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# Growth variability of Irish potato (*Solanum tuberosum* L.) as affected by cultivars and sowing date in the Sudan savannah zone of Nigeria

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Field experiments were conducted in the Sudan savannah zone of Nigeria during the 2015/2016 dry season. The Research Farm of Audu Bako Collage of Agriculture, Danbatta (12° 44′ N and 8° 51′ E) and Federal Collage of Education Technical, Bichi (12°24′N and 8.24′E) represented the two locations. Subjects of interest were to determine the effect of variety and sowing date on growth of Irish potato. Treatment combinations were five certified varieties (Nicola YL, Nicola GL, Bertita, Ditta and Marabel) and four levels of sowing date (early November, middle of November, end of November and middle of December), respectively. In three replications, treatments were laid down in split plot design with variety in main plots and sowing date in sub plots. All cultural practices, irrigation facilities and determination in physico-chemical properties of soil samples were observed. Data collected on growth components were analyzed using a trail version (statistix-10). Statistically, the results obtained after comparison between five varieties of Irish potato and four levels of sowing dates shows that variety and sowing date had high significance (P≤0.01), significance (P≤0.05) and insignificance effects on measured growth parameters taken at four, six, and eight weeks after sowing on plant height (cm), number of leaves, leaf area index and crop growth rate.

**Key words:** Sudan savannah, Irish potato varieties, sowing dates, growth performance.

## INTRODUCTION

Potato (*Solanum tuberosum* L.) is an annual, herbaceous, tuber crop of family Solanaceae that contains all the essential food ingredients required for maintaining proper health (FAO, 1986). The potato plant produces swollen underground tubers when mature. The potato plant produces swollen underground tubers when mature.

Potato has its region of origin in the high plain of the Andes Cordillera where the Incas cultivated the plant largely for food. In Africa, it was not until the end of the 19th century that potato was imported from Europe by missionaries and thereafter by colonial administrations (Raemaekers, 2001). Irish potato was introduced into Nigeria early in the 20th Century by European miners in Jos Plateau (Obigbesan, 1976). In Nigeria, the area under potato cultivation during 2014 stands at 142, 680 ha of land with an average production of 1,184, 865

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metric tons (Muhammad et al., 2015a; Ugonna et al., 2013). Over 85% of potato produced in Nigeria comes from Jos plateau (Muhammad et al., 2015b). Jos Plateau has high altitude and thus, cool climate, which is favorable for the development of the crop in the area (Obigbesan, 1976). Being a hardy plant, potato is cultivated in the world over different growing conditions. However, best result in tropical areas are obtained in regions where climate is tempered by altitude (1800 to 2,300 m) or alternatively, at a low altitude, provided the crop is grown during the coolest season (the dry season). Potato prefers a light, moist and well-drained soil. It can tolerate slightly acid soil (pH of 5.5-6.0) (Raemaekers, 2001). The crop is efficient in converting land, labor, water and capital into a highly nutritious food. This is not surprising if for no other reason than it has a shorter growing cycle of about 95 days than most other tuber crops in the tropics (Wuyep et al., 2013). Thirty percent of world's potato production is from developing countries and it is expanding more rapidly than most of the other food crops. It is also becoming an important source of rural employment and income for growing population (Hort, 1987). Tubers are good, easy and cheap in process to many forms of food when boiled, roasted, cooked, frayed or mixed with other food items to provide nutritional value that ranked it to a world healthiest food (FOA, 2008). Potato is the world's fourth-largest food crop, following maize, wheat and rice (FAO, 2008), world's leading vegetable crop and is grown in 79% of the world's countries (Muhammad et al., 2013). The average composition of the potato is about 80% water, 2% protein, and 18% starch. As a food, it is one of the cheapest and easily available sources of carbohydrates and proteins and contains appreciable amount of vitamins B and C as well as some minerals. Hundreds of millions of people in developing countries depend on potatoes for their survival (FAO, 2008). Higher and rapid population growth of country like Nigeria, will require the production of crop like potato. The potato crop has special significance to the developing countries as it has high production potential per unit area and time and has high nutritional value to sustain burgeoning population and to overcome malnutrition and hunger (Pandey, 2002). It is now an important commodity in both local and international trade (Obigbesan, 1976).

Apart from more conventional aspects of using Irish potato as foodstuff, industrial processing such as potato starch, glucose, dextrose, biscuit, confectionaries and drinks are becoming increasingly prominent in Nigeria. These have considerably widened the range of possible uses and are enough to necessitate an increase in production. Introduction and production in the study area can save as an addition. The National Root Crops Research Institute, Vom, the plant breeders, universities and colleges are from their own part continually responding in an attempt to increase production. But unfortunately, due to some reasons (climatic variables),

most of the efforts or responses were largely confined in the northern Guinea Savannah of Nigeria. Less attention was given to the study area, despite the fact that extending its production to the study area will contribute to addressing national needs. Several factors do affect the yield attributes of potato of which selection of appropriate varieties and sowing date being among the most important ones. This will first require preliminary information on better adoption of appropriate varieties, and using the optimum time of sowing. Within this view and increasing need, this research was a topic of interest, designed and conducted to provide preliminary information on important aspects of potato cultivation. This includes appropriate time of planting and evidence for a superior variety of potato for growth performances in the current study area through evaluating the effect of variety and sowing date on growth of the Irish potato.

## MATERIALS AND METHODS

Field experiments were conducted in Sudan Savanna ecology of Nigeria. Dry season research (2015/2016) with two locations, namely the Research Farms of Audu Bako College of Agriculture Danbatta (12° 44′ N and 8° 51′ E) and Federal College of Education Bichi (12° 24′ N and 8.24′ E), Kano State with elevations of 418 and 535 m above sea level, respectively. Treatments consisted of five varieties of Irish potatoes, namely (Nicola YL, Nicola GL, Bertita, Ditta and Marabel) with four level of sowing dates (early November, middle November, end of November and middle December) for the locations. They were laid down in a split plot design in three replications with variety in main plots and sowing date in sub plots. Before sowing, each of the experimental site was cleared, harrowed, demarcated and prepared into ridges of total plot size of 150 m$^2$. It was further divided in to three replications with an alley of 2 m between replications. Replications were transformed into main plots of 10 m × 1 m with an alley of 1 m between. Main plots were further divided into sub plots of 1 m × 2.5 m containing six rows of 3 m length. Varieties are certified and improved for dry season production with useful traits. Seed tubers of uniform size were treated with soil-borne disease-preventing chemical and sown at a depth of 5 and 20 cm between stands first farrow watering was on sowing and week intervals and stopped 2 weeks to harvesting, weed and pest control fallows. Data were collected at harvest on growth characters: plant height (cm), number of branches plant$^{-1}$, number of leaves plant$^{-1}$, leaf area index and crop growth rate (C.G.R.) were subjected to analysis of variance (ANOVA) as described by Snedecor and Cochran (1976) using Statistix (Version 10). Significant means of treatments were separated using LSD All-Pairwise Comparisons Test.

## RESULTS

Table 1 shows the detail of the physico-chemical properties of soils of the experimental sites. Meteorological records of each experimental sites are presented in Appendix I. The results of the soil analysis of the experimental sites indicated that the soils were loamy sand in texture with sand having a higher proportion of 81 to 85%. With respect to soil located in Danbatta, the soil was slightly acidic to neutral with pH

**Table 1.** Physico-chemical properties of soils of the experimental site (2015).

| Sample collection deep in (cm) | Danbatta | | Bichi | |
|---|---|---|---|---|
| | 15-30 cm | 15-30 cm | 0-15 cm | 15-30 cm |
| **Physical composition (%)** | | | | |
| Clay | 5 | 5 | 7 | 9 |
| Silt | 10 | 10 | 8 | 10 |
| Sand | 85 | 85 | 85 | 81 |
| Textural class | Loamy sand | Loamy sand | Loamy sand | Loamy sand |
| | | | | |
| **Chemical composition** | | | | |
| pH in $H_2O$ (1:2.5) | 6.33 | 7.00 | 5.9 | 5.9 |
| PH in $Cacl_2$ (0.01 M) | 5.16 | 4.01 | 4.83 | 4.10 |
| Organic carbon (g $kg^{-1}$) | 0.47 | 0.18 | 0.56 | 0.18 |
| Total Nitrogen (g 0.5 $kg^{-1}$) | 0.04 | 0.28 | 0.07 | 0.11 |
| Available P (mg/kg) | 21.95 | 25.81 | 23.78 | 27.64 |
| | | | | |
| **Exchangeable bases (cmol (+) $kg^{-1}$)** | | | | |
| Ca | 1.83 | 1.67 | 3.17 | 2.33 |
| Mg | 1.25 | 1.25 | 1.17 | 1.08 |
| K | 0.20 | 0.18 | 0.22 | 0.20 |
| Na | 0.12 | 0.12 | 0.09 | 0.12 |
| CEC (cmol $kg^{-1}$) | 4.57 | 3.88 | 5.14 | 9.23 |

Source: Department of Soil Science, Faculty of Agriculture Bayero University, Kano.

range of 6.3 to 7.0; while that of Bichi site was slightly acidic at both 0-15 and 15-30 cm depths, with the pH of 5.9. Chemically, the two soils shared similar composition in that they have very low levels of organic carbon (0.18-0.56 g $kg^{-1}$), low CEC (3.88-9.23 cmol $kg^{-1}$), low sodium (0.09-0.12) and magnesium (1.08-1.25), and very low to high levels of total nitrogen (0.04-0.07 g 0.5 $kg^{-1}$, 0.11-0.28 g $kg^{-1}$) at 0-15 cm and 15-30 cm, respectively.

However, the results of the soil analyses also showed that the trial sites have moderate potassium (0.18-0.22 cmol (+) $kg^{-1}$), high available phosphorus (21.95-27.64 cmol (+) $kg^{-1}$), but differs in calcium composition with Danbatta site having low calcium (1.83-1.67 cmol (+) $kg^{-1}$) but higher in Bichi site. Climatic variables (Appendix I) indicated that total rainfall received during the experimental period is zero with mean maximum and minimum temperature of 31.83 and14.51°C, and range in relative humidity of 52.45 and 13.45. The average maximum and minimum temperature for each month in the period of trial from November to March during the 2015 dry season are: November 33.46 and 14.01°C, December 25.95 and 11.95°C, January 28.39 and 11.31°C, February 35.38 and 14.15°C, March 35.95 and 21.11°C. Likewise, the ranges in relative humidity for this time period are: November 75.52 and 16.87, December 54.07 and19.39, January 47.01 and 12.98, February 48.67 and 8.03, and March 36.99 and 9.96.

The effect of variety and sowing date on plant height (cm) of Irish potato in the 2015/2016 dry season was shown in Table 2. From Danbatta site, plant height was highly significantly (P≤ 0.01) affected by variety at 4WAS and significantly (P≤ 0.05) affected at 6WAS.

Variety Nicola GL followed by Nicola YL produced taller plants. They were followed by Ditta and Marabel. Bertita was found to produce shorter plants. Effect of sowing date on plant height was found to be highly significant (P≤ 0.01) at 8WAS and significant (P≤ 0.05) effect at 6WA. Sowing date of middle of November was found to produce taller plants. This was followed by middle of December. Plants height attained in sowing date of early November and end of November are almost similar. Variety and sowing date shows insignificant (P≤ 0.05) effect from Danbatta and Bichi locations. From Bichi site, plant heights were highly significantly (P≤ 0.01) affected by variety at 4WAS and significantly (P≤ 0.05) affected at 6WAS. Nicola GL followed by Nicola YL produced taller plants. Ditta and Marabel followed, they produced plants with almost similar height and Bertita produce shorter plants. Effect of sowing date on plant height showed highly significant (P≤ 0.01) effect at 4 and 6WAS and significant effect at 8WAS. Sowing date of middle of November produced taller plants. This was followed by end of November. Plants height attained in sowing date of early November and end of November are similar. The interaction of variety and sowing date on plants height during the 2015/2016 dry season is shown in Tables 3 and 4. Highly significant (P≤ 0.01) interaction was from Bichi at 4WAS and significance (P≤ 0.05) was at 6WAS.

**Table 2.** Effect of variety and sowing date on plant height (cm) of Irish potato (*Solanum tuberosum* L.) at 4, 6 and 8WAS in Danbatta and Bichi during the 2015/2016 dry season.

| Treatment | Danbatta | | | Bichi | | |
|---|---|---|---|---|---|---|
| Variety | 4WA | 6WAS | 8WAS | 4WA | 6WAS | 8WAS |
| Nicola GL | 7.37[a] | 12.03[a] | 17.69 | 10.13[a] | 13.35 | 18.95 |
| Bertita | 2.88[b] | 7.28[b] | 11.93 | 6.98[c] | 9.55 | 12.28 |
| Marabel | 3.06[b] | 10.60[a] | 14.96 | 8.40b[c] | 12.00 | 15.66 |
| Ditta | 5.26[ab] | 11.54[a] | 17.58 | 8.41[bc] | 11.89 | 17.81 |
| Nicola YL | 6.77[a] | 11.20[a] | 15.68 | 9.73[ab] | 13.36 | 18.50 |
| SED+ | 1.05 | 1.05 | 2.25 | 0.64 | 2.28 | 2.95 |
| Significance | ** | * | NS | ** | NS | NS |
| | | | | | | |
| **Sowing date** | | | | | | |
| Early November | 3.75 | 10.35[ab] | 14.11[bc] | 8.69[b] | 12.33[b] | 14.83[bc] |
| Middle of November | 6.95 | 12.43[a] | 19.23[a] | 11.08[a] | 15.39[a] | 18.32[ab] |
| End of November | 3.41 | 8.07[b] | 12.77[c] | 8.69[b] | 11.86[b] | 19.41[a] |
| Middle of December | 6.15 | 11.26[a] | 16.17[ab] | 6.45[c] | 8.53[c] | 14.01[c] |
| SED+ | 1.58 | 1.46 | 1.58 | 0.78 | 1.15 | 1.88 |
| Significance | NS | * | ** | ** | ** | * |
| Interaction | | | | | | |
| V×SD | NS | NS | NS | ** | * | NS |

Means along the same column with unlike letter(s) are different at P≤ 0.05 using LSD All-Pairwise Comparisons Test. NS: = Not significant, *= significant at P≤ 0.05, **= significant at P≤ 0.01, V=variety, SD=sowing date and SED=standard error of difference.

**Table 3.** Interaction between variety and sowing date in plant height (cm) at 4WAS of Irish potato (*Solanum tuberosum* L.) at Bichi.

| Sowing date | Variety | | | | |
|---|---|---|---|---|---|
| | Nicola GL | Bertita | Marabel | Ditta | Nicola YL |
| Early November | 7.10[de] | 10.33[bcd] | 8.0[de] | 8.97[bc] | 9.03[cd] |
| Middle of November | 12.57[a] | 10.60[ab] | 9.33[cd] | 10.43[ab] | 12.47[a] |
| End of November | 9.53[cd] | 7.00[de] | 8.50[bc] | 9.23[cd] | 9.20[cd] |
| Middle of December | 9.80[cd] | 0.01[f] | 7.77[de] | 5.00[e] | 9.70[cd] |
| SED+ | | | 0.78 | | |

Means along the same column with unlike letter(s) are different at P≤ 0.05 using LSD All-Pairwise Comparisons Test. SED=standard error of difference.

Nicola YL with corresponding sowing date of middle of November statistically produced taller plants. These were followed by Nicola GL, Bertita, Ditta, and Marabel with corresponding sowing date of end of November, middle of December and early November, respectively.

Table 5 shows the effect of variety and sowing date on number of leaves per plants in the 2015/2016 dry season. From Danbatta site, number of leaves was highly significantly (P≤ 0.01) affected by variety at 4, 6 and 8WAS. Nicola GL produced more number of leaves; this was followed by variety Nicola YL. Ditta, Marabel and Bertita, respectively followed Nicola YL in number of leaves produced. Number of leaves was also affected by sowing date; highly significant (P≤ 0.01) level at 6WAS, significant (P≤ 0.05) level at 4 and 8WAS. Higher numbers of leaves are produced at sowing date of middle of November. This is followed by early November, end of November and middle of December, respectively. Interaction between variety and sowing date in number of leaves of Irish potato were insignificant at all level of sowing date.

From Bichi location, effects of variety on number of leaves were highly significant (P≤ 0.01) at 6WAS. Nicola GL produced more number of leaves; this was followed by Nicola YL. Ditta, Marabel and Bertita, respectively followed Nicola YL in number of leaves produced.

**Table 4.** Interaction between variety and sowing date in plant height (cm) at 6WAS of Irish potato (*Solanum tuberosum* L.) at Bichi.

| Sowing date | Variety | | | | |
|---|---|---|---|---|---|
| | Nicola GL | Bertita | Marabel | Ditta | Nicola YL |
| Early November | 10.53[cd] | 12.17[abc] | 10.50[cd] | 12.17[abc] | 11.30[bcd] |
| Middle November | 16.23[ab] | 13.93[abc] | 14.83[abc] | 14.80[abc] | 17.17[a] |
| End of November | 13.60[abc] | 12.10[abc] | 11.93[abc] | 14.23[abc] | 12.43[abc] |
| Middle of December | 13.03[abc] | 0.00[e] | 10.73[cd] | 6.37[d] | 12.53[abc] |
| SED+ | | | 1.15 | | |

Means along the same column with unlike letter(s) are different at P≤ 0.05 using LSD All-Pairwise Comparisons Test. SED=standard error of difference.

**Table 5.** Effect of variety and sowing date on number of leaves of Irish potato (*Solanum tuberosum* L.) at 4, 6 and 8WAS at Danbatta and Bichi during the 2015/2016 dry season.

| Treatment | Danbatta | | | Bichi | | |
|---|---|---|---|---|---|---|
| Variety | 4WA | 6WAS | 8WAS | 4WAS | 6WAS | 8WAS |
| Nicola GL | 10.82[a] | 19.92[a] | 28.83[a] | 13.83 | 19.92[a] | 27.92 |
| Bertita | 3.50[b] | 9.00[c] | 13.67[c] | 7.58 | 9.96[c] | 16.42 |
| Marabel | 4.25[b] | 14.08[b] | 21.67[b] | 11.42 | 13.33[bc] | 23.83 |
| Ditta | 5.75[b] | 14.08[b] | 22.08[b] | 12.92 | 14.54[bc] | 25.93 |
| Nicola YL | 10.43[a] | 16.42[ab] | 26.67[ab] | 13.17 | 18.17[ab] | 26.25 |
| SED+ | 1.47 | 1.87 | 2.6 | 1.96 | 2.10 | 3.72 |
| Significance | ** | ** | ** | NS | ** | NS |
| | | | | | | |
| **Sowing date** | | | | | | |
| Early November | 8.47[ab] | 16.20[a] | 23.13[a] | 10.33[b] | 16.20[b] | 21.20[b] |
| Middle of November | 9.67[a] | 17.87[a] | 26.00[a] | 15.87[a] | 20.33[a] | 29.00[a] |
| End of November | 5.00[b] | 10.33[b] | 17.13[b] | 11.00[b] | 12.47[bc] | 22.73[b] |
| Middle of December | 4.67[b] | 14.40[ab] | 20.07[a] | 9.93[b] | 11.73[c] | 21.23[b] |
| SED+ | 2.05 | 2.18 | 2.82 | 1.22 | 2.90 | 2.90 |
| Significance | * | ** | * | ** | ** | * |
| | | | | | | |
| **Interaction** | | | | | | |
| V×SD | NS | NS | NS | NS | * | NS |

Means along the same column with unlike letter(s) are different at P≤ 0.05 using LSD All-Pairwise Comparisons Test. NS= not significant, *= significant at P≤ 0.05, **= significant at P≤ 0.01, V=variety, SD=sowing date and SED=standard error of difference.

Statistically, effect of sowing date on number of leaves produced were highly significant (P≤ 0.01) at 4 and 6WAS and significant at 8WAS. Higher numbers of leaves are produced at middle of November with Nicola GL at par. These were followed by sowing date of early November, middle of December and end of November, respectively.

Table 6 shows the interaction between variety and sowing date in number of leaves of Irish potato at Bichi Nicola GL with sowing date of middle of November significantly (P≤ 0.05) produced higher number of leaves. Sowing date of early November interactively favored

Marabel and Ditta and producing more number of leaves after Nicola GL. The lowest number of leaves produced was from Bertita at sowing date of middle of December.

Effect of variety and sowing date on leaf area index of Irish potato at Danbatta and Bichi during the 2015/2016 dry season is presented in Table 7. From Danbatta location the leaf area index produced were highly significantly (P≤ 0.01) affected by variety at 6WAS and significant at 4 and 8WAS. Nicola YL followed by Nicola GL was found to produce higher leaf area index. These were followed by Marabel and Ditta, respectively. Lower leaf area index was produced by Bertita. Similarly,

**Table 6.** Interaction between variety and sowing date in number of leaves of Irish potato (*Solanum tuberosum* L.) at Bichi.

| Sowing date | Variety | | | | |
|---|---|---|---|---|---|
| | Nicola GL | Bertita | Marabel | Ditta | Nicola YL |
| Early November | 19.67[b] | 17.33[b] | 12.00[bcd] | 12.00[bcd] | 20.00[ab] |
| Middle of November | 28.67[a] | 18.00[b] | 19.33[b] | 17.00[b] | 18.667[b] |
| End of November | 14.67[bc] | 4.51[de] | 11.510[bcd] | 16.00[bc] | 15.667[bc] |
| Middle of December | 16.67[bc] | 0.00[e] | 15.33[bc] | 8.33[cde] | 18.33[b] |
| SED+ | | | 1.89 | | |

Means along the same column with unlike letter(s) are different at P≤ 0.05 using LSD All-Pairwise Comparisons Test. SED=standard error of difference.

**Table 7.** Effect of variety and sowing date on leaf area index of Irish potato (*Solanum tuberosum* L.) at 4, 6 and 8WAS at Danbatta and Bichi during the 2015/2016 dry season.

| Treatment | Danbatta | | | Bichi | | |
|---|---|---|---|---|---|---|
| Variety | 4WA | 6WAS | 8WAS | 4WAS | 6WAS | 8WAS |
| Nicola GL | 2.10 | 3.37[b] | 10.12 | 4.12[b] | 4.88 | 8.32 |
| Bertita | 0.33 | 1.07[c] | 2.59 | 3.17[b] | 3.76 | 7.15 |
| Marabel | 1.31 | 2.51[bc] | 8.85 | 3.99[b] | 4.44 | 10.11 |
| Ditta | 0.44 | 2.42[bc] | 5.54 | 2.33[b] | 4.39 | 10.20 |
| Nicola YL | 2.12 | 5.46[a] | 10.17 | 5.00[a] | 6.21 | 10.56 |
| SED+ | 0.71 | 0.90 | 2.28 | 0.73 | 1.09 | 2.08 |
| Significance | NS | ** | NS | * | NS | NS |
| | | | | | | |
| **Sowing date** | | | | | | |
| Early November | 0.64[b] | 2.84 | 6.36 | 4.64 | 5.84[bc] | 9.56[a] |
| Middle of November | 2.69[a] | 3.22 | 10.30 | 5.80 | 6.20[a] | 11.33[a] |
| End of November | 0.84[b] | 2.99 | 5.63 | 5.36 | 5.81[ab] | 9.63[a] |
| Middle of December | 0.81[b] | 2.83 | 7.54 | 3.78 | 4.46[c] | 7.02[b] |
| SED+ | 0.51 | 1.39 | 2.06 | 0.52 | 0.73 | 1.18 |
| Significance | ** | NS | NS | NS | * | ** |
| Interaction | | | | | | |
| V×SD | NS | NS | NS | NS | NS | NS |

Means along the same column with unlike letter(s) are different at P≤ 0.05 using LSD All-Pairwise Comparisons Test. NS= not significant, *= significant at P≤ 0.05, **= significant at P≤ 0.01, V=variety, SD=sowing date and SED=standard error of difference.

sowing date of middle of November favored the varieties and produced higher leaf area index. The effects of the remaining sowing dates on leaf area index produced are close to similar. Interactively, no significant effects between variety and sowing date on leaf are index was observed from the location. Variety shows significant (P≤ 0.05) effect in leaf area index at 4WAS in Bichi and insignificant (P≤ 0.05) effects at 6 and 8WAS. Nicola YL followed by Nicola GL produced higher leaf area index, Marabel and Ditta followed, respectively. Lower leaf area index produced was from Bertita. Similarly, the effects of sowing date on leaf area index show that sowing date of middle of November produced better for higher leaf area index at 4, 6 and 8WAS. Sowing date of middle of

November is higher in leaf area index produced, it was followed by end of November, early November and middle of December, respectively. Variety and sowing date show no significant interaction on leaf area index from the location.

The effect of variety and sowing date on crop growth rate of Irish potato at Danbatta, Bichi and combine during the 2015/2016 dry season is shown in Table 8. Statistically, Danbatta site shows no significant effect from variety in crop growth rate. Nicola YL shows higher crop growth rate, this was followed by Nicola GL. Ditta, Marabel and Bertita, respectively followed Nicola GL. Significantly higher growth rate was on sowing date of middle of November. Sowing date of early November,

**Table 8.** Effect of variety and sowing date on crop growth rate of Irish potato (*Solanum tuberosum* L.) at 4, 6 and 8WAS at Danbatta, Bichi and combine during the 2015/2016 dry season.

| Treatment | Danbatta | Bichi | Combine |
|---|---|---|---|
| **Variety** | | | |
| Nicola GL | 0.90 | 0.79[ab] | 0.87a |
| Bertita | 0.36 | 0.39[c] | 0.38b |
| Marabel | 0.46 | 0.63[bc] | 0.55b |
| Ditta | 0.51 | 0.61[bc] | 0.56b |
| Nicola YL | 0.95 | 1.06[a] | 0.98a |
| SED+ | 0.20 | 0.16 | 0.09 |
| Significance | NS | * | ** |
| | | | |
| **Sowing date** | | | |
| Early November | 0.66 | 0.73 | 0.70 |
| Middle of November | 0.79 | 0.79 | 0.79 |
| End of November | 0.41 | 0.75 | 0.58 |
| Middle of December | 0.68 | 0.51 | 0.59 |
| SED+ | 0.20 | 0.12 | 0.12 |
| Significance | NS | NS | NS |
| Interaction | | | |
| V×SD | NS | NS | NS |

Means along the same column with unlike letter(s) are different at P≤ 0.05 using LSD All-Pairwise Comparisons Test. NS= not significant, *= significant at P≤ 0.05, **= significant at P≤ 0.01, V=variety, SD=sowing date and SED=standard error of difference.

middle of December and end of November followed. Interaction between variety and sowing date shows insignificant effect. Variety shows significant (P≤ 0.05) effect on crop growth rate from Bichi location. Nicola YL shows higher crop growth rate. This was followed by Nicola GL Marabel, Ditta and Bertita, respectively. Effect of sowing date on crop growth rate was higher on sowing date of middle of November. This was followed by sowing date of end of November, early November and middle of December, respectively. Interaction between variety and sowing date on crop growth rate shows insignificant (P≤ 0.01) effect. Statistically at combined, crop growth rate was highly significantly (P≤ 0.01) affected by varieties. Nicola YL followed by Nicola GL shows higher crop growth rate. These were followed by Ditta, Marabel and Bertita. Effect of sowing date on crop growth rate proved insignificant difference (P≤ 0.01) at combined. Higher growth rate was from the sowing date of middle of November. This was followed by sowing date of early November, end of November and middle of December, respectively. Interaction between variety and sowing date shows insignificant effect on crop growth rate at combined.

## DISCUSSION

The study shows that variety has effect on growth performance of Irish potato from both locations and combined. The significance was observed from plant height, number of branches, number of leaves, leaf area index and crop growth rate. Among tested varieties, measured growth parameters (plant height, number of branches, and number of leaves) were higher in Nicola GL and leaf area, leaf area index and crop growth rate were higher in Nicola YL. These two varieties generally performed better than other varieties and it could be due to their faster adaptation, resistances and or tolerance to harsh weather conditions of the new environment (experimental sites). Generally, with Bichi, higher variations occurred in the level of effect among the locations and measured parameters. This could be due to soil pH as a factor, the crop prefers soil that is slightly acidic pH of 5.5 to 5.9 (Raemaekers, 2001), which of course was observed from Bichi at both 0-15 cm and 15-30 cm. Besides that, inherent traits like green leaf for photosynthetic efficiency from Nicola GL and more leaf area for better sun light interception, from Nicola YL could also be attributed to better utilization of environmental resources over other varieties. This was in line with variety that had influence on growth of Irish potato after conducting a research involving two varieties of Irish potato Namangu and SP in two different locations of Sudan savannah zone, where at 6WAP found growth parameters: plant height, number of branches, number of leaves, leaf area, leaf area index, total fresh and dry weight and crop growth rate higher in SP variety over Namangu (Ibrahim, 2014).

Effects of sowing date on growth of Irish potato were observed from the 2015/2016 dry season in the two locations. Measured parameters on growth were higher from sowing date of middle November. This could be attributed to effects of mean maximum 33.46°C, 75.52 and minimum 14.01°C, 16.87 temperatures and relative humidity of the month (Appendix 1) which favored the crop during earlier stages of development. Ifenkwe and Okonkwo (1983) under irrigation, Irish potato production in Nigeria should coincide with the coldest month (November - January). Among management practices, sowing date is an important factor that modifies the growth environment by way of regulating the availability of fundamental natural endowments. Gallagher and Biscoe (1978) reported that crop sown at the optimum time makes the best use of the available growth factors such as temperature and solar radiation at different stages of growth for high productivity.

## Conclusion

The result of the experiments shows that variety Nicola YL and Nicola GL give higher performances at Danbatta and Bichi. Similarly, sowing date of middle of November give better performance. The significant effect from variety and sowing date could be attributed to genetic and ability and/or inability of the crop (Irish potato) to utilize available environmental resources as water, temperature, nutrients and light. These factors however do vary in their effect from locations as well as from one species to another (Watson, 1978)

## RECOMMENDATION

It could be suggested that for dry season production variety Nicola YL and Nicola GL with corresponding sowing date of middle of November could be used for Irish potato production in the Sudan savanna zone of Nigeria.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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