ISSN NO. 2320-5407

*Journal homepage: http://www.journalijar.com*

*INTERNATIONAL JOURNAL OF ADVANCED RESEARCH*

**RESEARCH ARTICLE**

# INTER- RELATIONSHIPS AMONG THE GROWTH AND YIELD PARAMETERS OF IRISH POTATO (SOLANUM TUBEROSUM L.): CORRELATION/REGRESSION ANALYSES.

**KAREEM, I. A**
Dept. of Plant Science and Biotechnology, Adekunle Ajasin University,
Akungba,Western Nigeria (formerly at the Federal College of Forestry, Jos Plateau, Nigeria)

## *Manuscript Info*

***Manuscript History:***

Received: 23 March 2014
Final Accepted: 25 April 2014
Published Online: May 2014

***Key words:***
agroforestry, potato, growth /yield parameters, correlation/regression analysis

***Corresponding Author***

**KAREEM, I. A**

## *Abstract*

An agroforestry experiment was conducted to investigate the interplay of the apparent growth parameters of Irish potato (Solanum tuberosum L.) and their relationships with yield. It was a 3 – year study consisting of 5 treatments (and 3 replicates) in a randomized complete block design. Both rainfed and irrigated cropping seasons were involved, sprouted potato tubers were planted in the alleys (space between rows of trees) of Albizia lebbeck (rattled tree) and the green manure of the rattle tree was applied at various levels. Results from the correlation / regression analyses indicated positive correlation between the independent variables (collar girth, number of leaves and plant height) with the dependent variable (yield) while stem count had a negative correlation with yield. Very importantly, leaf count (number of leaves) and collar girth were the two determinants of this Irish potato (bertita variety) yield. These two independent variables accounted for 61.6 – 91.3% variation in yield ($R^2$ = 0.616 – 0.913).



## 1.0 INTRODUCTION

1.1 Agroforestry

Agroforestry is a form of multiple land use system which involves the production of both perennial forest tree crops, annual (agronomic) crops and animals ( in some cases) on the same land management unit either simultaneously or sequentially (Kareem, 2008). The international council for Research in Agroforestry (ICRAF, 1983) defined agroforestry as a collective name for land use systems and practices where woody perennials (trees, shrubs, palms, bamboos, etc) are deliberately used on the same land management unit as agricultural crops and / or animals, either in some form of spatial arrangement or temporal sequence. In agroforestry systems, there are both ecological and economic interactions between the different components. The main components of agroforestry systems are multipurpose trees (mostly woody perennial nitrogen fixing legumes), herb (agronomic / annual / pasture plants) and animal (livestock which may not be present always or at once)**.**

Albizia lebbeck L. Benth (rattle tree) The rattle tree was said to have originated from India and also native to Bangladeshi, Burma, Pakistan and the Andanman Aslands (Prinsen, 1986). This tree had also naturalized in many tropical and sub-tropical regions of the world such as North Africa, the West Indies, South America and South East Asia (Streets, 1962). It competes reasonably with Leucaena and Gliricidia especially in the areas of nodulation, nitrogen fixation and supply of green manure (Kadiata et..al.,1986; NFTA, 1988; Parrota, 1988). It is medium sized tree and very prolific interns of seed production and can be propagated by seeds, stem and root cuttings with vigorous growth rate (NFTA, 1988; Kareem et.al., 2005a & b).

Solanum tubersum L.(Irish potato) was said to have originated from the Altiplano around the Lake Titicaca at an attitude of about 300m in the Bolivian Andes (Burton, 1966; Kay, 1987). It was also reported that Irish potato

originated from South America and that it was introduced into Nigeria in the later part of 19th century and early 20th century by the Europeans notably tin miners in Jos Plateau and the Germans in Cameroom (Stanton 1960; Ifenkwe, 1981). It belongs to the family Solanaceae, a herb with free branching pattern, leaves alternate, pinnately compound and spirally arranged on the stem with midrib and many leaflets and 30 – 100 cm in height (Huaman, 1986; Kay, 1987).

Green manure in this medium refers to the fresh leaves of multipurpose tree species (for example, A. lebbeck) that are added to the soil to improve its fertility. . It inrceases the level of effective cation exchange capacity (ECEC) coupled with improved soil structure (Kang, 1993). It could bring about profound efficiency of P (Hue,1992) and increase plants' P and K concentrations thereby improving corn yield (Hunter et al.,1995).Young (1985) observed that it decreases nutrient loss due to leaching.

### 1.2 Interrelationships between Growth Parameters and Yield

More often than not, it is desirable or even imperative to assess the nature and strength of the relationship between pairs of variables in a particular study / experiment. Examples are plant height versus yield, number of leaves versus yield, number of stems versus yield and collar girth versus yield (paired variables). Potato farmers / producers need to know the determinants of potato yield so as to guide against any loophole / error in the cause of production. For instance, a potato producer may want to know if many stems per stand lead to higher yield or fewer stems bring about fewer and larger tubers and thus higher yield. Therefore, it is necessary to employ correlation / regression analyses (as statistical tools) to test or assess the strength of relationship. This could be simple bivariate, multivariate / multiple correlation / regression analyses. Multiple correlation analysis is often employed in order to examine the inter-relationships among sets of variables, identify spurious correlation among variables and make known the intervening or suppressing variables (Blalock, 1971; Oche, 1992). Thus, multiple correlation analysis enables one to handle more than two independent variables at a time. The degree of association between the variables or the goodness of fit of a prescribed relationship to the data at hand can be measured by employing correlation / regression analyses (Gomez and Gome,1984; Adesoye, 2004).

## 2.0 Materials and Method

### 2.1 The Study Area

The study was carried out in the Federal College of Forestry (opposite University of Jos) Bauchi Road, Jos, Plateau State, Nigeria .The Jos Plateau lies between latitude $8^0\ 50^1$N and $10^0\ 10^1$N and longitude $8^0\ 22^1$E and $9^0\ 30^1$E (Udo, 1978). The average elevation is about 1250 meters above sea level while its height above the surrounding plains is about 600 m and the highest point is about 1777 meters above mean sea level.

### 2.2 Method

The experimental design was randomized complete block design (RCBD) consisting of five (5) treatments and three (3) replicates. A table of random numbers was employed in assigning treatments to each block. The five treatments used are as follows:

$T_o$ : Potato planted on flat bed without tree rows and green manure of A. lebbeck.
$T_1$ : Potato planted in the alleys of A. lebbeck without green manure.
$T_2$ : Potato planted with green manure of A. lebbeck at 5 ton $ha^{-1}$ without its tree rows.
$T_3$ : Potato planted in alleys of A. lebbeck tree rows with its green manure at 5 ton $ha^{-}$
$T_4$ : Potato planted in alleys of A. lebbeck tree rows with its green manure at 10 ton $ha^{-1}$

Each plot/replicate in a block was 3m x 2m, the green manure was single application on soil surface two weeks before planting the pre - sprouted potato tubers (bertita variety). A. lebbeck tree seedlings had early been raised prior to planting (seedlings were 6 months old before planting (0.60m and 2.0m within and between rows respectively) .All necessary tending operations were carried out. Analysis of variance (ANOVA) was employed in analyzing the data collected on the apparent growth parameters (plant height, number of leaves, stem count, collar girth) and yield parameters (tuber count and tuber weight) in order to find out if there were significant differences among treatments and blocks with regard to the growth and yield parameters mentioned above. Duncan's Multiple Range Test (DMRT) was used where significant differences were recorded in separating the mean values of the variables so as to help in giving appropriate recommendations. The analyses were carried out by employing statistical analysis software (SAS) package. Also, the interplay

of the growth parameters and their relationships with the crop (potato) yield were examined by employing simple / bivariate, multiple correlation and regression analyses (SPSS 11.0 package).

## 3.0 RESULTS

### 3.1 Plant Height, Leaf Count, Collar Girth and Stem Count

There was a significant effect of different treatments on plant height at 63 DAP (Day After Planting) throughout the five cropping seasons (CSs). At cropping season (CS) 1, 3 and 5 (all rainfed) T4 had the highest mean value of 66.3, 75.3 and 82.3 cm respectively (Table 1) while CS2 and CS4 (irrigated) recorded 68.3 cm and 80.7cm respectively in all the seasons. However, no block effect was observed among the cropping seasons (CSs).The treatments applied brought about some significant effects on the leaf count. The maximum leaf count was observed in $T_4$ in CS1, CS2, CS3, CS4 and CS5 with mean values of 56.7, 68.3, 70.3, 77.7 and 78.7 respectively. Next to $T_4$ was $T_2$ in CS1, CS2 and CS5 only but in CS3 and CS4 $T_3$ was next to $T_4$ (Table 1).

The stem count was not significantly affected by the different treatments applied. The highest mean main stem count in CS1was recorded in T0 (3.0) while those of CS2, was observed in T2 and T4 (3.0). In C3, T0, T1 and T2 had the highest mean stem count (3.0 each). The highest value (of mean stem count) was observed in T0 and T1 in the CS4 (3.0 each) while T0, T1 and T3 had the value of 2.7 (each) at CS5 (Table 2).During the five cropping seasons, collar girth of the potato crops was significantly affected by the treatments (P=0.01). Also, ANOVA showed significant effect of season and treatment x season on the variable (P = 0.01). However, no block effect was observed in the CS1. T4 had the maximum collar girth of 4.5 cm. The same trend was recorded in CS2, CS3, CS4 and CS5 where T4 had 4.70, 4.90, 5.30 and 5.33 respectively (Table 2).

### 3.2 Tuber Count and Tuber Yield

Tuber count was significantly influenced by the treatments during the 3-year study, in CS1, CS3 (at P=0.01) and CS5 (at P=0.05). There was no significant effect of the treatments on the variable in CS2 and CS4 (dry seasons) due to the fact that the values in CS2 and CS4 almost the same (160.7

**Table 1: Plant height (cm) and leaf count of Irish potato from five cropping seasons (63 DAP)**

| Treatments | Cropping Seasons (CS) 2004-2006 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2* | | 3 | | 4* | | 5 | |
| | Plant ht | Leaf count | Plant ht | Leaf count | Plant ht | Leaf count | Plant ht | Leaf count | Plant ht | Leaf count |
| $T_0$ | 46 | 25 | 46 | 28 | 62 | 36 | 62 | 47 | 64 | 46 |
| | 45 | 24 | 48 | 31 | 63 | 39 | 69 | 44 | 60 | 43 |
| _ | 43 | 25 | 50 | 31 | 61 | 35 | 63 | 41 | 67 | 49 |
| x | 44.7 | 24.7 | 48.0 | 30.0 | 62.0 | 36.7 | 64.7 | 44.0 | 63.7 | 46.0 |
| S.D | 1.25 | 0.47 | 1.63 | 1.41 | 0.82 | 1.70 | 3.09 | 2.45 | 2.87 | 2.45 |
| $T_1$ | 50 | 27 | 54 | 34 | 63 | 50 | 69 | 60 | 71 | 70 |
| | 52 | 26 | 55 | 36 | 65 | 54 | 72 | 59 | 68 | 72 |
| _ | 52 | 28 | 58 | 35 | 67 | 53 | 70 | 61 | 73 | 75 |
| x | 51.3 | 27.0 | 55.7 | 35.0 | 65.0 | 52.3 | 70.3 | 60.0 | 70.7 | 72.3 |
| S.D | 0.94 | 0.82 | 1.70 | 0.80 | 1.63 | 1.70 | 1.25 | 0.82 | 2.06 | 2.06 |
| $T_2$ | 54 | 41 | 60 | 49 | 66 | 63 | 76 | 65 | 79 | 70 |
| | 54 | 43 | 59 | 56 | 68 | 60 | 78 | 66 | 76 | 69 |
| _ | 53 | 40 | 57 | 54 | 69 | 62 | 75 | 67 | 77 | 74 |
| x | 53.7 | 41.3 | 58.7 | 53.0 | 67.7 | 61.7 | 76.3 | 66.0 | 77.3 | 71.0 |
| S.D | 0.47 | 1.25 | 1.25 | 2.90 | 1.25 | 1.25 | 1.25 | 0.82 | 1.25 | 2.16 |
| $T_3$ | 56 | 37 | 61 | 55 | 61 | 64 | 76 | 71 | 71 | 73 |
| | 54 | 34 | 62 | 53 | 66 | 65 | 75 | 74 | 73 | 68 |
| _ | 57 | 36 | 64 | 50 | 64 | 63 | 72 | 72 | 70 | 70 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| x | 55.7 | 35.7 | 62.3 | 52.7 | 63.7 | 64.0 | 74.3 | 72.3 | 71.3 | 70.3 |
| S.D | 1.25 | 1.25 | 1.25 | 2.06 | 2.06 | 0.82 | 1.70 | 1.25 | 1.25 | 1.81 |
| $T_4$ | 66 | 58 | 66 | 67 | 77 | 70 | 80 | 76 | 86 | 79 |
| | 68 | 57 | 69 | 66 | 75 | 72 | 82 | 78 | 79 | 80 |
| | 65 | 55 | 70 | 69 | 74 | 69 | 80 | 79 | 82 | 77 |
| $\bar{x}$ | 66.3 | 56.7 | 68.3 | 67.3 | 75.3 | 70.3 | 80.7 | 77.7 | 82.3 | 78.7 |
| S.D | 1.25 | 1.25 | 1.70 | 1.25 | 1.25 | 1.25 | 0.94 | 1.25 | 2.87 | 1.41 |

SD = Standard Deviation (σ), ht = height, *Dry Season Croppings. For What $T_o$ - $T_4$ denote see section 2.2, the three values per treatment are the replicates

**Table 2: Stem count and collar girth (cm) of Irish potato from five cropping seasons 63 DAP**

| Treatments | Cropping Seasons (CS) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2* | | 3 | | 4* | | 5 | |
| | Stem count | Collar Girth | Stem count | Collar Girth | Stem count | Collar Girth | Stem count | Collar Girth | Stem count | Collar Girth |
| $T_0$ | 3 | 2.22 | 2 | 2.39 | 3 | 2.45 | 3 | 2.48 | 3 | 2.49 |
| | 2 | 2.25 | 2 | 2.40 | 3 | 2.40 | 3 | 2.40 | 2 | 2.44 |
| | 3 | 2.23 | 3 | 2.37 | 3 | 2.47 | 3 | 2.49 | 3 | 2.46 |
| $\bar{x}$ | 2.66 | 2.230 | 2.3 | 2.390 | 3.0 | 2.440 | 3.0 | 2.950 | 2.66 | 2.460 |
| S.D | 0.48 | 0.01 | 0.47 | 0.01 | 0.00 | 0.03 | 0.00 | 0.50 | 0.48 | 0.02 |
| $T_1$ | 3 | 2.87 | 3 | 2.98 | 3 | 3.25 | 3 | 3.50 | 3 | 3.52 |
| | 3 | 2.80 | 3 | 3.00 | 3 | 3.31 | 3 | 3.49 | 3 | 3.50 |
| | 3 | 2.70 | 2 | 2.97 | 3 | 3.27 | 3 | 3.51 | 2 | 3.54 |
| $\bar{x}$ | 3.0 | 2.790 | 2.7 | 2.980 | 3.0 | 3.280 | 3.0 | 3.500 | 2.66 | 3.52 |
| S.D | 0.00 | 0.07 | 0.47 | 0.01 | 0.00 | 0.03 | 0.00 | 0.01 | 0.48 | 0.12 |
| $T_2$ | 3 | 3.10 | 3 | 3.36 | 3 | 3.60 | 2 | 4.30 | 2 | 4.44 |
| | 2 | 3.12 | 3 | 3.38 | 3 | 3.59 | 2 | 4.35 | 3 | 4.38 |
| | 2 | 3.00 | 3 | 3.40 | 3 | 3.61 | 2 | 4.37 | 2 | 4.39 |
| $\bar{x}$ | 2.33 | 3.070 | 3.00 | 3.380 | 3.0 | 3.600 | 2.0 | 4.330 | 2.33 | 4.40 |
| S.D | 0.48 | 0.05 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.03 | 0.47 | 0.03 |
| $T_3$ | 2 | 3.35 | 2 | 3.46 | 3 | 3.50 | 2 | 4.00 | 2 | 4.10 |
| | 3 | 3.39 | 2 | 3.48 | 3 | 3.52 | 3 | 4.10 | 3 | 4.13 |
| | 2 | 3.40 | 3 | 3.50 | 2 | 3.54 | 2 | 4.21 | 3 | 4.22 |
| $\bar{x}$ | 2.33 | 3.380 | 2.3 | 3.480 | 2.66 | 3.520 | 2.3 | 4.100 | 2.66 | 4.150 |
| S.D | 0.48 | 0.02 | 0.47 | 0.02 | 0.57 | 0.02 | 0.47 | 0.09 | 0.48 | 0.05 |
| $T_4$ | 2 | 4.44 | 3 | 4.70 | 3 | 4.87 | 2 | 5.25 | 2 | 5.29 |
| | 2 | 4.47 | 3 | 4.81 | 2 | 4.79 | 3 | 5.30 | 3 | 5.30 |
| | 2 | 4.49 | 3 | 4.69 | 3 | 4.88 | 2 | 5.33 | 2 | 5.40 |
| $\bar{x}$ | 2.00 | 4.470 | 3.0 | 4.730 | 2.66 | 4.850 | 2.3 | 5.290 | 2.33 | 5.330 |
| S.D | 0.00 | 0.02 | 0.00 | 0.05 | 0.57 | 0.04 | 0.47 | 0.03 | 0.47 | 0.08 |

SD = Standard Deviation (σ), * Dry Season Cropping. DAP=Day After Planting

and 161.7 respectively). The maximum tuber count recorded in T4 at CS1 was (160.7), CS2 (160.7) and CS5 (161.7) while T2 had the maximum mean value in CS3 and CS4 (144 and 142 respectively) during the study (Table 3). The potato tuber sizes varied from 30mm to 50mm in diameter.

**Table 3: Tuber count (TC) and tuber yield (TY) in ton ha$^{-1}$ of Irish potato from five cropping seasons**

| Treatments | Cropping Seasons (75 DAP) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2* | | 3 | | 4* | | 5 | |
| | TC | TY | TC | TY | TC | TY | TC | TY | TC | TY |
| T0 | 116 | 5.00 | 113 | 5.13 | 98 | 5.20 | 90 | 5.20 | 101 | 5.30 |
| | 112 | 4.90 | 117 | 5.24 | 90 | 5.30 | 96 | 5.10 | 92 | 5.26 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| _ | 109 | 5.20 | 99 | 5.21 | 89 | 5.33 | 101 | 5.28 | 98 | 5.28 |
| x | 111.33 | 5.03 | 109.67 | 5.19 | 89.67 | 5.28 | 95.67 | 5.22 | 97.00 | 5.28 |
| S.D | 3.05 | 0.13 | 7.72 | 0.04 | 28.1 | 4.49 | 4.51 | 0.08 | 3.74 | 0.02 |
| T1 | 115 | 5.13 | 114 | 5.47 | 91 | 5.30 | 93 | 5.70 | 99 | 5.83 |
| | 110 | 5.01 | 103 | 5.44 | 101 | 5.40 | 90 | 5.74 | 88 | 5.80 |
| _ | 102 | 5.10 | 116 | 5.39 | 92 | 5.42 | 98 | 5.78 | 86 | 5.91 |
| x | 109.00 | 5.08 | 111.0 | 5.43 | 94.67 | 5.37 | 93.67 | 5.74 | 91.00 | 5.85 |
| S.D | 5.35 | 0.05 | 5.72 | 0.60 | 0.05 | 3.30 | 5.72 | 0.03 | 5.72 | 1.72 |
| $T_2$ | 135 | 8.33 | 150 | 9.75 | 155 | 9.16 | 146 | 9.78 | 160 | 9.67 |
| | 149 | 8.40 | 152 | 9.72 | 145 | 9.10 | 140 | 9.72 | 163 | 9.65 |
| _ | 133 | 8.36 | 159 | 9.69 | 154 | 9.14 | 142 | 9.70 | 159 | 9.58 |
| x | 139.00 | 8.36 | 153.67 | 9.72 | 151.33 | 9.13 | 142.67 | 9.73 | 160.67 | 9.63 |
| S.D | 7.12 | 0.03 | 3.86 | 0.02 | 0.03 | 1.85 | 2.49 | 0.03 | 33.3 | 0.04 |
| $T_3$ | 119 | 8.13 | 130 | 9.00 | 124 | 8.67 | 110 | 8.95 | 146 | 9.08 |
| | 108 | 8.00 | 125 | 8.70 | 110 | 8.56 | 98 | 8.86 | 140 | 9.01 |
| _ | 112 | 7.81 | 128 | 8.80 | 120 | 8.61 | 102 | 8.90 | 142 | 8.96 |
| x | 113.00 | 7.98 | 127.67 | 8.83 | 118.0 | 8.61 | 103.33 | 8.90 | 142.67 | 9.02 |
| S.D | 4.55 | 0.13 | 2.05 | 0.13 | 5.85 | 0.05 | 4.99 | 0.04 | 2.51 | 2.96 |
| $T_4$ | 165 | 9.37 | 164 | 10.42 | 93 | 9.80 | 86 | 9.93 | 165 | 12.00 |
| | 161 | 9.40 | 160 | 10.44 | 90 | 9.77 | 84 | 9.01 | 161 | 11,88 |
| _ | 156 | 9.32 | 158 | 10.38 | 95 | 9.82 | 91 | 9.88 | 159 | 12.01 |
| x | 160.07 | 9.36 | 160.67 | 10.41 | 92.67 | 9.80 | 87.0 | 9.61 | 161.67 | 11.96 |
| S.D | 3.73 | 0.03 | 2.50 | 0.03 | 2.05 | 0.08 | 2.94 | 0.42 | 2.51 | 0.06 |

--

X = Mean (average), SD = Standard Deviation (σ), * Dry Season Cropping.

In all the five cropping seasons, treatments and seasons had significant effects on tuber yield at 1%. In the CS1, T4 had the maximum tuber yield of 9.36 ton ha-[1]. The trend was not different in the CS2, CS3, CS4 and CS5 where T4 emerged as the treatment with highest tuber yield with mean values of 10.41, 9.80, 9.73 and 11.96 ton/ha-1 respectively. The reasons for the differences observed above could be probably due to the different rates of green manure application and presence or absence of trees of A. lebbeck which must have brought about differential nutrient status among the treatments.

**3.3 Inter-relationships of Growth Parameters and Crop Yield**

The influence of the growth parameters on the yield of Irish potato investigated in this study demonstrates reasonable degree of interdependence or interrelationships among the growth parameters and crop yield.The results from the simple bivariate and the multiple correlation analyses which were employed in the statistical verification of the interrelationships indicated that there were variations among the growth parameters. This assertion is quite evident in the correlation between plant height and leaf count being positive and strong (r = 0.955) in the rainfed cropping season ( Table 4).This agrees with a similar observation earlier made by Fomba (1998) on okro. This connotes that the leaf count increases with increasing plant height.

The same reason could also be advanced in respect of the high positive correlation between collar girth and plant height, collar girth and leaf count in both rainfed and irrigated cropping seasons (Tables 4, 5 and 6). However, the negative correlation observed between collar girth and stem count proves that the more the number of stems per stand the less the average collar girth and vice versa

**Table 4: Correlation matrix for the growth and yield parameters of Irish potato (rainfed)**

| | Y | $X_1$ | $X_2$ | $X_3$ | $X_4$ |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Y | 1.000 | | | | |
| $X_1$ | 0.881* | 1.000 | | | |
| $X_2$ | 0.905* | 0.955* | 1.00 | | |
| $X_3$ | -0.891* | -0.898* | -0.803* | 1.000 | |
| $X_4$ | 0.954* | 0.970** | 0.956** | -0.941** | 1.000 |

** Significant at 1%, * Significant at 5%

**Variable Description:** Y = Tuber Yield in t/ha (dependent variable), $X_1 - X_4$ =Independent variables.$X_1$ = Plant Height $X_2$ =Leaf Count $X_3$ = Stem Count $X_4$ = Collar Girth

**Table 5: Correlation matrix for the growth and yield parameters Irish potato (irrigated)**

| | Y | $X_1$ | $X_2$ | $X_3$ | $X_4$ |
|---|---|---|---|---|---|
| Y | 1.000 | | | | |
| $X_1$ | 0.911* | 1.000 | | | |
| $X_2$ | 0.956** | 0.981** | 1.000 | | |
| $X_3$ | -0.573$^{\cdot}$ | -0.300$^{\cdot}$ | -0.471$^{\cdot}$ | 1.000 | |
| $X_4$ | 0.897* | 0.984** | 0.965** | -0.246$^{\cdot}$ | 1.000 |

* Significant at 5 % , ** Significant at 1 % $^{\cdot}$Not Significant

Y = Dependent variable, $X_1 - X_4$ = independent variables

**Variable Description:**

Y = Tuber Yield (t/ha) , $X_1 - X_4$ = Independent variables.$X_1$ =Plant Height $X_2$ =Leaf Count $X_3$ = Stem Count $X_4$ = Collar Girth

**Table 6: Correlation matrix of the growth and yield parameters of Irish potato(combined cropping seasons)**

| | Y | $X_1$ | $X_2$ | $X_3$ | $X_4$ |
|---|---|---|---|---|---|
| Y | 1.000 | | | | |
| $X_1$ | 0.720$^{\cdot}$ | 1.000 | | | |
| $X_2$ | 0.938** | 0.866* | 1.000 | | |
| $X_3$ | 0.052$^{\cdot}$ | 0.053$^{\cdot}$ | 0.193$^{\cdot}$ | 1.000 | |
| $X_4$ | 0.785$^{\cdot}$ | 0.977** | 0.873* | -0.126$^{\cdot}$ | 1.000 |

* Significant at 5 %, ** Significant at 1 %, $^{\cdot}$Not Significant

Y = Dependent variable, $X_1 - X_4$ = independent variables

**Table 7: Bivariate correlation/regression: growth parameters versus Irish potato yield (rainfed)**

| Variables | Correlation Coefficient 'r' | Intercept 'a' | $R_2$ | p Value |
|---|---|---|---|---|
| Y vs $X_1$ | 0.881* | 0.310 | 0.777 | 0.048 |
| $X_2$ | 0.905* | 0.173 | 0.820 | 0.034 |
| $X_3$ | -0.891* | -5.982 | 0.794 | 0.043 |
| $X_4$ | 0.954** | 2.308 | 0.910 | 0.012 |

** Significant at 1%, *Significant at 5%

**Variable Description:** Y = Crop Yield (t/ha) , $X_1 - X_4$ = Independent variables. $X_1$ = Plant Height, $X_2$ =Leaf Count, $X_3$ = Stem Count, $X_4$ = Collar Girth

a = Incercept [the part the of the dependent variable (yield) that does not change or vary with change in the independent variable (plant height, leaf count, collar girth and stem count]

$R^2$ = Coefficient of determination = proportion of variation in the dependent variable which is explained by the independent variable.

**Table 8: Bivariate correlation / regression: growth parameters**

**versus Irish potato yield (irrigated)**

| Variables | | Correlation Coefficient 'r' | Intercept 'a' | $R^2$ | p value |
|---|---|---|---|---|---|
| Y vs | $X_1$ | 0.911* | 0.304 | 0.830 | 0.031 |
| | $X_2$ | 0.958** | 0.150 | 0.913 | 0.011 |
| | $X_3$ | -0.573$^{\cdot}$ | -6.314 | 0.328 | 0.313 |
| | $X_4$ | 0.897* | 2.313 | 0.804 | 0.039 |

** Significant at 1% , * Significant at 5%, $^{\cdot}$ Not Significant

**Table 9: Bivariate correlation/regression: combined effects of growth parameters of Irish potato versus yield (combined cropping seasons)**

| Variables | | Correlation Coefficient 'r' | Intercept 'a' | $R^2$ | p value |
|---|---|---|---|---|---|
| Y vs | $X_1$ | 0.720$^{\cdot}$ | 0.036 | 0.519 | 0.170 |
| | $X_2$ | 0.938** | 0.036 | 0.881 | 0.018 |
| | $X_3$ | 0.052$^{\cdot}$ | 0.148 | 0.003 | 0.933 |
| | $X_4$ | 0.785$^{\cdot}$ | 1.040 | 0.616 | 0.116 |

** Significant at 1%, $^{\cdot}$ Not Significant

**Table 10: Multiple regression and correlation analyses: growth parameters versus yield of Irish potato (rainfed)**

| Variables | 'a' | Std Error | Multiple R | R Square | F-Value | P Value |
|---|---|---|---|---|---|---|
| $X_1$ | 0.310 | 0.096 | 0.881 | 0.777 | 10.450 | 0.048* |
| $X_2$ | 0.173 | 0.047 | 0.905 | 0.820 | 13.653 | 0.034* |
| $X_3$ | -5.982 | 1.761 | -0.891 | 0.794 | 11.540 | 0.0426* |
| $X_4$ | 2.308 | 0.419 | 0.954 | 0.910 | 30.424 | 0.012** |

* Significant at 5%, ** Significant at 1%

**Table 11: Multiple regression and correlation analyses: growth parameters versus yield of Irish potato (irrigated)**

| Variables | 'a' | Std Error | Multiple R | R Square | F-value | P.value |
|---|---|---|---|---|---|---|
| $X_1$ | 0.304 | 0.080 | 0.911 | 0.830 | 14.645 | 0.031* |
| $X_2$ | 0.150 | 0.027 | 0.956 | 0.913 | 31.631 | 0.011** |
| $X_3$ | -6.314 | 5.214 | 0.573 | 0.328 | 1.467 | 0.313$^{\cdot}$ |
| $X_4$ | 2.313 | 0.659 | 0.897 | 0.804 | 12.335 | 0.039* |

* Significant at 5%, ** Significant at 1%, $^{\cdot}$Not significant

**Table 12: Multiple regression and correlation analyses: combined seasonal effects versus yield of Irish potato (combined cropping seasons)**

| Variables | 'a' | Std Error | Multiple R | R Square | F-value | P.value |
|---|---|---|---|---|---|---|
| $X_1$ | 0.036 | 0.020 | 0.720 | 0.519 | 3.231 | 0.170$^{\cdot}$ |
| $X_2$ | 0.036 | 0.008 | 0.720 | 0.881 | 22.120 | 0.02* |

| | | | | | | |
|---|---|---|---|---|---|---|
| $X_3$ | 0.148 | 1.623 | 0.052 | 0.003 | 0.008 | 0.933ˆ |
| $X_4$ | 1.039 | 0.474 | 0.765 | 0.616 | 4,809 | 0.116ˆ |

* Significant at 5%, ˆ Not significant

**Variable Description:**

Y = Tuber Yield (dependent variable), $X_1 – X_4$ = Independent variables.$X_1$ = Plant Height $X_2$ =Leaf Count $X_3$ = Stem Count $X_4$ = Collar Girth a = Incercept [the part the of the dependent variable (yield) that does not change or vary with change in the independent variable (plant height,leaf count,collar girth and stem count]

$R^2$ = Coefficient of determination = proportion of variation in the dependent variable which is explained by the independent variable.

The high level of bivariate correlation between potato collar girth and yield (r = 0.954) at 1% level of significance connotes that the potato plants with high values of collar girth produced larger tubers/higher yield. This was exactly what was discovered during harvest in all the five cropping seasons. Those stands with 3-5 stems (i. e. at a point) had lower tuber weight/yield due to smaller sizes of the tubers per stem as opposed to stands with 1-2 stem(s) which had big sizes of potato tubers which resulted in higher tuber weight/yield. Amadi e.t al. (2005) made a similar observation regarding the negative and significant correlation between number of tubers per plant and average tuber weight and positive relationship between stem count (number of stems per plant) and tuber count. This means that each of the stems per plant produces tubers, (Irish potato being a stem tuber) thus making the tuber count higher but due to the fact that the sizes of those tubers are small, tuber weight/yield is correspondingly low especially where soil nutrient status is low.

Similarly, plant height and leaf count are positively and significantly correlated in the rainfed and irrigated cropping seasons (Tables 7- 9). This means that potato plants with higher values of plant height had more leaves which brought about increased surface area for photosynthesis which leads to increased accumulation of photosynthates. These enhanced tuber formation as a result of assimilation (after nutrient absorption) which eventually culminated in high tuber yield though an optimal number of leaves or leaf area index is needed to optimize tuber yield (Fomba, 1998; Lopez et al.,1987; Amadi et. al., 2005).The significant effects recorded on multiple correlation and regression analyses in respect of the growth parameters versus yield in both rainy and dry season croppings indicated a high influence of the independent variables on the dependent variable (crop yield). Apart from stem count which had a negative correlation and regression coefficient with yield, all the remaining growth parameters positively correlated with yield (10 - 12).

These phenomena demonstrate that the more the stem count per plant or stand the lesser the tuber size/weight though subject to soil fertility status and other factors such as disease attack and level of competition by weeds. Since potato is a stem tuber crop, more stems bring about more tuber count which has negative correlation with tuber weight due to small sizes of the tubers. Amadi et al. (2005) observed a negative correlation between tuber count and tuber yield and even if the soil fertility status is high the tuber can only increase to a maximum value (limit) with increasing stem density (Allen and Wurr, 1992). Most of the stands of this bertita variety under study in $T_0$ and $T_1$ which had lower nutrient status owing non - incorporation of Albizia lebbeck green manure had lower tuber weight /yield irrespective of their tuber count due to the small nature of their tubers. In the rainfed cropping, collar girth had the highest correlation coefficient (r) and the intercept ‘a’ probably due to the fact that it had the highest $R^2$ value (0.910) at 1% (Table 10). Besides this, collar girth of potato stems in $T_4$, $T_2$ and $T_3$ with green manure of the rattle tree which brought about high nutrient status had higher values of collar girth and tuber weight/yield, as opposed to smaller stem sizes in $T_0$ and $T_1$ with corresponding smaller tuber sizes and low tuber weight / yield. This means that collar girth accounts for 91.0% of variation in tuber yield in the rainfed planting season.

Unlike the rainfed cropping season, leaf count recorded the highest value of coefficient of determination ($R^2$), correlation coefficient (r) and level of significance in the irrigated cropping which are 0.913, 0.956 and 0.011 respectively (Table 11).This is probably due to effect of leaf count on tuberization (tuber formation) and subsequent tuber weight / yield. Large leaf area index is a function of leaf count which paves way for increased photosynthetic activities and subsequent build-up / anabolism / assimilation / accumulation of photosynthates for tuber formation. It accounted for 91.3% of the variation in potato yield at 1% level. Similarly, leaf count also recorded the highest value

of coefficient of determination and level of significance in the combined cropping seasons which are 0.881 and 0.018 respectively (Table 12). This trend as earlier opined could be due to the vital roles of leaves in crop growth, development and yield (Fomba, 1998; Amadi et al., 2005) with regard to photosynthesis, assimilation of photosynthates and subsequent tuber formation and yield.

## 4.0 Conclusion

The apparent growth parameters of the Irish potato (plant height number of leaves and collar girth) with the exception of the number of stems were highly influenced by Albizia lebbeck (its tree rows and green manure) and concomitantly its (potato) yield. The multiple correlation and regression analyses of the growth parameters (independent variables) versus yield (the independent variable) revealed that collar girth had the highest positive and significant correlation ($P \leq 0.01$) with yield and highest coefficient of determination ($R^2$=0.910) in the rainfed cropping seasons. Leaf count had the highest positive and significant correlation (at 1 %) and highest value of $R^2$ (0.913) in the irrigated cropping seasons. This was followed by collar girth ($R^2 = 0.616$) and plant height ($R^2 = 519$) while the least was stem count ($R^2 = 0.003$) and not at significant level. Very importantly, leaf count and collar girth were the two determinants of yield (of this bertita variety of Irish potato) from this study. They accounted for 61.6 – 91.3% of the variation in yield ($R^2 = 0.616 – 0.913$).

## 5.0 Recommendation

Potato farmers should emphasize on the improvement of the plant height, number of leaves and collar girth rather than increasing the number of stem per stand (that is planting 2 – 4 tubers at a point) which brings about smaller sizes of tuber and subsequently lower tuber weight/ yield.

## 6.0 References

Adesoye, P. O. (2004). Practical guide to statistical Analysis for scientists. A Primer Edition. 189pp.

Allen, E. J. and Wurr, D. C.(1992). Plant Density. In: The Potato Crop (P. M. Harris ed.). Chapman and Hall London pp. 292 – 330.

Amadi, C. O., Ene-obong, E. E. and Okonkwo, J. C. (2005). Correlation and Regression Analysis of Yield and Yield Components of Potato in Jos Plateau, Nigeria. Proc. Of the 39th Annual Conference of the Agricultural Society of Nigeria Held in the University of Benin, Benin City Nigeria. In: Orheruata, A. M. Nwokoro, S.O; Ajayi, M. T.; Adekunle, A. T. and Asumugha, G. N. (eds.). pp 364 -367.

Blalock, J.J.M. (1971). Casual Models in the Social Sciences. Aldine Publishing Co. Chicago, U.S.pp.1-14.

Burton. W. G. (1966). The Potato. A Survey of Its History and Factors Influencing its Yield, Nutritive Value, Quality and Storage. 2nd Ed. Wageningen, Netherlands: European Association for Potato Research, 382 pp.

Fomba, V. N. (1998). Effects of Gliricidia sepium Leaf Mulching Time as Green Manure on the Growth and Yield of Okra. Unpub. M.Sc. Thesis. Dept. of Forest Resources Management, Faculty of Agric. and Forestry, University of Ibadan, Ibadan – Nigeria. Pp 16 – 58.

Gomez, K. A. and Gomez, A. A. (1984). Statistical Procedures for Agricultural Research. Second Edition . pp. 1 – 422.

Huaman, Z. (1986). Systematic Botany and Morphology of the Potato. Tech. Information. Bul. 6. Inter. Potato Centre (CIP), Lima, Peru pp. 5 – 19.

Hue, N.V. (1992). Correcting Soil Acidity of a Highly Weathered Ultisol with Chicken Manure and Sewage Sludge. Commonwealth Soil Sc. Plant Anal. 23: 241 – 264.

Hunter, D. J. L.; Yapa, G. G.; Hue, N.V. and Eaqub, M. (1995). Comparative Effects of Green Manure and Lime on the Growth of Sweet Corn and Chemical Properties of an Acid Oxisol in Western Samoa. Comm. Soil Sci. Plant Anal. 26 (3 & 4): 375 – 388.

ICRAF (1983). A Global Inventory of Agroforestry Systems: A Project Announcement. Agroforestry Systems 1: 269 – 273.

Ifenkwe, O. P. (1981). A Review of the Status of Potato Production in the Plateau State of Nigeria pp 1 – 2.

Kadiata, B. D.; Mulongoy, K. and Isirimah, N. O. (1986). Time Course of Biological Nitrogen Fixation, Nitrogen Absorption and Biomass Accumulation in Three Woody Legumes. IITA P.M.B. 5320 Ibadan, Nigeria. Biological – Agriculture and Horticulture 1996, 13:3, 253 – 266.

Kang, B. T. (1993). Change in Soil Chemical Properties and Crop Performance with Continuous Cropping on an Entisol in the Humid Tropics. In Mulongoy, K. and Meckx, V. eds. Soil Organic Matter Dynamics and Sustainability of Tropical Agriculture. John Wiley and Sons, Chichester, N. Y. pp. 297 – 305.

Kareem. I. A.; Obiaga, P. C.; Owa, O. J. Okonkwo, M. C.; Nwadike, N. and Sani Y. R. (2005a). Propagation of Albizia lebbeck Benth from Cuttings as an Alternative to Production from Seeds. Nigeria Journal of Botany Botanical Society of Nigeria Jos . 106-110.

Kareem, I.A.; Ahmed, D.J.; Ojo, B.J. and Faloye, S.B. (2005b) Appropriate Technologies for Intensifying Small Holder Farming Systems and Improving National Resource Management in the Sudan Savanna Agro-ecological zone of Nigeria: The Agroforestry Option. Seminar Paper Presented at the IITA Kano Station Workshop on Development of Concept Role for the Sudan Savanna. Savanna Agro-ecological zone of Kano, Katsina-Maradi Learning Sites 28th – 19th November, 2005 pp 1-10

properties and productivity of Irish Jos Plateau, Nigeria. Ph.D Thesis, 231pp.

Kareem, I. A. (2008). Rattle tree (Albizia lebbeck Benth) effects on Soil potato (Solanum tuberosum L). on the

Kay, D. E. (1987). Potato (Solanum tuberusum). Tropical Development and Research Institute. 127 Derkenwell Road, London ECIR 5DB Overseas Development Administration. 308 pp.

Lopez, D. F.; Boe, A. A.; Johansen, R. H. and Jansky, S. H. (1987). Genotype x Envrionment Interaction, Correlations and Combing Ability of Six Traits in Potato (Abstract) Amercian Potato Journal 64:447.

NFTA (1988). Albizia lebbeck – A Promising Fodder Tree for Semi-Arid Regions. Nitrogen Fixing Trees Association. P.O. Box 680, Waimanalo, HI 96795, U.S.A. August, 1988 pp. 110 – 112.

Oche, C. Y. (1992). Agroclimatology of Wheat (Triticum spp.) in Nigeria. Ph.D Thesis (Unpub.), Department of Geography, Faculty of Science, University of Ibadan, Ibadan, Nigeria. April 27, 1992. 271pp.

Parrotta, J. A. (1988). Early Growth and Yield of Albizia lebbeck at a Coastal Site in Puerto Rico. NFTRR 6:47-49.

Prisen, J. H. (1986). Potential of Albizia lebbeck (Mimosaceae) as a Tropical Fodder Tree – A Review of Literature. Tropical Grasslands 20(2): 78-83.

Stanton, W. R. (1960). Potato Culture in Northern Nigeria. Newsletter No. 7.

Streets, R. (1962). Exotic Forest Trees in the British Commonwealth Clarendon Press. Oxford pp. 169-170.

Udo, R. K. (1978). Geographical Regions of Nigeria. Ibadan; London: Heinemann pp. 1 - 14

Young, A. (1985). Effects of Trees on Soils. Commonwealth Series Council. pp. 28-41.