Journal of
Plant Science & Research

Open Science Publications

Volume 3, Issue 1 - 2016

www.opensciencepublications.com

Effectiveness of Organic Control of Biodeterioration of Yam Tubers in Storage Using Plant Extract (*Alstonia boonei, Xylopia aethopica, Crotolaria spp, Chromoleana odorata*) Against Farmers Post Harvest Crop Loss

Research article

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Article Information: Submission: 07/04/2016; Accepted: 21/04/2016; Published: 01/05/2016

Abstract

Organic leaf extracts of four plants (*Alstonia boonei* De Wild, *Chromolaena odorata* Lam, *Crotolaria retusa* Linn, and *Xylopia aethiopica)* were assessed for their effectiveness in the control of biodeterioration of yam tubers in storage. The root knot (40%) infested yam tubers were dipped in the various organic leaf plant acetone extracts for 24 hours and assessed for 6 weeks on sprout inhibition, 8 weeks for sprouting inducement and 12 weeks for biodeterioration in storage. The results indicated that there was no significant difference (P>0.05) among the treatments and control on inhibition of yam tuber sprout. However, there were significant differences (P<0.05) among the treatments as regards the inducement of sprouting. *Xylopia aethiopica* (43.4) and *Chromolena odorata* (42.4) extracts significantly (P<0.05) stimulated yam tuber sprouting potentials and also controlled yam tuber biodeterioration in storage. *Chromolaena odorata* (0.00) and *Xylopia aethiopica* (0.00) best inhibited the yam biodeterioration activities in 12 weeks of storage as there were significant differences (P<0.05) among the treatment means of *Crotoleria spp, Alstonia boonei,* and the control. The organic leaf extracts can evidiently be used for effective prevention of biodeterioration of yam tubers in storage, the study therefore recommend wide spread use by farmers.

Keywords: Yam tubers; Organic leaf extract; Biodeterioration in storage

Introduction

Productivity of crops grown for human consumption is at risk due to the incidence of pests, especially weeds, pathogens and animal pests. Crop losses due to these harmful organisms can be substantial and may be prevented, or reduced, by sustainable crop protection measures. Organic control measures offer a sustainable solution to many environmental and food security problems in sub-Saharan Africa and world over. It uses fertilizers and pesticides (which include herbicides, insecticides and fungicides) if they are considered natural (such as plant extracts, bone meal from animals or pyrethrin from flowers), but it excludes or strictly limits the use of various methods (including synthetic petrochemical fertilizers and pesticides; plant growth regulators such as hormones; antibiotic use in livestock;

genetically modified organisms [1]. Storage Crop loss has been the bane of arable crop farmers in Nigeria and effective plant protection strategies has replicated their frequently asked questions during extension service sessions hence this study.

Most uncultivated ethno-medicinal tropical plants with bio-pesticidal potentials are yet to be investigated and exploited for the purpose of organic plant protection. The use of plant protection chemicals to a larger extent is not only very expensive, it possesses toxic and poses potential hazards to man and environment among others [2]. There is need for alternative organic control of biodeterioration of arable crops such as cassava and yam tubers in storage using plant extracts.

Yams (*Dioscorea rotundata)* and cassava (*Manihot esculenta,* Crant) contribute about 80% of the food calories in West Africa and yam alone accounts for 60% of this total. Yam is to West Africa as what potatoes is to Europeans and occupies important position in the economic and social life of Nigerians in which about 1.5 million metric tons are produced annually [3].

The root knot nematodes [4] (*Meloidogyne spp*) have been identified as the most economic pest of yam in Nigerian with an incidence range of 25-30% in major yam producing areas [5]. The root knot nematodes damage yam tissues by their feeding on the tubers and also create micro wounds through which secondary pathogens (fungi, bacteria and viruses) can enter and cause complete decay. Infestation of root knot nematodes on stored yam tubers resulted into complete deterioration due to subsequent attack of fungi and bacteria and was reported to contribute greatly to post- harvest bio-deterioration with consequent losses in monetary terms [6].

Onyenobi reported in a survey on pesticide use and misuse in Nigeria that 60% of local farmers use Aldrex T to protect their seed yam setts at planting and that Aldrex T is a combination of 250g/kg, Aldrin (a cyclodiene insecticide) and thiram (a fungicide at 200g/kg) [7]. Aldrex or soildrin is the trade name for Aldrin. The International Register of Potentially Toxic Chemicals (IRPTC) of United Nations Environmental Program (UNEP) listed Aldrin as one of the chemicals banned or severely stricted in several countries [8]. The organochlorine have been reported to be deleterious to man and his environment due to their persistence in crops, bioaccumulation in soil and within the fatty tissue of human reproductive systems.

This investigation was designed to screen the organic pesticidal potentials of four plants (*Alstonia boonei* De Wild, *Chromolaena odorata* Lam, *Crotolaria retusa* Linn, and *Xylopia aethiopica*) in the control of bio-deterioration in yam at storage and also on their effects in the inhibition and stimulation of the sprouting potentials of yam tubers in storage. Passam reported that the ability of yam tubers to germinate after variable and often prlong periods of dormancy is a vital quality characteristic which could be manipulated to improve the flexibility of storage duration and date of planning [9]. A long dormant period, without loss of viability, enables the tubers to be used in propagation and is a factor in the perenniality of yams. If sprouting could be delayed by prolong dormancy, a longer shelf life of healthy yam tubers could be achieved. The plants used in this research were readily available, affordable, and non-toxic to man and his environment also contain natural products that have been proved effective in the treatment of various diseases by the natives.

The need for organic based pesticides that could be used in place of these synthetic chemicals which are also environmentally friendly for the protection of yam tubers in storage against bio- deterioration has given impetus for this trials.

Materials and Methods

The investigation was conducted at the Nematological laboratory of Abia State University Uturu, Nigeria. The yam tubers used weighed (100± 5g) and was slightly infested,(using gall index (GI) of 2 for(21-40%) galled root-knot nematode, scale of 0-5=0 (no infection), 1= 1-20% of tuber galled, 2 = 21-40% of tuber galled, 3 = 41-60%tuber galled, 4= 61-80% and 5= 81-100% of tuber galled. The 40% surface area covered tubers with phytonematode visually classified were grouped in three replicates of four each (12 yam tubers) for each treatment with each natural product, and the control (untreated infested control) [10].

The ethnomedicinal plants used were *Alstonia boonei, Xylopia aethopica, Crotolaria spp, Chromoleana odorata* and the untreated control. The healthy harvested leaves were dried at room temperature in the laboratory for three weeks and pulverized (ground into powder with an electrically powered Warring blender). One gram of the powdered dust of each sample was soaked in 10ml acetone in a glass specimen bottle for one week to extract the active ingredients. This was filtered and the solvent was allowed to evaporate within three days outside the laboratory. Each extract was dissolved in 1000cm water (acetone extract of 1g/L of water [11]. Each group of seed yam sets were soaked in each plant extract solution and the control yam tubers also soaked in water for 24 hours. The soaked yam seeds were laid out on benches at room temperature and relative humidity range of 75 to 90%. The treatments were monitored weekly and data were collected on the 6^{th} week for inhibition, 8 week for sprouting and at 12 week for biodeterioration (growth of fungi and number of rotted seed yams). The data generated was transformed into logarithmic function before the computation of the analysis of variance.

Results and Discussion

Table 1 shows the mean and confidence limits in respect of the percentage of sprout inhibited seed yams at the end of 6 weeks in storage, *Crotoleria retusa* extract fairly inhibited seed yam sprouting

Table 1: % age of sprout inhibited seed yams at six weeks after treatment.

Treatment	Replication			Mean
	R1	R2	R3	
Alstoniaboonei	50	100	50	66.7
Xylopiaethiopica	50	50	100	66.7
Crotoleriaspp	0	50	75	41.9
Chromolaena odorata	75	75	50	66.7
Water	75	75	50	66.7

*95% confidence interval for mean ± 1.15.
Total logarithms of the percentage of sprout inhibited seed yams at the end of 6 weeks computed from transformed data used for analysis of variance.

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Table 2: Shows the effect of organic extracts on the percentage of sprouted seed yams at 8weeks in storage.

Treatment	Replications			Mean	logs
	R1	R2	R3		
Alstonia boonei	25	35	30	30.4	2.4
Xylopia ethiopica	45	45	35	43.4	3.61
Crotoleria spp	30	25	35	30.4	2.4
Chromolaena odorata	40	50	50	42.4	3.6
Untreated control	35	45	30	40.4	3.42

*95% confidence interval means $\pm$1.65
Total logarithms of the percentage of sproutedseedyams at the end of 8 weeks computed from transformed data used for analysis of variance.

Table 3: Effect of organic extract on yam biodeterioration @ 12weeks in storage.

Treatments	Replications			Mean
	R1	R2	R3	
Alstonia boonei	1.70	0.0	1.40	3.10
Xylopia ethiopica	0.00	0.00	0.00	0.0
Crotoleria spp	1.40	0.00	1.40	2.80
Chromolaena odorata	0.00	0.00	0.00	0.0
Untreated Water	1.88	2.00	1.88	5.76
Total	4.98	2.00	4.68	11.66

Sources	DF	SS	MS	F-cal	F-tab
Treatment(SS)	4	7.81	1.95	9.28	1.73
Error	14	2.96	0.21		
Total	18	10.7			

potentials (49.1) when compare with other plant extracts, though without statistical difference (P> 0.05). The indication was that the application of extract from *Crotoleria retusa* inhibited sprouting higher than the other treatments. Table 2, shows the effect of organic extracts on the percentage of sprouted seed yams at 8 weeks in storage. *Xylopia aethiopica* (43.4) and *Chromolena odorata* (42.4) extract significantly (P<0.05) stimulated yam tuber sprouting potentials. However, there was significant differences (P<0.05) among the treatments as regards the inducement of sprouting. It appears that the different inoculum levels did not significantly determine the sprouting ability of the yam tubers, but resulted into significant differences (P<0.05) among the active ingredients of the plant extracts and the control. Yam tuber infestation by nematodes destroy the germinative cells and subsequently reduced the sprouting potentials, but Onyenobi reported that slight nematode infestation stimulate sprouting and the yam tubers used in the investigation were slightly infested with root knot nematode (40% coverage with nematodes) [12]. And there were no significant differences (P>0.05) in the inhibition of the sprouting potentials of the yam tubers by the treatments due to the low level of nematode infestation on the tubers.

Table 3 indicates that *Chromolaena odorata* (0.00) and *Xylopia aethiopica* (0.00) best inhibited the yam biodeterioration activities in 12 weeks of storage as there were significant differences (P<0.05) among the treatment means of *Crotoleria spp, Alstonia boonei* and the control. The rot organism reported to associate with yam deterioration are fungi , bacteria and viruses and Adesiyan reported that synergistic relationship between these plant pathogenic organism and nematodes increase the severity of the yam rot [13]. It is however accepted that plant parasitic nematodes create micro wounds on the tubers thus facilitating entry of other pathogens, the nematodes produce the enzyme amylase which hydrolyse the starch into sugar that provide an ideal medium for microbial attack [13,14]. The plants (*Xylopia* and *Chromolaena odorata*) do possess strong biopesticidal potentials and also do not have adverse effect on the viability of the seed yams. It could therefore be used for the protection of yam bio-deterioration before planting and on storage.

Conclusion

Yam nematodes regarded as primary pathogens in yam tuber deterioration cause decay or necrosis of the tissue and also make the infected tubers more prone to fungi and bacteria attack. Nematodes attack gives rise to dry rot while fungal and bacteria attack gives rise to wet rot [10]. Studies on nematode infected yam tubers show that there is a biochemical conversion of starch to simple sugar induced by the nematode and these inter- conversion processes affect the storage of the tuber adversely. In the presence of the simple sugar, fungi and bacteria grow actively and their activities result in progressive deterioration of the tuber.

The effect of the organic extracts on nematodes (*Meloidogyne incognita*) infected yam tubers indicated that the different plant extracts and the control did not stastistically differ significantly in their efficacy in the inhibition of yam sprout at 6 weeks in storage. The results from the biodeterioration revealed that *Xylopia* and *Chromolaena odorata* effectively controlled the biodeteriorations of yam tubers based on the assumption that rot organisms (fungi and bacteria) are neccessarially the major cause of biodeterioration in storage and not high temperature.

The intensification of crop production necessary to meet the increasing demand through enhanced productivity per unit area might be impossible without a concomitant intensification of pest/disease control. The application of organic principles inpest/disease control enables the employment of local resources and therefore cost-effective. It contributes to ecologically sustainable and socio-economic development. Therefore the technique should be inculcated to the farmers through extension services package delivery (On-Farm Adaptive Research (OFAR) for wide spead farmer's use.

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Citation: Aghale DN, Umeh OJ, Okorocha A. Effectiveness of Organic Control of Biodeterioration of Yam Tubers in Storage Using Plant Extract (*Alstonia boonei, Xylopia aethopica, Crotolaria spp, Chromoleana odorata*) Against Farmers Post Harvest Crop Loss. J Plant Sci Res. 2016;3(1): 147.

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