Effect of Pesticides and Fertilizer on the Dormancy Period of White Yam Tubers (Dioscorea Spp) during Storage

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Abstract

An experiment was conducted with three varieties of white yams namely Faketsa, Mumuye and Ogede, obtained from the three Senatorial Zones of Benue State to determine the effect of using insecticides, herbicides and fertilizer during the cultivation of white yam on the dormancy period of its tubers. The experimental design was a 3 x 3 factorial with 3 replications. The three yam varieties were planted on an experimental farm raised in Gboko, Benue state. Insecticide, herbicides and fertilizer were used on one plot, organic manure only was used on a second plot while the control plot was raised without herbicides, organic manure or fertilizer. The yams were harvested at full maturity and stored on shelves in a well-ventilated zinc-covered-room. Signs of sprouting were monitored and recorded at 10 days interval for up to 120 days. A dormancy period of from 70 – 120 days was recorded for all the treatments. Significantly higher sprouting rate was observed in Faketsa from day 70-100, while the highest sprouting rate of 100% was observed in Ogede at the end of 120 days ($P < 0.05$). The Control group showed higher rate compared to the organic manure group from day 70 – 90. No significant difference was however observed in the groups treated with chemicals when compared to the Control group from day 100 – 120 ($P > 0.05$). Ogede yam however had the highest sprouting rate of 100% in all the treatments at day 120 ($P< 0.05$).
Key Words: White yam, Herbicides, Fertilizer, Dormancy period, Sprouting

Introduction

Yam ranks next to cassava as the most important tuber crop in the whole world in terms of production [1]. Over 600 species of yam have been reported [2]. White yam (*Dioscorea rotundata Poir),* water yam (*D. alata*), bitter yam (*D. dumetorum*), and yellow yam (*D. cayenesis*) are the predominantly cultivated yam varieties [3]. The highest concentration of yam production is the West African region but it is also produced in many parts of the world including Asia, Latin American and Caribbean countries like Colombia, Brazil, Haiti, Cuba and Jamaica, and in some parts of North Africa such as Ethiopia [4]. Nigeria is the world's largest producer of yams followed by Ghana, Cote d'Ivoire, Benin, Togo, Cameroon, Central African Republic, Chad, Columbia and Papua New Guinea [5]. It is regarded as the most nutritious of the tropical root crops [6]. Yam is an excellent source of carbohydrate (energy), minerals (such as phosphorus, calcium

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and iron), vitamins (A and C) and dietary fibre [7]. Yam is also a good source of protein. Yam production provides a great deal of finance to farmers since it stores relatively better than many tropical crops and as such, sold for good prices during the lean season. It is important in the local commerce in West Africa and accounts for about 32% of farm income [8]. Yam is again used as raw material for starch industries and pharmaceutical companies and provides employment for a great number of people [9]. The entire production, processing and marketing chain of yam offers vast employment opportunities for millions of people. The supply of yam creates prospects for income generation due to the number of people involved and the value attached to it. The marketing system of yam has a profound impact on sustainable food security [10]. In tropical Africa, yam cultivation and harvesting are seasonal. However, the consumption of the crop is normally spread over the whole year. Fresh yam tubers are stored to provide seeds for the next planting season, to reduce seasonal glut and to ensure extended availability [11, 12]. The storage of yam however is faced with numerous problems. During storage period, a substantial amount of yam is lost. Some of these losses are endogenous, i.e., physiological and include transpiration, respiration, and sprouting. Other losses are caused by exogenous factors like insects, nematodes, rodents, rot bacteria and fungi on the stored products [13]. The rate of tuber deterioration becomes faster at the expiration of the dormancy period of the tubers and onset of sprouting. Sprouting is the conversion of edible tuber material to inedible sprout and is considered a postharvest loss. Sprouting rapidly increases a tuber's respiration rates, and accelerates the rate at which its food value decreases [14]. The dormancy period of white yam varies from one variety to another. A dormancy period range of between 63 and 125 days has been reported. [15,16]. Investigation by Coursey [17] showed that while sprouting of yams stored in different regions of Nigeria was very variable, it could reach 100% after 4 months' storage. Termination of dormancy and initiation of sprouting is the main cause of postharvest loss of yam [18]. To reduce the effect of sprouting white yam tubers exhibit a period of reduced physiological activities referred to as dormancy period. The dormancy period can be defined as the period of reduced endogenous metabolic activity during which the tuber shows no intrinsic or bud growth, although it retains the potential for future growth. Dormancy is a physiological rest period without obvious external signs of physiological or biochemical activity. Dormancy in yam is an important adaptive mechanism that helps to maintain organoleptic quality during storage and also ensures that tubers germinate at the start of the growing season [19]. In research carried out by IITA it was discovered that among 286 D. rotundata accessions grown in the field and stored in a yam barn the duration from harvesting to sprouting ranges from 60 to 110 days, with the greatest number of accessions sprouting between 70 and 80 days after harvest [20]. It has been reported that dormancy of yam species is an adaption to the prevailing environmental conditions of the ecological zones of origin [21, 22]. Dioscorea species from the forest zone of West Africa, which has no discernible dry season, do not exhibit dormancy. In contrast, species such as D. elephantiphes from semi-desert regions have a very prolonged dormant period [23]. Dormancy period has also been reported to be affected by storage method. White yam stored under pit method has been reported to sprout in three months, marking the end of dormancy while those stored in a wooden box sprouted after four months. [24]. Dormancy of white yam also varies with cultivar and pre-storage treatment of tubers. A variation of 53 – 71 days among five cultivars of white yam treated with gibberellic acid and extracts of 5 botanicals has been reported [25]. Whereas dormancy is widely assumed to start at or shortly after tuber maturity and most studies begin measuring `dormancy time' from harvest, studies have shown that tubers are dormant from well before harvest. Tubers of four *D. rotundata* cultivars were harvested every seven days between 98 and 252 days after planting and the time of sprouting was recorded in a common storage environment. Tubers harvested after 98 days sprouted about 175 days after harvesting, whereas those harvested after 252 days sprouted within 14 days of harvest [26, 27]. The aim of this study is to assess the effect of insecticides, herbicides and fertilizer on the dormancy period of white yam tubers during storage.

Materials and Methods

The experimental design was a 3 by 3 factorial in a randomized pattern. A piece of land was selected in Gboko LGA (inside the school compound of Federal Government Girls' College Gboko) and used to raise a yam farm. Three varieties of white yam obtained from zones A, B and C of Benue State, namely; 'Faketsa', 'Mumuye' and 'Ogede' respectively were planted on the land. The planted yams were given three treatments. No chemical was used from pre-planting to harvest in the first treatment. This served as the control. Neither organic manure nor chemical fertiliser was applied. In the second treatment organic manure (poultry dung) was applied on the yams. Weeds control was by manual removal. In the third treatment, planting material was treated with an insecticide (Perfect Killer) by dipping each piece in a mixture of the chemical and water. Sarophosate, a foliar acting, systemic, non-selective post emergence herbicide, whose active ingredient is glyphosate (360g/l), was used to clear weeds during land preparation at a concentration of 200ml/15 litres of water. Another herbicide, Rakeout, with the same active ingredient was used after planting for weeds control. The first application of herbicide was done after 4 weeks of planting. NPK 15:15:15: fertiliser was applied. The yams from all the treatments were harvested at full maturity after 180 days when all the stems and leaves were totally dry. 20 sound tubers selected from each treatment were kept on wooden shelves in a well-ventilated zinc-roofed room for storage. The yams were inspected at 30 days interval and the number of sprouted tubers counted. The rate of sprouting was determined at 10 days interval as was done by Eze, S.C., (2011) using the ratio:

$$\text{Rate of sprouting} = \frac{\text{No of sprouted tubers}}{\text{Total no of tubers stored}} \times 100$$

Results and Discussion

Main Effect of Variety and Treatment on the Rate of Sprouting of White Yam in storage in Benue

The main effect of variety and treatment on the rate of sprouting is presented in Table 1. The result showed that there was no sprouting in any of the varieties at the end of 60 days in storage. By day 70 all the varieties and treatments started sprouting. The Faketsa treated with organic manure was the first to start sprouting followed by Mumjye and Ogede given the same treatment. Significantly higher sprouting rate was observed in Faketsa from day 70-100, while the highest sprouting rate of 100% was observed in Ogede at the end of 120 days ($P < 0.05$). **By** day 100 all the Faketsa tubers that had not rotted sprouted. Statistical analysis of the main effect of treatment on the rate of sprouting showed higher rate in the Control group compared to the organic manure group from day 70 – 90. Higher rates were however observed in the organic manure group from day 100 – 120 days. No significant difference was however observed compared to the Control group from day 100 – 120 ($P > 0.05$). The interaction effect between variety and treatment on the rate of sprouting of white yam at harvest in Benue State is presented in Table 2. The result showed higher sprouting rates in the Faketsa variety from day 70 – 100 in all the treatments ($P < 0.05$). In the Mumuye variety all the treatments showed equal rate of sprouting at the initial stage but the chemical treatment group showed faster sprouting rate thereafter and by 120 days all the viable tubers sprouted. In Ogede variety both the chemical and organic manure treatment showed the same rate of sprouting and also recorded the highest sprouting rate of 100% in all the treatments at day 120 ($P< 0.05$).

Table1. Main Effect of Variety and Treatment on the Rate of Sprouting of White Yam

Variety	**Rate of sprouting (%) in days**						
	60	70	80	90	100	110	120
Faketsa	0.00±0.00	10.17±4.71	57.50±9.87	78.67±6.83	88.33±6.83	93.33±2.58[d]	93.33±2.58
Mumnye	0.00±0.00	3.33±2.58	8.67±5.71	28.17±6.79	51.67±18.62	70.83±12.81	85.00±4.47
Ogede	0.00±0.00	5.00±0.000	23.33±5.16	43.00±5.48	75.67±8.55	93.50±2.74[d]	100.00±0.00
FLSD (0.05)	**0.000**	**0.844**	**12.667**	**13.010**	**10.666**	**11.550**	**NS**
Treatment							
Organic manure	0.00±0.00	6.67±2.58[a]	32.83±23.11[b]	49.83±24.05	65.33±26.85	80.00±19.49	91.67±9.31
Chemical	0.00±0.00	5.00±0.00	23.33±18.07	49.67±19.71	77.00±2.45	89.33±6.06[c]	93.33±5.11
Control	0.00±0.00	6.83±7.08[a]	33.33±26.96[b]	50.33±27.29	73.33±22.06	88.33±10.33[c]	93.33±6.80
FLSD (0.05)	**0.000**	**1.500**	**8.560**	**NS**	**3.000**	**6.330**	**NS**

*Values are Mean ± Standard deviation in duplicates. Mean values with similar alphabets are not significant. NS = No significant difference. FLSD = Fisher's Least Significant Difference

Table 2. Interaction Effect between Variety and Treatment on the rate of sprouting of White Yam in Benue State

Treatment	Variety	Rate of sprouting (%) in days						
		60	70	80	90	100	110	120
Organic manure	Faketsa	0.00± 0.00	10.00 ±0.00	62.50± 3.54	80.00± 7.07	45.00± 0.00	95.00± 0.00	95.00± 0.00
	Mumnye	0.00± 0.00	5.00± 0.00[a]	16.00± 1.41	29.50± 0.71	35.00± 0.00	55.00± 0.00	80.00± 0.00
	Ogede	0.00± 0.00	5.00± 0.00[a]	20.00± 0.00	40.00± 0.00	66.00± 1.41	90.00± 0.00	100.00 ±0.00
Chemical	Faketsa	0.00± 0.00	5.00± 0.00[b]	45.00± 0.00	75.00± 0.00	80.00± 0.00	90.00± 0.00	90.00± 0.00[f]
	Mumnye	0.00± 0.00	5.00± 0.00[b]	5.00±0. 00	35.00± 0.00[c]	75.00± 0.00[d]	82.50± 3.54	90.00± 0.00[f]
	Ogede	0.00± 0.00	5.00± 0.00[b]	20.00± 0.00	39.00± 1.41[c]	76.00± 1.41[d]	95.50± 0.71	100.00 ±0.00
Chemical	Faketsa	0.00± 0.00	15.50 ±0.71	65.00± 0.00	81.00± 1.41	90.00± 0.00	95.00± 0.00[e]	95.00± 0.00
	Mumnye	0.00± 0.00	0.00± 0.00	5.00±0. 00	20.00± 0.00	45.00± 0.00	75.00± 0.00	85.00± 0.00
	Ogede	0.00± 0.00	5.00± 0.00	30.00± 0.00	50.00± 0.00	85.00± 0.00	95.00± 0.00[e]	100.00 ±0.00
FLSD (0.05)		**0.000**	**4.996**	**10.000**	**6.000**	**13.000**	**4.000**	**4.445**

*Values are Mean ± Standard deviation in duplicates.

Mean values with similar alphabets are not significant.

FLSD = Fisher's Least Significant Difference

Conclusion

It can be concluded from the results of the investigation that varieties of white yam produced in Benue state, Nigeria and harvested at full maturity after180 days of planting, have a dormancy period of between 70 – 120 days when stored on shelves in a well-ventilated zinc-roofed house. This finding is in agreement with other researchers who have reported a similar range of 63 – 120 days [1, 15, 16]. Result of the experiment has also shown that use of insecticides, herbicides and fertilizer during the production stage has no significant effect on the dormancy period and rate of sprouting of white yam varieties. There is however slight variation in the rate of sprouting among the varieties. Further work is however recommended in the aspect of applying different types and quantities of these chemicals and fertilizers on the same varieties of white yam.

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