Gashua Journal of Irrigation and Desertification Studies
Available online at www.gjidsfugashua.org.ng
Maiden Edition: Vol 1, Nos. 1 & 2

# CORRELATION AND REGRESSION ANALYSIS OF SQUASH PUMPKIN (*Cucurbita maxima* L.) IN RESPONSE TO DEFOLIATION SEVERITY AND MANURE RATE IN SAMARU, ZARIA

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## Abstract
Two field trials were conducted in 2012 and 2014 on the experimental farm of the Institute for Agricultural Research, Ahmadu Bello University, Samaru, Zaria ($11^0$ $11^1$ N, $07^0$ $38^1$ E, 684 meters above sea level) to study the association of some growth and yield characters of two varieties of squash pumpkin (*Cucurbita maxima* L.) to severity of defoliation and farm yard manure (FYM) rates. Regression study was also used to obtain the optimum level of FYM and defoliation severity. The treatments consisted of three degrees of defoliation (0, 25 and 50%), three levels of farm yard manure (0, 5 and 10 t $ha^{-1}$) and two varieties (Yar-Madina and Ex-Ajiwa) of pumpkin. The defoliation severity of the pumpkin was imposed at 6 weeks after sowing (WAS) starting from the bottom towards the apex. The treatments were laid out in Randomized Complete Block Design (RCBD) replicated three times. The correlation result indicated that leaf area (LA) and relative growth rate (RGR) were the highest contributor of fruit yield. Other characters that contributed to the fruit yield include; crop growth rate (CGR), vine length, leaf area index (LAI) and fruit circumference. The regression analysis showed a quadratic response of fruit yield per hectare to defoliation severity which indicated that the optimum defoliation severity that pumpkin can tolerate was attained at 25% while linear responses was observed on FYM rates, indicating that the optimum levels was not obtained at 10 t $ha^{-1}$.

**Keywords**: Squash pumpkin, Defoliation, Severity, Manure, Samaru

## INTRODUCTION
Pumpkin (*Cucurbita maxima* L.) is a gourd-like fruit which belongs to the genus *Cucurbita* and family *Cucurbitaceae*. It is thought to have originated in America where the wild forms are found in the forests of Mexico (Lawal, 2000). The leaves and flowers are eaten as potherb while calabashes of various shapes and sizes are fashioned from the fruits (Lawal, 2009). In many African countries like Nigeria, Niger, Cameroun and Mali, the fruit may be roasted, boiled, baked, patched or dried. The seeds, which are believed to have medicinal value, are roasted and eaten (Lawal *et al.*, 2009). Pumpkins are known to possess antioxidant beta-carotene, which has been shown to help improve immune functions and reduce the risk of cancer and heart diseases. In addition, pumpkin also contains many vitamins and nutrients, including calcium, iron, magnesium, potassium, zinc, selenium, niacin, foliate and vitamins A, C and E (Ondigi *et al*., 2008).

Shibbles *et al*. (1987) indicated that plants are affected by various manipulations that alter the source-sink ratio including depodding, partial or total shading of the foliage, foliage removal, light and carbon dioxide enrichment. Defoliation had reduced the rate of leaf photosynthesis and alter the ability of the photosynthetic source (the leaves) to export assimilate (Ibrahim *et al*., 2010).

A considerable number of insect pests have been reported feeding on pumpkin leaves and sometimes defoliating the plants more especially squash beetle. In view of this, several studies on cucurbits defoliation was focused on insect infestation. For instance, Hoffman *et al.* (2000) observed response of pumpkin to defoliation by squash beetles and found defoliation of 60% reduced yield.

Bayu *et al.*, (2006) advocated the use of organic matter because it supplements the inorganic fertilizer and reduced lost of fertilizing. Makinde and Ayoola (2008) emphasised the need for application of organic matter because it gives residual effects on growth and yield of succeeding crops through improvement of soil structure and aeration.

There is the need to determine the important characters which contribute to pumpkin yield with a view to breeding for their improvement and thus increase the potentials. This study was therefore conducted to assess the relationship between some growth and yield components of squash pumpkin and to determine which component(s) contributes significantly to pumpkin fruit yield.

## MATERIALS AND METHODS

Field trials were conducted during 2012 and 2014 rainy seasons at the Institute for Agricultural Research Experimental Farm Samaru ($11^0$ $11^1$ N, $07^0$ $38^1$ E and 686m above sea level) located in the northern Guinea savanna of Nigeria. The land was harrowed and ridged 0.75m apart divided into gross plot sizes of 27 $m^2$ and net plot sizes of 18 $m^2$ separated by alley of 1.0 m between plots and 1.5 m between replicates. Thus the gross plot consisted of 6 rows of 6 m long while the 4 inner rows constituted the net plot. Prior to land preparation, soil samples were randomly collected at various points within the experimental plots at a depths of 0 – 30 cm and subjected to routine analysis. The treatments consisted of three levels each of defoliation severity (0, 25 and 50%) and farm yard manure (0, 5 and 10 t $ha^{-1}$) and two pumpkin varieties (Yar-Madina and Ex–Ajiwa). The treatments was laid out in randomized complete block design (RCBD) replicated three times. The defoliation treatments were imposed at 6 weeks after sowing (WAS) and involved removal of the older leaves using scissors, i.e. from the base of the plant upwards towards the apex. The farm yard manure was analyzed and applied as per the varied treatments rates ten days before sowing. The seeds were treated with Apron Star (20% w/w thimethoxan, 20% w/w metalaxyl-m and 2% w/w difenoconazole) at the rate 10 g per 5 kg of seeds against pests and diseases before planting. Three seeds per hill were sown which were later thinned to two plants per stand after germination. The seeds were sown on $5^{th}$ July and $17^{th}$ June in 2012 and 2014 respectively with 1.0 x 0.75m intra and inter row spacing. Basal application of inorganic fertilizer N(60kg $ha^{-1}$), $P_2O_5$(30kg $ha^{-1}$) and $K_2O$(30kg $ha^{-1}$) using NPK 20:10:10 were applied to all plots irrespective of the treatments at 2 WAS. The plots were weeded twice using hoes at 3 and 6 WAS and at 8 WAS a single hand pulling was conducted. Cypermethrin (cymbush) and Benomyl (benlate) were applied at the rates of 2 litres $ha^{-1}$ and 1.5 kg ai. $ha^{-1}$ respectively to prevent insect pests and fungal attack four times during the vegetative growth of the crop. Spraying starts from 5 WAS and stopped at 8 WAS.

Data collected include; vine length, leaf area, number of leaves per plant, total dry matter per plant, leaf area index, days to 50% flowering, crop growth rate, relative growth rate, fruit circumference and fruit yield per hectare. The association between the characters were assessed as described by Little and Hill (1978) using simple correlation coefficient Regression analysis was also worked out using the procedure described by Reddy and Reddi (1995).

## RESULTS AND DISCUSSION

### Correlation Analysis

Table 1 presents matrix of combined correlation coefficients between some growth and yield characters of squash pumpkin during the 2012 and 2014 rainy seasons at Samaru. The combined correlation analysis shows that the CGR, fruit circumference, LAI and vine length were positive and significantly ($P \leq 0.05$) correlated to fruit yield. The LA and the RGR were positive and highly significantly ($P \leq 0.01$) correlated to fruit yield. The CGR was positive and significantly ($P \leq 0.05$) correlated to the fruit circumference while the TDM was positive and highly significantly ($P \leq 0.01$) correlated to the fruit circumference. Similarly, the LA was positive and highly significantly (0.01) correlated to the TDM and the RGR while positive and highly significantly ($P \leq 0.01$) correlated to the vine length. The result further shows that number of leaves per plant, total dry matter and days to 50% flowering were not significantly correlated to the fruit yield.

The significant and positive correlation between yield and leaf area, leaf area index and vine length indicated the role the photosynthetic surface area plays in the yield of pumkin. It also shows that increasing the photosynthetic surfaces area increases yield of the crop per hectare. Similarly, the positive correlation between fruit yield and CGR, RGR and the fruit circumference showed that increase in these characters contribute to increase in fruit yield. This agrees with the findings of Lawal (2000), Aissami (2005) and Lawal *et al.* (2009).

**Regression Analysis**

Figures 1 and 2 shows the combined regression analysis between pumpkin yield against defoliation severity and combined regression analysis between pumpkin yield against farm yard manure rates in 2012 and 2014 rainy seasons respectively. The combined regression equations for yield against defoliation severity was quadratic, such that the optimum yield per hectare for Yar-Madina variety was 7443 kg $ha^{-1}$ at 25% defoliation severity (regression equation, $y = 1.368x^2 + 64.1x + 6696$), while Ex-Ajiwa yielded 7899 kg $ha^{-1}$ at 25% defoliation severity (regression equation, $y = 2.711x^2 + 117.9x + 6644$).

The highest yield and optimum rate of farm yard manure for the combined regression was not attained because the regression equations was linear ($y = 418x + 5478$ and $y = 505x + 4501$ being regression equations for Yar-Madina and Ex-Ajiwa respectively). The regression analysis showed a quadratic response of fruit yield per hectare to defoliation severity which indicated that the optimum defoliation severity that pumpkin can tolerate was attained at 25% while linear responses was observed on FYM rates, indicating that the optimum levels was not obtained at 10 t $ha^{-1}$.

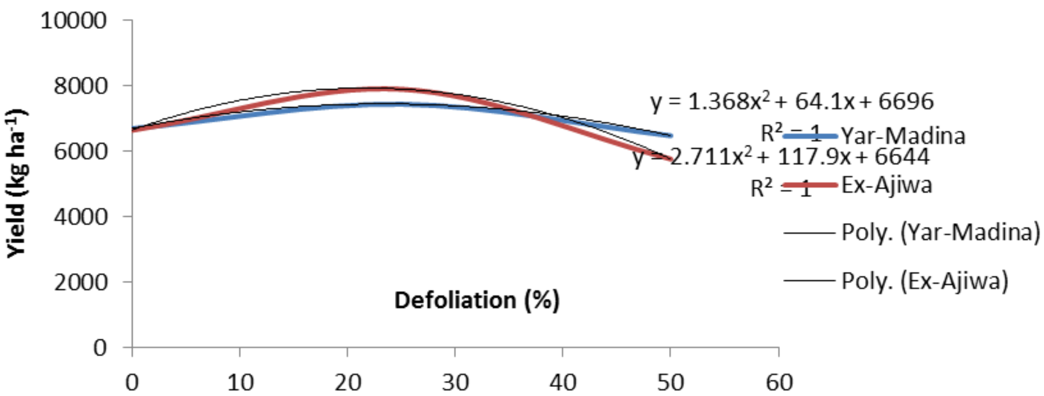


**Figure 1: Combined regression of defoliation severity against yield of pumpkin in 2012 and 2014 rainy seasons at Samaru.**

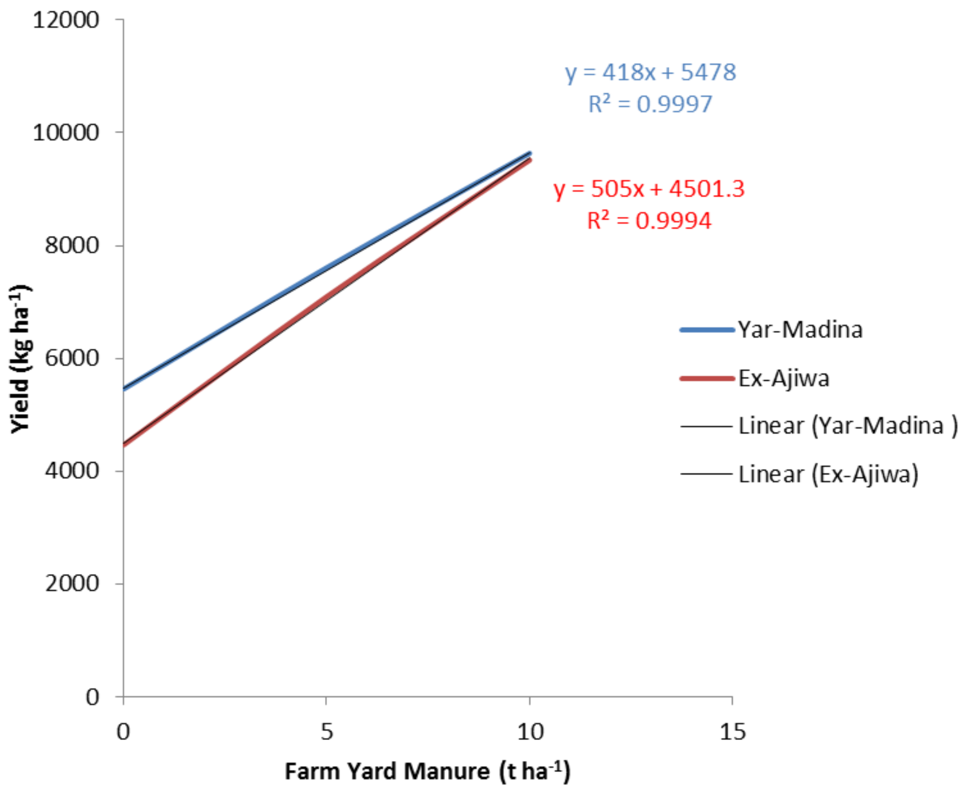


**Figure 2: Combined regression of farm yard manure against yield of pumpkin in 2012 and 2014 rainy seasons at Samaru.**

## CONCLUSION

The significant and positive correlation between yield and leaf area, vine length and leaf area index indicated that these characters evaluated significantly contribute to pumpkin fruit yield. It means increasing the photosynthetic materials increased yield of the plant. Similarly, the positive correlation between fruit yield and CGR, RGR and the fruit circumference showed that increase in these parameters contribute to increase in fruit yield.

The quadratic response of fruit yield per hectare to defoliation severity indicated that the optimum defoliation severity that pumpkin can tolerate was attained at 25% while linear responses were observed on FYM rates, indicating that the optimum level was not obtained at 10 t $ha^{-1}$.

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**Table 1: Matrix of combined correlation coefficients between some growths and yield characters of squash pumpkin during the 2012 and 2014 rainy seasons at Samaru, Nigeria.**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 Yield (t) per hectare | 1.000 | | | | | | | | | |
| 2 Crop growth rate | 0.337* | 1.000 | | | | | | | | |
| 3 Fruit circumference | 0.291* | 0.312* | 1.000 | | | | | | | |
| 4Days to 50% flowering | 0.57$^{NS}$ | -0.201$^{NS}$ | 0.004$^{NS}$ | 1.000 | | | | | | |
| 5 Total dry matter | 0.239$^{NS}$ | 0.234$^{NS}$ | 0.366** | -0.021$^{NS}$ | 1.000 | | | | | |
| 6 Leaf area | 0.465** | -0.178$^{NS}$ | 0.119$^{NS}$ | 0.032$^{NS}$ | 0.333** | 1.000 | | | | |
| 7 Leaf area index | 0.293* | 0.223$^{NS}$ | 0.025$^{NS}$ | -0.102$^{NS}$ | 0.017$^{NS}$ | 0.121 $^{NS}$ | 1.000 | | | |
| 8 Vine length | 0.337* | 0.197$^{NS}$ | 0.233$^{NS}$ | 0.021$^{NS}$ | 0.235 $^{NS}$ | 0.279* | 0.119 $^{NS}$ | 1.000 | | |
| 9 Number of leaves | 0.119$^{NS}$ | 0.210$^{NS}$ | 0.075$^{NS}$ | 0.031$^{NS}$ | 0.229$^{NS}$ | 0.162$^{NS}$ | 0.132$^{NS}$ | 0.315* | 1.000 | |
| 10 Relative growth rate | 0.406** | 0.235$^{NS}$ | 0.188$^{NS}$ | -0.218* | 0.072$^{NS}$ | 0.351** | 0.088$^{NS}$ | 0.224$^{NS}$ | 0.001$^{NS}$ | 1.000 |

**Keys**

** = Highly Significant at 1%

* = Significant at 5%

Ns = Not significant

DF = N-2=52

Table value at 5% = 0.268

Table value at 1% = 0.348