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RADIATION SENSITIVITY TEST IN YAM, A STEP IN YAM IMPROVEMENT THROUGH MUTATION

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ABSTRACT

In an attempt to establish the dose range of gamma rays that will give high frequency of beneficial mutations in *Dioscorea rotundata,* batches of micro-tubers of D. rotundata var. "Obiaoturugo" were exposed to gamma rays at doses ranging from 0 - 90gray (Gy).

High gamma ray doses tended to inhibit sprouting in setts from both the head and tail regions of yam tubers. However, the effects were more severe on setts isolated from the tail, region than those from the head region, indicating that the tail region is more radiation sensitive than the head region.

Vine length, number of nodes and number of leaves per stand decreased with increase in doses of gamma rays on stands from both the tail and head regions of treated yam tubers. The dose limitation range for the improvement of yams by mutation induction has established between 20 - 40Gy for the variety under study.

INTRODUCTION

The white guinea yam, *Dioscorea rotundata* is native to West Africa and among the genus, *Dioscorea,* it is the most widely cultivated species (Onwueme, 1978). Yields in yam as in the other root and stem tuber crops in West Africa are generally low (Okigbo, 1987). The high cost of production and low productivity have been attributed to several factors among which high labour input has received special mention. Studies conducted at the National Root Crops Research Institute, Umudike has shown that staking yam vines alone account for more than 23% of the cost input in yam production coming next to the cost of planting materials which accounts for more than 33% (Anon, 1987).

Onweme, (1978) advanced that the ultimate aim in yam production is to develop a system in which staking in yams would be eliminated. It is believed that yams were originally small herbaceous plants that evolved twining stems (Ammirato, 1984). During speciation, this climbing habit offered the species a better chance to reach the sunlight in the forest. Therefore, the gene for effective bushy growth may still be latent in yams. Abraham, *et al* (1989) reported the isolation of a dwarf, non-climbing yam type from seedlings of white guinea yam, *Dioscorea rotundata* poir in 1982. However, the white guinea yam is a difficult plant for genetic manipulation considering that it is a polyploid (Ene, 1977), highly heterozygous and progenies form any successful crosses segregate widely. Low and inconsistent flowering, poor fruit and seed set militate against hybridization. Mutation inducement offers a useful apprroach to generting variants for breeding. Useful crop mutants both for yield and dwarfism have been developed using induced mutations, (Wang, 1991 and Awan, 1991).

This study is aimed at establishing the dose range of gamma radiation that will give high frequency of beneficial mutations, and to mass irradiate micro-tubers of yam using the established gamma doses, and screen mutants for useful types.

MATERIALS AND METHOD

Batches of micro-tubers of *Dioscorea rotundata,* var. "Obiaoturugo" numbering three hundred (300) each were irradiated with gamma rays at doses, 0,10,20,30,40, and 50 Gray (Gy) during the 1990 cropping season, using cobalt 60 (co 60) gamma source at the National Institute for Trypanomiasis Research, Vom, Plateau state. Similar dose range has been established for *in vitro* yam plantlets (Mbanaso, 1988).

Each irradiated tuber was divided into 10g setts, separating head from tail region. The setts were dusted thinly with minisett dust, (an antifungal, antibacterial and insecticidal mixture) and pre-sprouted in heat sterilized top-soil in nursery trays before transplanting to the field, three weeks after planting when majority of the setts have shown signs of sprouting.

The trial was repeated in 1991 extending the dose range to 90Gy, since observations showed some percentage survival at 50Gy.

Setts from the head region were planted separately from those of the tail region in rows. Each row was made up of materials from a dosage level. The sprouts were staked singly to facilitate observation on individual plants. Weeding was done when necessary.

Data were collected 12 weeks after planting when vegetative growth had peaked (Onwueme, 1978), on the vine length, number of leaves, nodes and number of vine branches per stand,
and number of sprouts per stand. The total number of setts planted.

and the number that sprouted and were transplanted were also recorded.

RESULTS AND DISCUSSION

Higher doses of gamma radiation tended to inhibit sprouting in white guinea, *D. rotundata*, poir, (Table 1). The results showed that increase in dose resulted in decreased percentage survival. This effect was more severe in setts isolated from the tail region than those from the head region indicating that the tail region is more radiation sensitive than the head region.

The number of nodes, leaves and vine lengths per stand decreased with increase in dosage in both setts from tail and the head regions (Table 2). From fig. 2, representing the effects of gamma rediation on the vine length, expressed as percentage of control, LD50 and GR50 were obtained at 20GY and 40GY respectively. There was complete Inhibition of sprouting (100% lethality) at doses higher than 60GY.

Mutagens result in physiological damage, factor mutation, (sometimes referred to as point or gene mutations) and chromosome mutations. However, physiological damages are easily measured in the M_1 generation than gene and chromosome mutations and therefore are used extensively in establishing dose limitation range for mutation breeding (Gaul, 1977). For practical purposes the most important effects of irradiation are growth reduction and death. Broertjes (1977) stated that there is a relationship between physiological damage and mutation frequency and generally, mutation frequency increases with inceasing dose, whereas survival capacity decrease with increasing dose. In establishing dose limitation range for any crop, one must choose a range between a low dose with higher survival but lower mutation frequency, and high dose with higher mutation frequency but lower survival. Based on this premise, the dose limitation is 20 - 40GY. LD50 was obtained at 20GY and GR50 was obtained at 40GY. Brunner (1985) stated that for mutation induction, the mutagen dose must allow survival of about 40 - 60% and or a retardation in growth of about 50%.

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Table 1: The effect of doses of gamma irradiation on sprouting and survival of setts isolated from the head and tail regions of yam tubers.

Gamma ray dose (GY)	Total No. Setts planted	No. Setted sprouted transplanted	Percentage No. sprouted (%)	Lettality (%) ++
Tail region setts				
0	839	587	70	-
10	457	198	43	38.6
20	1012	264	26	62.9
30	799	121	15	78.6
40	503	66	13	81.4
50	684	17	3	95.7
Head region setts				
0	327	299	91	-
10	222	180	81	11.0
20	264	185	70	23.1
30	258	121	47	48.3
40	270	133	49	46.1
50	269	51	19	79.1

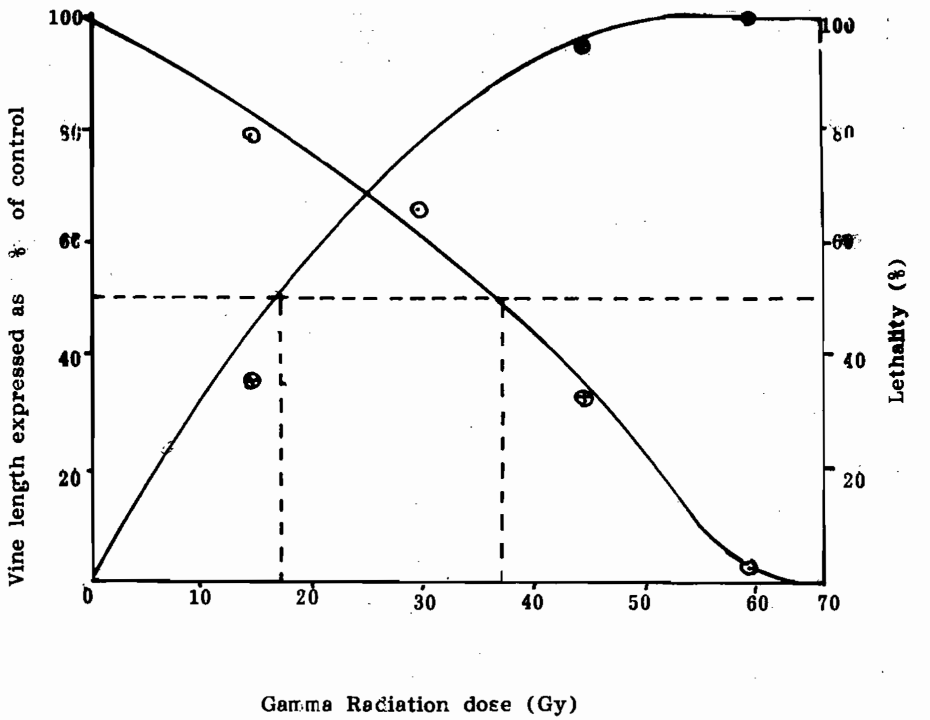
++ Relative survivial (Rs) = $\frac{\text{No. sprouted treated setts}}{\text{No. sprouted untreated setts}} \times 100$

% lethality (L) = 100 - Rs.

Table 2: The effect of gamma ray dose on average vine length, number of nodes and number of leaves of yam setts from the head and tail region.

Gamma ray dose (GY)	Vine length (cm)	Number of Nodes	Number of leaves
Tail region			
0	44.9	30.4	31.1
10	36.9	27.4	27.0
20	28.1	24.4	22.6
30	26.5	24.4	15 0
40	20.5	16.4	14.7
50	-	-	-
Head region setts			
0	65.8	48.3	43.9
10	58.3	42.0	88.1
20	41.7	35.9	32.1
30	37.2	23.3	25.1
40	35.1	26.0	22.8
50	24.2	23.3	20.2

+ No sprouts produced.



⊕ .... Lethality %

⊙ .... %Vine length of control

Fig 1 The effect of gamma radiation dose on the % length of control and lethality (%) of irradiated yam tubers,

CONCLUSION

The dose limitation range for the improvement of yams by mutation induction . has been established between 20 - 40GY for the variety under consideration. This radiation sensitivity dose range will be utilized in our yam improvement programme (by mutation inductions) for improved plant architecture (vines that will not require staking for high yield), improved yield, high dry matter and starch content.

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