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Evaluation of Different Methods of Sterilizing Sprouting Media for in the Control of Minisett Rot of White Yam (*Dioscorea rotundata* Poir)

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Abstract: Different methods of sterilizing sprouting media for the control of rot in minisetts of *Dioscorea rotundata* var Pona and Dente were evaluated. Sawdust and topsoil sprouting media were sterilized by roasting, solarization and fumigation in a completely randomized block design replicated thrice in the laboratory. Significantly higher percentage rot was recorded for minisetts planted in unsterilized sprouting media than those in sterilized media. Incidence of minisett rot was, however, higher in unsterilized topsoil than in unsterilized sawdust. Roasting was most effective in sterilizing the sprouting media, followed by fumigation and the least was solarization. There was no significant difference between the effects of sterilized sawdust and topsoil on rotting and sprouting of yam minisetts. Pona minisetts planted in sterilized medium produced higher percentage sprouting and lower percentage rotting as compared with that of Dente minisetts.

Key words: Control, *Dioscorea rotundata*, media, microorganism sterilization, sprouting

Introduction

Yam, *Dioscorea* sp., is an important energy giving carbohydrate food in Africa, particularly West Africa. The major type grown in Ghana is the white yam (*Dioscorea rotundata* Poir), especially the Pona and Dente cultivars and they constitutes about 80% of the total yam production in the country (Tetteh and Saakwa, 1994). Among the white yam cultivars, Pona is the most preferred by both foreign and local markets because of its excellent organoleptic qualities. It is also preferred by farmers because of its early maturity, which ultimately becomes the hunger breaker at harvest time when other white yam cultivars and other crops are not ready for harvest. Total production of yam in Ghana, however, is far below requirement for export and local consumption.

The major problem militating against yam production in Ghana has been the unavailability of planting material which constituted about 33% of the total cost out-lay (Orkwor and Asadu, 1997; Marfo *et al*., 1998). The yam minisett technique increased the multiplication ratio from 1:5 to 1:30, has offered a valuable breakthrough in solving the problem of inadequate planting material. Unfortunately, Pona, unlike other white yam cultivars such as Dente and Asana, does not respond well to the minisett technique due to minisett rot in the sprouting medium. Okoli *et al*. (1982) recommended minisett dust, a component of minisett package for effective control of minisett rot diseases. However, considerable percentage of Pona minisett has rot pathogens than the other white yam cultivars. It had been found that both the sprouting media and the yam minisetts themselves are sources of the rot pathogens and must be sterilized (Osai and Ikotun, 1994; Cornelius, 1998).

The study therefore was aimed at identifying the most effective, cheap, easy and readily available method of sterilizing the sprouting media in order to control yam minisett-rot so as to enhance sprouting and good performance of yam minisetts especially Pona cultivar.

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Materials and Methods

Three sterilization methods were evaluated using topsoil and sawdust as the sprouting media. These were solarization, roasting and fumigation. Two white yam cultivars were used for the study, Pona and Dente. The experiment was a Completely Randomized Design, replicated three times in the laboratory at Department of Crop Science, University of Cape Coast, Ghana. The three sterilization techniques were carried out as follows.

Sawdust and sandy loam topsoil were solarized a month prior to the experiment. An amount of 48000 cm^3 of each medium was moistened with water and placed in 0.3 mm thick transparent polythene bags measuring 120×40 cm. The ends of the bags were tied with cotton strings and the bags were placed in horizontal position and compressed to flatten the sawdust to 5-6 cm thick. Thermometers were inserted into the media through holes made in the polythene cover and the temperatures of the media taken every five days at 12.00 noon over a period of 30 days.

A metal drum, measuring 85 cm in height and 55 cm in diameter was cut lengthwise into two halves and used as troughs. Each was filled to about three-quarters full with topsoil moistened with water. The trough was then placed over a fire prepare with fuel wood, to heat the soil, it was periodically stirred with a piece of batten. Roasting of the medium continued to a temperature of 80°C. The procedure was repeated using sawdust.

The procedure followed was as described by Hartmann and Kester (1975). The sawdust and topsoil sprouting media were first moistened with tap water and formalin was then applied at a rate of 35 mL per 28 kg of medium. Each medium was thoroughly stirred and then put in polythene bags and sealed for effective fumigation by the formaldehyde gas. The polythene bags were opened the following day to expose the medium to air for the gas to escape before using the medium for the experiment.

Pona and Dente yam minisetts were prepared according to the procedure described by Otoo *et al*. (1987). Clean, healthy, medium sized mother seed yams that had sprouted were cut into several short cylindrical pieces, each about 5 cm in thickness. Depending on the circumference of the pieces, each was cut longitudinally into 2, 3, 4 or more pieces such that each piece had a periderm. Each piece termed minisett weighed about 25 to 30 g. Freshly cut minisetts were treated with aqueous suspension containing wood ash and kocide (fungicide). The mixture was made by adding 100 g of wood ash (from *Senna siamea*) and 24 g of kocide to 4 L of water in a plastic container. Rubber gloves were worn for protection against the chemicals. A small basket, half-filled with the minisetts was dipped into the suspension for 3 min, removed and the liquid allowed to drain. The treated setts were then spread on palm fronds to dry in the shade.

Pre-sprouting of treated setts was done in baskets containing roasted, fumigated, solarized and unsterilized sawdust and topsoil as control. Fifteen minisetts were placed on a layer of moist sawdust in the baskets, 1 cm apart with the exposed cut- surfaces facing upwards. They were then covered with 3 cm layer of moist sawdust. On this was arranged a second set of 15 minisetts which was covered by another 3 cm thick layer of moist sawdust. Equal numbers of minisetts from head, middle and tail regions of the mother tuber was used for each experimental unit, as recommended by Ogbu and Okereke (1990). The sprouting media were kept moist by watering when necessary. The treatments were arranged in a Completely Randomised Block Design with four replications.

Data recorded include temperatures of the solarized media taken and recorded every three days at 12.00 noon. Data were taken on the following parameters four weeks after planting the minisetts: sprouted minisetts, rotten minisetts, sprouted but rotten minisetts, unsprouted and unrotten minisetts. The number of minisetts for each parameter was counted for each treatment and expressed as percentage of total yam minisett planted. Analysis of variance was done using square root transformed data. Mean separation was done using Duncan New Multiple Range Test (DNMRT).

Results

The Pona minisetts pre-sprouted in fumigated topsoil and pre-sprouted in unsterilized top soil were severely attacked by *Sclerotium rolfsii* resulting in rottened minisetts and some vines of sprouted setts were killed. Sterilization of the sprouting media significantly enhanced sprouting of Pona minisetts. Significantly lower mean percentage sprouting was recorded for minisetts planted in unsterilized medium than for those in sterilized media. Roasted sprouting media produced significantly higher mean percentage sprouted minisetts (69.1%) than that of fumigated (57.62%) and solarized (53.88%) which were not significantly different from each other (Table 1).

The interaction effects of sprouting media and yam cultivars were highly significantly different (Table 1). Dente minisetts pre-sprouted in top soil recorded significantly higher mean percentage sprouting (65.17%) than Pona (54.23%), Pona in sawdust (53.93%) and Dente in sawdust (49.69%) which were not significantly different from each other. The mean percentage of sprouted Pona minisetts was not significantly different from that of Dente minisetts.

Sterilization of sprouting media significantly reduced the rotting of the yam minisetts. Yam minisetts planted in unsterilized media gave significantly higher mean percentage rotten minisetts than those in sterilized media. Roasting of media resulted in significantly lower mean percentage rotten minisetts (13.5%) than control (40%) and solarization (27.1%) and fumigation (22.3%) (Table 2). Yam cultivars and sprouting media interaction effects were significantly different. Dente minisetts pre-sprouted in sawdust produced significantly higher mean percentage rotting (32.9%) than Dente pre-sprouted in topsoil (18.3%). However, neither of them was significantly different from Pona pre-sprouted in topsoil and Pona pre-sprouted in sawdust with respect to mean percent rottened minisetts.

Table 3 show mean percentage of sprouted but rotten minisetts. Pona minisetts (11.5%) was not significantly different from that of Dente minisetts (9.1%). The percentage sprouted but rotten minisetts was higher in Pona pre-sprouted in sawdust (13.3%) and Pona pre-sprouted in topsoil (9.6%) than Dente pre-sprouted in topsoil (9.0%), however, yam cultivar and sprouting media

Table 1: Effect of sterilized sprouting media on sprouting of Pona and Dente yam minisetts

Yam cultivars	Sprouting media	Sterilization methods				Yam cultivar×media means	Yam cultivars means
		Fumigation	Roasting	Solarization	Control		
Pona	Topsoil	61.6ns	69.9ns	46.5ns	38.9ns	54.2a	
	Sawdust	52.5	69.1	50.8	43.8	53.9b	54.1ns
Dente	Topsoil	69.1	80.0	70.0	41.7	65.2a	57.4ns
	Sawdust	47.3	57.5	48.2	45.8	49.7b	
Means		57.6b	69.1a	53.9b	42.43c		
SE		2.71				2.71	
CV (%)		19.44				19.44	

ns: Not significant at 5% probability level. Means in the same row and column followed by the same letter(s) are not significantly different by DMRTat 5 and 1% probability level, respectively

Table 2: Effect of sterilized sprouting media on rotting Pona and Dente yam minisetts

Yam cultivars	Sprouting media	Sterilization methods				Yam cultivar×media means	Yam cultivars means
		Fumigation	Roasting	Solarization	Control		
Pona	Top soil	22.5	12.5	23.3	49.2	26.9ab	
	Saw dust	18.3	12.5	30.8	37.5	24.8ab	25.8
Dente	Top soil	12.5	7.5	15.8	37.5	18.3a	
	Saw dust	35.8	21.7	38.3	35.8	32.9a	25.6
Means (Sterilization methods)		22.3bc	13.5c	27.1b	40.0a	25.7	
SE		2.44				2.44	
CV (%)		37.96				37.96	

ns: Not significant at 5% probability level. Means bearing identical letter(s) are not significantly different from each other DMRT at 1% level

Table 3: Effect of sterilized sprouting media on sprouted but rotten Pona and Dente yam minisetts

Yam cultivars	Sprouting media	Sterilization methods				Yam cultivar×media means	Yam cultivars means
		Fumigation	Roasting	Solarization	Control		
Pona	Topsoil	6.68ns	8.33ns	16.68ns	6.65ns	9.59ns	11.47ns
	Sawdust	20.83	9.18	9.18	14.1	13.34	
Dente	Topsoil	10.01	5.00	9.16	11.65	8.96	9.07
	Sawdust	10.00	10.86	7.53	8.33	9.18	
Means (Sterilization techniques)		11.88ns	8.34ns	10.64ns	10.20ns		
CV (%)			26.75				

ns: Not significant at 5% probability level

Table 4: Effect of sterilized sprouting media on unsprouted and unrotten Pona and Dente yam minisetts

Yam cultivars	Sprouting media	Sterilization methods				Yam cultivar×media means	Yam cultivars means
		Fumigation	Roasting	Solarization	Control		
	Top soil	15.85ns	9.18ns	13.35ns	5.00ns	10.85ns	
Pona	Saw dust	8.33	9.15	9.18	5.00	7.92	9.39ns
	Top soil	8.53	7.50	4.98	9.18	7.55	
Dente	Saw dust	6.83	10.03	5.83	8.33	7.76	7.66ns
Means (Sterilization techniques)		9.89	8.9	8.34	6.88		
CV (%)				40.92			

ns: Not singnificant at 5% probability level

interaction effects were not significantly different from each other (Table 3). Roasting of sprouting media resulted in the lowest mean percentage sprouted but rotten minisetts while fumigation of sprouting media recorded the highest mean percentage rotten sprouted minisetts (11.88%) although there was no significant difference among the sterilization methods. Yam cultivars, sprouting media and sterilization techniques interaction effects were not significant. In terms of their mean percentage sprouted but rotten minisetts.

Pona minisetts recorded higher mean percentage unsprouted unrotten minisetts of 9.39 than 7.66% recorded for Dente minisetts, although there was no significant difference between them. Similarly, mean percentage unsprouted and unrotten minisetts was higher in Pona pre-sprouted in topsoil (10.85%) and in sawdust (7.92%) than Dente pre-sprouted in topsoil (7.55%) and in sawdust (7.76%). There was, however, no significant difference between yam cultivar and sprouting media interaction effects. Percentage unsprouted and unrotten minisetts did not differ significantly among yam cultivar, sprouting media and sterilization methods interaction effects (Table 4).

Discussion

Minisetts pre-sprouted in unsterilized media recorded significantly higher percentage rotting and lower percentage sprouting mainly due to greater number of rot pathogens in the unsterilized sprouting media. It has been reported that unsterilized sawdust and topsoil used for pre-sprouting of minisetts were sources of minisett rot pathogens (Osai and Ikotun, 1994). Otoo *et al.* (1987) had earlier recommended that soil used for pre-sprouting minisetts should be sterilized except virgin soil was used.

The higher percentage rotting recorded for minisetts pre-sprouted in unsterilized topsoil than minisetts pre-sprouted in unsterilized sawdust suggest the occurrence of more rot pathogens in the topsoil than in the sawdust. It is possible that the rot-pathogens of yam are free soil inhabiting and any wound on yam would facilitate the invasion of the yam tissues by any soil fungus (Griffin, 1971). Minisetts pre-sprouted in roasted medium recorded higher mean percentage sprouting and lower mean percentage rotting than those pre-sprouted in fumigated or solarized medium. This indicated that roasting of sprouting media was the most efficient of the sterilization methods applied, since roasting could easily raise the temperature of the sprouting medium above 70°C. Fry (1982) and Fletcher (1984) observed that temperatures above 70°C inactivate plant pathogens in sprouting media.

The rather relatively poor performance of the minisetts in solarized soil as compared with fumigated and roasted soil with respect to percentages of sprouted and rotten minisetts could be attributed to low solarization temperature (47-48°C) attained within the media. Intermittent rainfall during the period of solarization could have reduced the intensity of solar radiation. Intense solar radiation is required to elevate soil temperatures to levels that inactivate pathogens. Temperature exceeding 50°C was necessary for any inactivating effect on pathogens. Further on, the most economic treatment of sprouting media is obtained by raising the soil temperature to 75°C (Fry, 1982; Fletcher, 1984).

The observed higher percentage rotting recorded by minisetts pre-sprouted in unsterilized topsoil than minisetts pre-sprouted in unsterilized sawdust is suggestive of occurrence of more rot pathogens in the topsoil than in the sawdust. Thus, topsoil performed significantly better than sawdust as seen by the high mean percent healthy sprouted minisetts than mean percent unsprouted rotten minisetts. This finding is at variance with those of Otoo *et al.* (1987) who observed that sawdust was the best pre-sprouting medium for yam minisetts.

The non-significant difference between Pona and Dente yam minisetts interaction for mean percentage sprouted minisetts and rotten minisetts, indicated that Pona performed equally well as Dente. This could be due to effective sterilization of the sprouting media against minisett-rot pathogens, suggesting that sprouting of Pona minisetts could be enhanced if the setts were pre-sprouted in roasted medium (well-sterilized medium). It was, however, observed that Pona minisetts, which were pre-sprouted in roasted sawdust, produced more vigorous and healthier sprouts with bigger vines, roots and tubers than those in roasted topsoil. This variation could be attributed to better drainage and aeration in the sawdust than in the topsoil, which encouraged normal physiological activity such as respiration. This was in agreement with the report of Onwueme (1978) that sprouting of yam setts requires ample supply of oxygen for good performance. The yam cultivars, sprouting media, sterilization techniques and their interactions had no influence on the percentage of unsprouted, unrottened minisetts and percentage sprouted but rotten minisetts.

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