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Analytical study of cow dung and poultry manure on survival and health performance of plantain genotypes in macropropagation acclimatization process

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ABSTRACT:

Macropropagation of plantain is not complete until successful acclimatization of generated plants with environment is achieved. After detaching plantlets from mother corm, high percentage of plantlets is usually lost during acclimatization due to shock and environmental change. Hence, the need for study on the efficient means of introducing generated plantlets to the field. This study of cow dung and poultry droppings as manure source was done using 3 different plantain genotypes ('Atagafong', 'Nble paul' and 'Owom'). The physicochemical properties of the substrates and the growth performance of the 3 plantain species were analyzed. Nine (9) replicates each of the genotypes were potted in top soil (TS) which served as control, substrate with cow dung (CT) and substrate with poultry dropping (PT) on ratio of 2:1 for top soil and manure. The result from acclimatization of plantain species revealed that in CT, 11% died while 89% survived and were healthy in 'Nble paul', 78% survive and were healthy in 'Atagafong' but 22% survive and were unhealthy while in 'Owom', 11% died, 11% survived but unhealthy and 78% survive and were healthy. In poultry dropping all 100% of the 3 genotypes died within 2 weeks. However, in soil, 56% of 'Nble paul', 33% of 'Atagafong' and 44% of 'Owom' genotype died, 33% each of 'Nble paul' and 'Atagafong' survived and 11% of 'Owom' was unhealthy, while 11% of 'Nble paul', 33% of 'Atagafong' and 44% of 'Owom' survived and were healthy. No significant difference at5% probability level was observed across the survivability of plantlets in substrates. This study revealed among the manures worked on, cow dung is better for plantain plantlets' acclimatization.

Keywords: poultry dropping, physicochemical properties, plantain plantlets

INTRODUCTION

Over the decades, a changing climate, growing global population, rising food prices and environmental stresses have had significantly high impacts on global food security [1]. The productivity of crops and livestock has declined because of insufficient land, insufficient farmers, diseases outbreak, unavailability of farming aids, high temperature and drought-related stress

resulting from ozone layer depletion. Food, the most basic of all human survival needs should be adequately produced to offset hunger among pregnant women and children.Hunger in childhood and pregnancy has many adverse consequences for child survival and long-term well-being, hence, should be alleviated from the society. Nigeria is giant of Africa with its economy rated largest in 2014, yet the poverty rate in the country is alarming [2]. Food insecurity prevalence in the low income urban house-holds and rural areas respectively stands at 79% and 71% [3]. This calls for need to produce large and different varieties of food to curb hunger and malnutrition, thereby, enhancing our food security.

Plantain is one of the major foods in Nigeria and source of income for both private and commercial farmers. However, the productivity and lifespan of plantain fields have drastically reduced due to global warming, pest and disease pressure [4]. He also attributed the reduction in plantain production to dependence of farmers on natural regeneration of plants for the supply of planting materials, which are contaminated by pests and diseases. Population growth and the consequent demand for more food have encouraged the search for innovative methods of production that can obtain higher sustainable yields. High plant density can significantly increase yield per unit area. To offset the challenges of diseases and pest, plantain can now be propagated aseptically in the laboratory through tissue culture techniques and also through macro propagation.

Macro propagation, as described by [5], has the potential to produce 50-60 shoots per sucker in 4-5 months and eliminates all sucker-transmitted pests and diseases, with the exception of viruses [6]. This process allows for rapid multiplication of suckers that can be successfully transferred to the farmer for large scale cultivation. This can help in mass production of plantain that can help in providing enough food for the populace. But the survival of plantlets after being detached from the corm is not certain due to its exposure to shock. As a result, a lot of plantlets die, leaving the farmer with huge loss. Hence, there is need for extensive research on protocol through which we can reduce plant loss, as this will help provide enough planting materials for both commercial and subsistence farmers. Therefore the aim of this research was to determine the effectiveness of cow dung and poultry manure as potting mixture during acclimatization of plantain.

METHODOLOGY

Macropropagation process

Three genotypes of plantain suckers ('Nble paul','Atagafong'and 'Owom') were gotten from Ebonyi State University *Musa* germplasm. The suckers were peeled to remove roots and the pseudostems were cut off 6 inches above the corm. The corms were thoroughly washed with clean running water to remove adhering soil and plant debris. Using sharp kitchen knife, the meristem was properly exposed after removing the leave sheet. Then an opening was made at the centre of the stem to arrest the meristem. Sterilization was carried out using a solution of Jik and water (250ml Jik per 0.015 m^3 of water) and the peeled corms were soaked in the solution for 20 minutes in order to achieve surface sterilization. The saw dust used as substrate for macro propagation was steam sterilized for 2 hours and allowed to cool for 1 day before it was transferred using sterilized shovel to fill up the wooden propagator which measured 60" × 20" ×15" for length, width and height respectively. Suckers were then initiated into the sterilized substrate and allowed to grow in the green house where they were irrigated twice weekly using 0.012 m^3 of water

per propagator to avoid water logging. Detaching of shoots with minimum of three leaves was done after three weeks and subsequent weeks.

Substrate Preparation for Acclimatization

The **t**hree substrates used were top soil (soil or TS) which served as control, cow dung mixed with top soil (cow dung or CT) and poultry manure mixed with top soil (poultry dropping or PT). Substrates were prepared using top soil and manures under the ratio of 2:1 for soil and any of the manures. Each substrate was potted in 27nylon bags, being 9 substrate bags for one genotype which served as replicates, and irrigation carried out at 4 days interval. The nylon bags were cut open at the base to facilitate drainage.

Determination of Features Of Substrates

The water holding capacity was determined using the method described by Soil Testing Procedure Manual (2008). Bulk density of the substrates was determined using the method described by [7]. To determine moisture content, oven-drying which is the standard method was adopted. The pH of all substrates were examined using the method described by [8]. In determination of electrical conductivity of substrates, method described by [9] was employed. Determination of organic carbon was carried out following rapid titration method [10]. For nitrogen content of substrates, alkaline permanganate method was adopted [11]

Statistical Analysis

Analysis of variance (ANOVA) and Least Significance Difference (LSD) analysis was carried out with the help of statistical software SPSS version 20. The significant difference among the plantain genotypes and different substrates was assessed at $P < 0.05$.Records were taken by grouping the replicates per genotype per substrates into survived but unhealthy, survived and unhealthy and dead plants.

RESULTS

The result in Table revealed the properties of the growth substrate used in the propagation of the different plantain species used in this study. The result revealed that TSwas more acidic with pH of 6.57 followed byCT with pH of 6.95 while PT was basic. very high electric conductivity (EC) of 265 N/cm^3 was observed in PC, and 20 N/cm^3 for both TS and CT while very high water holding capacity (255.56) was observed in PT. PT contained very high nitogen (6412.601kg/ha), organic matter (2.129g/cm^3) and organic carbon (1.235%)

The result of survivability and health performance of the plantlets on different substrates as shown in Figure 1 revealed that in CT, among nine replicates per genotype used, one (1)replicate of 'Nble paul' and 'Owom' died while none died in 'Atagafong'. In PT, all replicates per genotype ('Nble paul', 'Atagafong' and 'Owom') died giving rise to zero per cent survival across genotypes. In TS, 5, 3 and 4 plantlets died from 'Nblepaul', 'Atagafong' and 'Owom' respectively.

Genotypes pictorial response to different substrates after two weeks shows that none of the genotypes survived on PT substrate while genotypes on CT had highest survival and development.The ANOVA result revealed that there was significant difference between the genotypes and across the substrate used at $P = 0.05$.

DISCUSSION

The result of the properties of the different substrates used in the acclimatization of the three different species of plantain showed that the pH of the substrate with cow dung and soil substrate were 6.95 and 6.57 respectively (Table) which is slightly acidic but substrate with poultry

dropping was slightly basic with pH 7.63 and should have contributed to the death of the entire replicates as observed in Figure 2e above. This corresponds to the work of [12] which reported that plantains grow optimally in a substrate with a pH scaling 5.5 to 7.0 as seen in Figure 2(a – d) . Therefore, substrate mixed with poultry dropping would not have supported the survival of the plantain genotypes since it is basic. The electric conductivity (EC) content of poultry dropping was 266 N/cm^3 but 20 N/cm^3 for both cow dung substrate and the control (soil) respectively (Table). It has been reported that banana and plantains are very sensitive to salinity and substrates with an EC of less than 300 N/cm^3 are required for good growth [13] as observed in CT and TS. According to [14], Water holding capacity is described as the percent of the entire volume of the medium that is filled with water after processes of irrigation and drainage. According to [15], a humidity that is not below 60% is preferable but plantain can be grown on a wide range of substrates provided those substrates are deep, well-drained loams with a high water holding capacity and humus content. Although, PT substrate had the highest water holding capacity (255.56), CT substrate which had 50.062 water holding capacity supported better survival of the plantain suckers. This suggests that the optimal water requirement may be at this level.

The Nitrogen content of poutry dropping substrate was 6412.601 kg/ha, 272.89 kg/ha for cow dung and 382.089 kg/ha for soil. Nitrogen (N) is an essential macronutrient that is deficient in most soils [16] and is an important component of many structural, genetic and metabolic compounds in plants [17]; [18]. As reported by [19], Nitrogen affects carbon partitioning and improves accumulation of soluble sugars, especially starch which in turn improve leaf growth. However, [20] observed reduction in leaf production, individual leaf area and total leaf area under N deficient conditions. Also, in a recent study, it was observed that two plantain genotypes maintained their best growth where N was applied at 200 kg/ha [3]. But high level of N in poultry droppings may have contributed to the failure of plants introduced to them as [5] suggested lower N fertilization regimes between 50 and 100 kgha^{-1} as the optimum for production of plant. Excessive applications of N may decrease the concentration and toxicity of phenols used by plants against invading pathogens (Rubio-Covarrubias, 2005), hence, resulting to the death of entire replicates from all the genotypes as observed in Figure 1 and Figure 2e.

CONCLUSION

The work has shown that CT substrate is a very good potting mixture in acclimatization process of plantain macro propagation. This could be attributed to its favourable pH range, nitrogen, phosphorus and water holding capacity among others. The high nitrogen content of PT combined with other unfavourable traits made it an unsuitable potting material for acclimatization process in macro propagation of plantain.

RECOMMENDATION

CT should be adopted for weaning of plantain shoots generated from macro propagation especially in Africa where food scarcity, food insecurity, hunger and starvation, poverty among others are becoming endemic. However, further research should be initiated on poultry dropping to know the suitable ratio that will be favourable to macro propagated plants.

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Table: 1 Properties of potting materials used for acclimatization

Parameters	Poultry droppings and top soil (PT)	Cow dung and top soil (CT)	Top Soil (TS)
pH**	7.63±0.05	6.95±0.05	6.57±0.05
EC N/cm^{3**}	265±5	20±0.5^{a}	20±0.5^{a}
Bulk Density (g/cm^{3})	1.042±0.05	1.02±0.02	1.6±0.5
Porosity (%)**	60.68±0.05	61.509±0.05	39.623±0.05
Moisture (%)**	5.92±0.05	14.5±0.05	8.92±0.04
Water Holding capacity**	255.56±0.05	50.062±0.05	48.927±0.05
Nitrogen (kg/ha)**	6412.601±0.05	272.89±0.09	382.089±0.02
Phosphorus (kg/ha)**	14.8±0.05	19.208±0.05	18.528±0.05
Organic matter (g/cm^{3})**	2.129±0.05	1.224±0.01^{a}	1.276±0.05^{a}
Organic Carbon (%)*	1.235±0.01	0.71±0.03^{a}	0.74±0.02^{a}

Result shows Mean±SD. Significance determined at $P < 0.05$. Means with the same subscript on the same row are not significantly different. * = significant; ** = highly significant

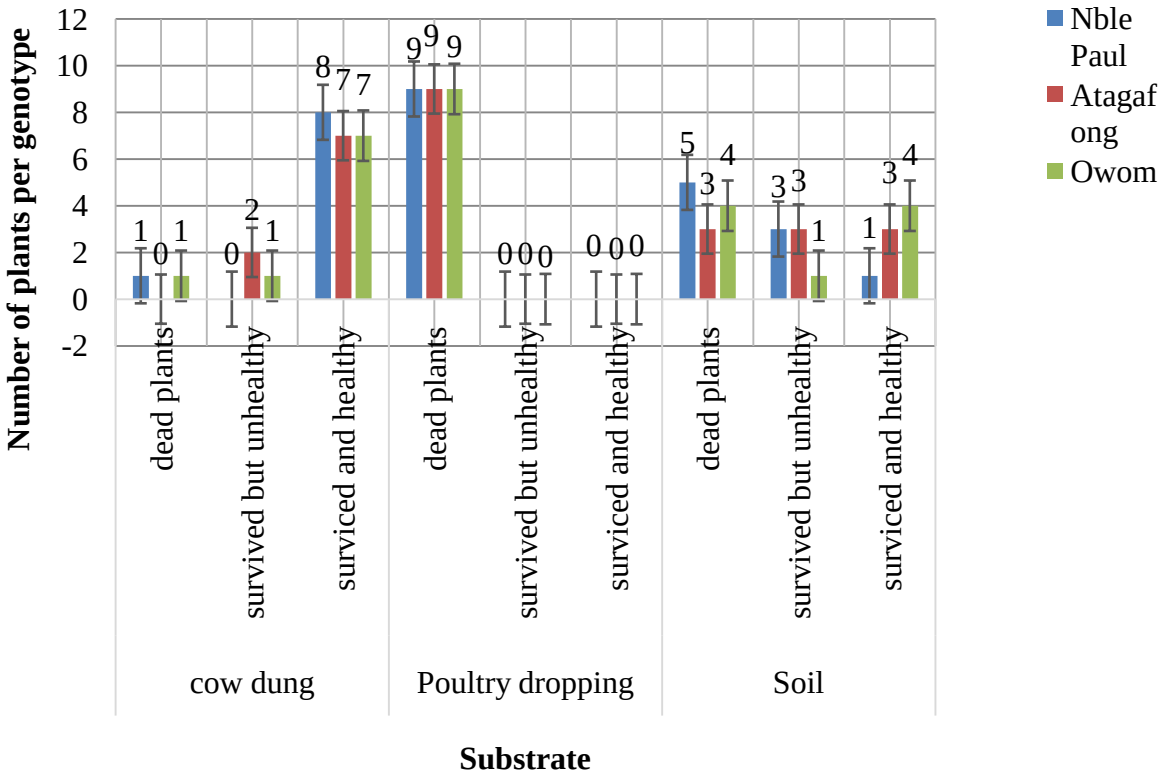

Figure 1: survivability and health performance of the plantain genotypes on the different substrates.

a 

b 

c. 

d. 

e. 

Figure 2. Pictorial view of plantlets survival and development after two weeks;a. Three genotypes acclimatized on top soil. b. 'Atagafong' acclimatized on cow dung.c. 'Nble paul'acclimatized on cow dung. d. 'Owom' acclimatized on cow dung. e. Genotypes acclimatized on poultry dropping.