg ha⁻¹ calcium-fertilized plants respectively and they were not significantly different from one another at 8MAP (Table 5). They were however 51.95%, 87.23% and 50.5% higher than tuber weight per plant in the border plants respectively (Table 5). Tuber weight for the 0 kg ha⁻¹, 2 kg ha⁻¹ and 4 kg ha⁻¹ calcium-fertilized plant is equivalent of 23.40 tons ha⁻¹, 42.5 tons ha⁻¹ and 30.4 tons ha⁻¹ respectively as shown in Table 5, whereas that of border plants are equivalent to 1.54 tons ha⁻¹, 22.7 tons ha⁻¹ and 20.2 tons ha⁻¹ respectively.

Table 5: Plant weight, shoot number, tuber number and yield in calcium-fertilized *D.alata* var. Agbodo and Border plants (1m away) at 8 MAP.

Calcium kg ha ⁻¹	PW in kg	PW BP in kg	% INC	SNPP	SNPP (BP)	% INC	TNPP	TNPP (BP)	% INC	TWPP in kg	TWPP(BP) in kg	%INC	YIELD tons ha ⁻¹
0	1.49	1.15	29.57	3.67	3.25	12.92	4.54	3.50	29.71	2.34	1.54	51.95	23.40
2	1.85	1.53	20.92	6.47	1.92	236.98	7.14	3.00	138.00	4.25	2.27	87.23	42.50
4	1.27	0.95	33.68	3.53	2.83	24.74	5.27	3.72	41.67	3.04	2.02	50.5	30.40
LSD	1.59			3.80			1.57			3.1			
Overall Mean	1.54	1.21		4.56			5.65			3.21			

PW = Plant weight (fresh at 8MAP)
 SNPP = Shoot Number per Plant
 TNPP = Tuber Number per Plant
 TWPP = Tuber Weight per Plant
 % INC = % INCREASE over BORDER Plants
 MAP = Months after Planting
 Kg = Kilogram

Discussion

Calcium nitrate is being used for the first time after fallow in the fertilization of *Dioscorea* species in this study. The site soil had calcium, magnesium and potassium above the critical levels determined for optimum yam production in South West Nigeria (Ibedu, 1988). The site had been left fallow for three years and a little over before the study. Only Nitrogen which was 0.79% in the field soil was below the critical determined for optimum yam production in South West Nigeria [11]. Four weeks after (at 4 MAP) the soil amendment with calcium nitrate, increase in emergence was 100% in the 2 kg ha⁻¹ treatment, significantly higher than in the control (11.11%) and the 4 kg ha⁻¹ treatment (22.24%). Also at 4MAP increases in shoot number per plant which were 60.19% (control), 94.75% (2 kg ha⁻¹) and 113.55% (4 kg ha⁻¹) were not significantly different. Shoot length increase at 4MAP of 119.29% in the 4 kg ha⁻¹ treatment was higher than in the control (15.98%) and in the 2 kg ha⁻¹ (45.73%) treatments. Mean infection was 0.64% with no significant difference in the three treatments in tubers harvested at 5MAP inoculated with *Rhizopus stolonifer* for 2 weeks. However weight loss of 5.9% in the 4 kg ha⁻¹ treatment was significantly lower than the control (19.07%) but similar/comparable to the 2 kg ha⁻¹ treatment (13.78%). Infection of the mean value 2.04% in the tubers harvested at 6 MAP and inoculated with *R. stolonifer* was comparable in the three treatments and relatively higher than that of the tubers inoculated at 5 MAP. Weight loss in the 6 MAP tubers inoculated with the pathogen for 2 weeks was a mean of 4.3% and was comparable/similar in the three treatments but was 336% lower than that of the tubers inoculated at 5MAP. Reason for the 318.75% higher infection and lower weight loss by 336% in the 6Map tubers needs to be further examined by different levels of Ca(NO₃)₂ other than those used in this study in future research. Anthracnose severity score at 8MAP was in the moderately susceptible category, 2.86 and 2.87 in the calcium-fertilized plants whereas severity in the control plot was in the category of susceptible that is 3.92. Lower levels of Ca(NO₃)₂ soil amendment of 1 kg ha⁻¹ to 2 kg ha⁻¹, as well as 1 or 2 Ca(NO₃)₂ foliar sprays (750 mg l⁻¹) at strategic points

in the 9-month growth cycle (which also depends on the water yam variety [10]) may be assessed in subsequent research for the control of Anthracnose on variety Agbodo.

Plant weight in kilograms at 8MAP was a mean of 1.54 kg, comparable in the three treatments but was 29.57%, 20.92% and 33.68% higher than the border plant 1 m away respectively from the control, 2 kg ha⁻¹ and 4 kg ha⁻¹ plants. Shoot number per plant was a mean of 4.56 and was comparable also across the three treatments but were 12.92%, 236.98% and 24.74% higher than in the border plants of the control, 2 kg ha⁻¹ and 4 kg ha⁻¹ treatments respectively. Tuber number per plant (also at 8MAP) was 7.14 in the 2 kg ha⁻¹ treatment, significantly higher than that in the control (4.54) and in the 4 kg ha⁻¹ treatment (5.27). These tuber numbers per plant were respectively higher than those in the border plants by 29.71%, 138% and 41.67%. Tuber weight per plant (at 8MAP) was 2.34 kg, 4.25 kg, 3.04 kg comparable in 0 kg ha⁻¹, 2 kg ha⁻¹ and 4 kg ha⁻¹ treatments respectively, but were respectively higher than border plant yield by 51.95%, 87.23% and 50.5%. The growth and yield parameter increases over border plants 1 meter (1m) away from each of the treatment row plants, indicate that calcium nitrate fertilization will increase yield in Agbodo, the most popular water yam variety in South West Nigeria over that which would have been obtained traditionally without fertilization after fallow. Also the additional cost of the calcium nitrate to the smallholder farmer comes to that of 486.7 gm for one hectare (one 500 g bottle of analar grade calcium nitrate). Also the equivalent of the yield in this study comes to 23.4 tons ha⁻¹ (control), 42.5 tons ha⁻¹ (2 kg ha⁻¹ treatment) and 30.4 tons ha⁻¹ (4 kg ha⁻¹ treatment). This yield in all the three treatments in this study is higher than the 16 to 25 tons ha⁻¹ for water yam with 8 bags/400 kg of NPK 15-15-15 per hectare (60 kg N, 60 kg P2O2 and 60 kg K₂O per ha) [12, 13]. The yield in this study of 30.4 tons ha⁻¹ (4 kg ha⁻¹ calcium treatment) and 42.5 tons ha⁻¹ (2 kg ha⁻¹ calcium treatment) falls within the potential yield of 30 to 75 tons per hectare for water yam [14, 15]. Palatability tests with staff in COLPLANT, FUNAAB indicate that the viscous texture of the calcium-fertilized yams is relatively reduced and thus they may

be boiled to eat with sauce as with the white guinea yam varieties. Viscosity of the flesh of local water yam varieties does not allow them to be boiled only to eat (like white yam) but are rather used in the preparation of special dishes such as “ikokore” (Ijebu-dish) or snacks such as “ojojo” in South West Nigeria. The uses of water yam however differ in the South-East region of Nigeria.

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