1st PROCEEDINGS

THE UNIVERSITY OF THE SOUTH PACIFIC

EDUCATION EXCELLENCE 50 YEARS 1968 2018

Celebrating the Pacific, Shaping its Future

INTERNATIONAL SOCIETY FOR TROPICAL ROOT CROPS

International Society for Tropical Root Crops-Pacific Branch

The First Symposium of the International Society for Tropical Root Crops - Pacific Branch

"Improving Root and Tuber Crops in the South Pacific Region"




24—27 April 2018

Tanoa International Hotel, Nadi, Fiji

The First Symposium of the International Society for Tropical Root Crops - Pacific Branch

USP
THE UNIVERSITY OF THE SOUTH PACIFIC
EDUCATION EXCELLENCE 50 YEARS 1968 2018

Celebrating the Pacific, Shaping its Future

INTERNATIONAL SOCIETY FOR TROPICAL ROOT CROPS

The University of the South Pacific Alafua Campus

ISBN 978-982-98150-4-0

9 789829 815040

Title : Improving root and tuber crops in the South Pacific region

Growth and Development of Taro Plants Applied with Controlled and Fast-release Nitrogen Fertilizers

Walter Faamatuainu[26] and Falaniko Amosa[27]

Abstract: Two field experiments were conducted to determine growth and development of Taro plants to which controlled release (CR) and fast release (FR) fertilizers were applied. Our results showed that FR nitrogen fertilizers was maximum at both sites. Also, FR nitrogen fertilizers produced the highest CI (Chlorophyll index) at 2, 3, 4, 5 MAP (months after planting) at both sites. At 6 MAP, FR and CR nitrogen fertilizers produced the highest CI at Mt Hope and Orange Grove respectively. As a result, FR nitrogen fertilizers produced the highest Taro heights and CI throughout the growing season.

Keywords: *Taro, Nitrogen, Release, Dry Matter.*

Introduction: Understanding the growth and development of taro plants is important because it is the prerequisite for determining the suitable time to harvest taro. Meanwhile, fertilization reduces the number growth and development stages for taro plants from six to four, as result, higher yields are obtained in shorter span of time. Fertilization also prolongs the vegetative stage which influenced partitioning of dry matter to the above and below portions of taro plants (Fa'amatuainu and Amosa, 2017; Lebot, 2009);

even though there are a number of studies that discuss the influence of applying varying nitrogen levels to taro plants (Fa'amatuainu, 2016; Faamatuainu and Amosa, 2016). There is a scarcity of information on the influence of FR and CR fertilizers on growth and development of taro plants. The use of CR fertilizers has been limited to high-value cash crops invariably produced in the Pacific region. Global population growth is promoting scientists and agronomists to explore avenues for maintaining food security. Therefore, this study intends to determine the growth and development of taro plants treated with CR and FR fertilizers.

Methodology: Field experiments on two sites were conducted at the UWI Field Stations in Mt Hope (10°38'17.16 North, 61°25'40.8 West) which contain River Estate soil series, fluventic eutropepts and Orange Grove soil series, aeric tropaquepts. Repeated trails were established as replications provide a powerful way of learning about natural systems and establishing causal relationships.

The experiments were setup in a factorial design layout in randomized complete block design with three replications. The factors include four nitrogen treatments (urea, calcium nitrate, polymer coated urea and control), three harvests (two, four, and six MAP) and two sites.

Taro suckers (uniform size of the local "Blue" taro cultivar) from farmers were used as planting materials. Each plot contains fifty-one plants (55 X 55 cm spacing, 33,025 plants per hectare) whereby the inner fifteen plants were used for data collection.

Fertilizers (100 kg/ha rate) were applied in the first month of planting, with the FR urea and calcium nitrate applied in split applications while the CR polymer coated urea was applied in a single application. Phosphorus (50 kg P/ha) was applied using triple superphosphate while potassium (100 kg K/ha) was applied as muriate of potash to the experimental plots at both sites before planting. The field experiments were kept free from weeds throughout by hand-weeding and spraying with the Gramoxone herbicide.

Number of leaves, plants height and indicators of chlorophyll indices were collected on a fortnightly basis. Chlorophyll index measurements were taken using the FieldScout CM1000 chlorophyll meter which uses a point and shoots action to instantly estimate the relative chlorophyll content of taro leaves. Fifteen taro plants per treatment were used for our measurement. Analysis of variance (ANOVA) was performed on the data collected using the SPSS20 statistical software.

Results: Figure 1 in Appendix shows the heights of Taro plants from 1 to 6 MAP, under the influence of CR and FR nitrogen fertilizers. The ANOVA reveal that interactions between sites, nitrogen sources and MAP were statistically significant (P <

[26] Student of the School of Agriculture and Food Technology (Samoa).

[27]Lecturer in the School of Agriculture and Food Technology, (Samoa).

0.05) for various taro heights. At 1 and 2 MAP, the highest heights were attained as a result of calcium nitrate and urea respectively. Further, urea produced highest heights at 3 MAP while calcium nitrate produced the same at 4, 5 and 6 MAP in Mt Hope. In Orange, calcium nitrate produced the highest heights at 1, 2, 3, 4, 5 and 6 MAP. Hence, these results show that FR nitrogen fertilizers produced highest heights throughout.

Unfortunately, so far, there are no studies in the literature that examined differences in the heights of taro plants as a result of CR and FR nitrogen fertilizers. The trend in taro heights from our experiment was also reported from taro cultivars in Samoa whereby the heights increased during the early growth stages, before gradually declined as the plants approached maturity (Faamatuainu and Amosa, 2016).

Figure 2 in Appendix shows the chlorophyll indices (in CI) of taro plants from 1 to 6 MAP, under the influence of CR and FR nitrogen fertilizers. The ANOVA revealed that interactions between sites, nitrogen sources and MAP were statistically significant ($P < 0.05$) for taro CIs. At 1 MAP, polymer coated urea produced the highest CI while urea produced the highest CI at 2 and 3 MAP in Mt Hope. Further, calcium nitrate produced the highest CI at 4, 5, and 6 MAP in Mt Hope. At Orange Grove, urea produced the highest CI at 1, 2, 3, 4 and 5 MAP while polymer coated urea produced the highest CI at 6 MAP.

Our results show that FR nitrogen fertilizers produced the highest CI during most of the six month's growth period. Hence, rapid nitrogen supply by FR fertilizers leads to maximum CI in taro plants. Despite differences in the time whereby taro plants at both sites achieved the highest CI, application of FR nitrogen fertilizer overwhelmingly produced the highest CI at both sites.

Figure 3 in Appendix show the number of leaves of taro plants from 1 to 6 MAP, under the influence of CR and FR nitrogen fertilizers. The ANOVA reveal that interaction between sites and MAP was statistically significant ($P < 0.05$) for taro leaves. The highest number of leaves production was reported at 3 MAP in Mt Hope. At Orange Grove, the number of leaves increased from 1 to 6 MAP and the application of urea produced maximum leaves. Hence, rapid nitrogen supply by FR fertilizers leads to the higher production. Other researchers had concluded that taro plants had fewer leaves at 1 and 2 MAP, and rapid leaves development at 3, 4 and 5 MAP (Faamatuainu and Amosa, 2016).

Conclusion: Taro plants have a strong positive response to FR nitrogen fertilization. Overall, the growth and development parameter such as plant heights and number of leaves increased as a result of FR fertilizers. It was also noted that nitrate fertilizers performed better than ammonium fertilizers. This is probably due to the fact ammonium fertilizers acidified the growth medium which leads to stunted growth and development in plants.

Acknowledgements: Much appreciation to the EU for funding through the CARPIMS scholarship and the support by the Department of Food Productions.

References

Fa'amatuainu, W. (2016). Dry matter accumulation and partitioning of two improved Taro (Colocasia esculenta (L.) Schott) cultivars under varying nitrogen fertilization rates in Samoa, The University of the South Pacific, Samoa.

Fa'amatuainu, W., and Amosa, F. (2017). Dry matter accumulation and partitioning of two Taro (Colocasia Esculenta (L.) Schott) cultivars under Inceptisol soils in Samoa. *The South Pacific Journal of Natural and Applied Sciences* **34**, 40-43.

Faamatuainu, W., and Amosa, F. (2016). Effect of Nitrogen Fertilization on the Physiological Aspects of Two Improved Taro Cultivars (Colocasia esculenta (L.) Schott in Samoa. *American-Eurasian Journal of Agricultural & Environmental Sciences* **16**, 1462-1466.

Lebot, V. (2009). "Tropical root and tuber crops: cassava, sweet potato, yams and aroids," Cabi.

Appendix

Figure 1: Heights of Taro plants

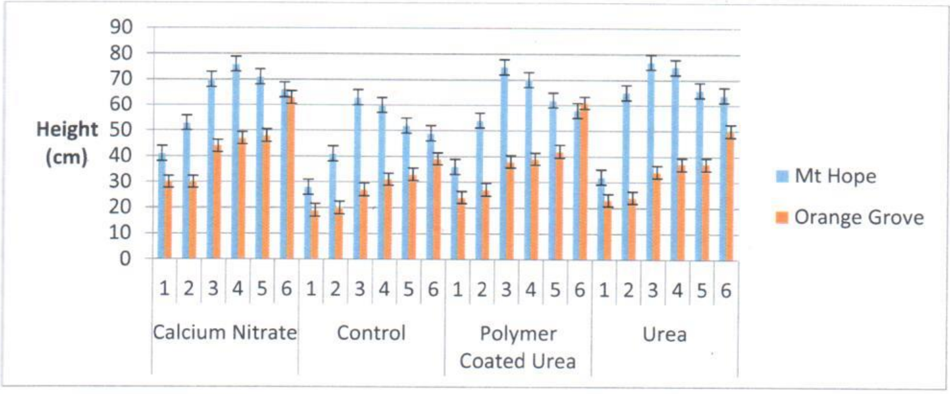


Figure 2: Chlorophyll indices of Taro plants

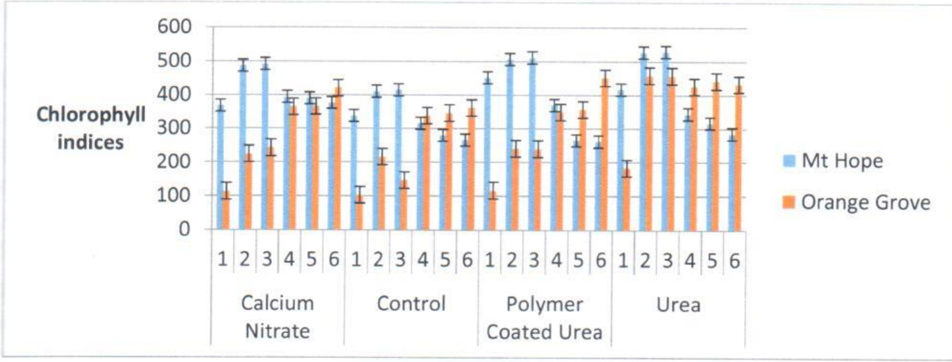
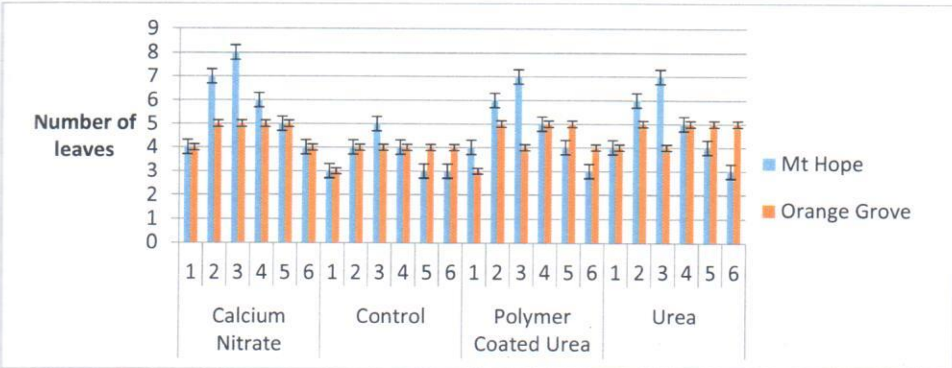


Figure 3: Leaves developed by Taro plants



Growth and Developmental Responses of Taro to Nitrogen Fertilizer in Vanuatu

Pakoa Leo[28], Falaniko Amosa[29]

Abstract: Field experiments to investigate effects of inorganic amendments on growth and development of two taro cultivars (Sakius & Tarapatan) laid out in a split-plot design were conducted. The study revealed that nitrogen treatments had significantly increased plant height, leaf area, corm fresh weight, corm dry weight, roots, petiole and leaf dry weights, as well as leaf and sucker numbers. However, no significant difference were noted between 100 N Kg/ha and 200 N kg/ha on these parameters except for leaf numbers and corm fresh weight.

Keywords: Agronomy, Colocasia esculenta, Inorganic Nitrogen Fertilizer, Corm

Introduction: Tropical root crops are an important staple food for the Pacific. However, their yields are generally low and inorganic fertilizer are considered an option to increase root crop production. Nitrogen is the most common element which is deficient in tropical soil (Sanchez, 1979) and it is the only nutrient that can be added to the soil by biological fixations. However Hartemink, (2000) stated that many cropping system in the tropics do not add adequate N through this method to replace the loss of nitrogen through crop removal, leaching or de-nitrification.

In the Pacific region, most cropping systems are built around shifting cultivation (Jacob and Clark, 1993); and with increased demand for food, length of fallow periods have diminished. Consequent availability of nitrogen (through organic matter) is therefore low and this leads to a greater need for higher nitrogen application to support high crop yields. However, farmers must be wary of off-site effects, environmental contamination and cost of increased fertilisation (Hartemink, 2000).

Taro (*Colocasia esculenta)* is one of the most popular root crops for the Pacific and has become a mainstay of many Pacific Island cultures (FAO, 2010). The crop is cultivated mainly in tropical climates with rainfall in excess of 2,000 mm/annum evenly distributed throughout the growing season (Manrique, 1995; Bradbury and Holloway, 1988). Taro has a relative high nitrogen requirement during its early growth stages. However, its responses to nitrogen fertilization are strongly modified by environment, cultivar, and crop management (Manrique, 1995).

There is a good body of literature on the use of inorganic fertilizer on taro production. For example, nitrogen application for optimum yield are 40 to 80 kg/ha for Vellayani area and 0 to 120 kg/ha for Kerala area both in India (Kumar *et al.* 1991; Ashokan and Nair (1984); 30 to 60 kg/ha of N in Philippines (Pardales *et al.*, (1982b). Manrique's (1995) review of the past literature on nitrogen requirements of taro concluded that 95% of maximum yields can be attained at 100 kg N/ha, but the uptake can be different for different soil types. In this study, response of growth and development of taro were evaluated in the reddish clay loam soil under a screen house in Vanuatu.

Methodology: The research was conducted at the Vanuatu Agriculture Research Technical Centre (VARTC), Valeteruru Espiritu (Santo) located at 15°25`S, 167°6`E. The maximum mean temperature during the trial phase (June 2014 to January 2015) was 30°C while minimum mean was 21°C. Annual average humidity was 85% with total rainfall of 1,114mm. The soil was a reddish brown clay

[28]Research Scientist, Vanuatu Agriculture Research Technical Centre, Port Vila (Vanuatu).

[29]Lecturer, School of Agriculture and Food Technology, the University of the South Pacific, (Samoa).

loam soil overlaid on limestone Quantine (1982) and Marie *et al*, (2002). Soil's physical and chemical properties of the general site of the A horizon (0-20 cm) were as follows: Organic matter 5.41%, Clay 47.80%, Silt 30.30%, Fine sand 7.58%, Course Sand 8.96%, Organic Carbon 2.82%, Nitrogen 0.32%, C/N 8.9 and exchangeable cations such as Calcium was 17.70%, Magnesium 3.45%, Potassium 1.22% with no Sodium.

The experiment was laid out in a split plot design with two cultivars (Sakius & Tarapatan) in main plots, three levels of nitrogen (0, 100 and 200 kg/ha) as sub-plots and three harvest times (2, 4 and 6 months after planting). Sulphate of ammonia (46 % of nitrogen) were casted around the plants in each pot. Two split applications of equal amounts were applied first during 2 days after planting and second, 6 weeks after planting. Taro was planted at a depth of 30 cm in pots.

Planting material were taken from the main plants and consisted of apical portion of the corm 25-30 cm of the petiole above corm. The corms were cut 3cm below the petioles. The planting materials were roughly of the same sizes and were weighed approximately 250g each. The pots were arranged in 1m x 1m spacing. Taro setts were planted on the 16th of July 2014. At each harvest, fresh weights of tubers, roots, petioles and leaf were measured. Sucker and leave number were also counted and recorded at each harvest. The plants were washed, air-dried to remove excess moisture and were dissected into petioles, corms and roots. The samples were then placed inside separated labelled bags for oven dried at 60% for 24 hrs.

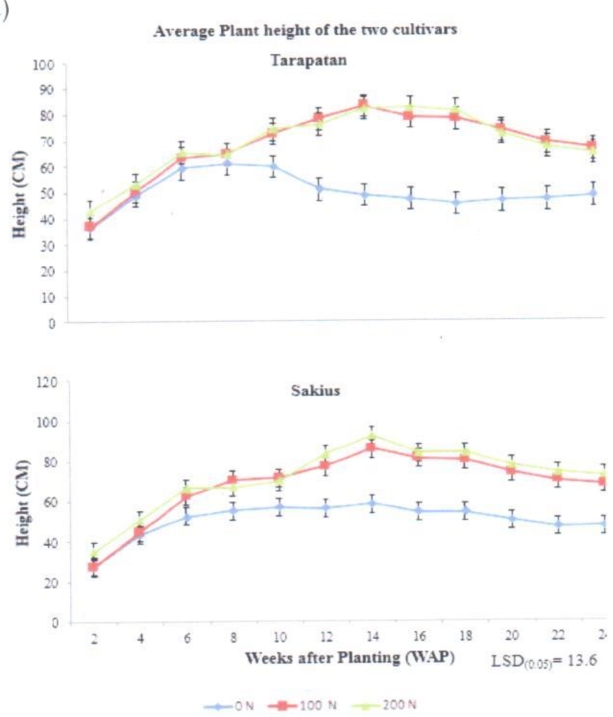
Data analysis was based only on blocks 1 and 2 since block 3 had a high shading effect. Data collected from each harvest were subjected to standard analysis of variance (ANOVA) for a split plot using the statistical package Genstat. An analysis was done overtime on the three harvests of a split plot to test the effect of time with replication by soil management (levels of N). F-test was used to test for treatment differences at 5% level and LSD values were used to compare between the treatment means.

Results: Figure 1(a) to (i) shows the taro plant growth and developmental responses to the 3 levels through a 6 month growing period. Figure (a) shows significant difference ($P<0.05$) in plant height between the 3 N levels and also overtime (WAP) ($P<0.01$). However no significant difference were detected in plant height between the two cultivars. Maximum plant height were achieved at the vegetative phase of the crop (113 DAP) which confirm results by Kumar *et al*, (2007) and Mare (2006) who found that plant height, leaf number and leaf area reached maximum at 120 days after planting. These results also agree with Mare (2009) and Manrique (1995) that different cultivars respond differently to N fertilization.

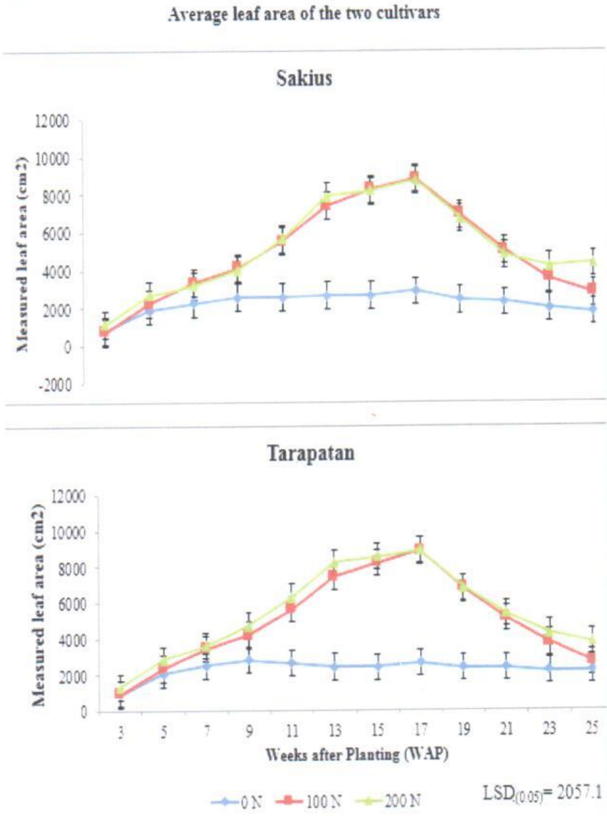
The two cultivars leaf area in Figure (b) follow a similar pattern throughout the growth phase and increase as the level of N increase to 200 N kg/ha. However the increase was not significant between the two cultivars. The application of N had a significant effect ($P<0.05$) on the leaf area growth of the two cultivars overtime. Maximum leaf area (5923 cm^2) of the two cultivars was achieved at 17 WAP which was at the vegetative phase of the crop. The findings from this study is supported by Goenaga (1995), Pardales (1985), Mare (2006) and Singh et al. (1992). Leaf number (Figure c) between the two cultivars shows a significant difference ($P<0.05$) where Sakius has more leaf compared to Tarapatan. The leaf number were not influenced by N levels.

Figure 1: Taro Plant Growth and Development Responses

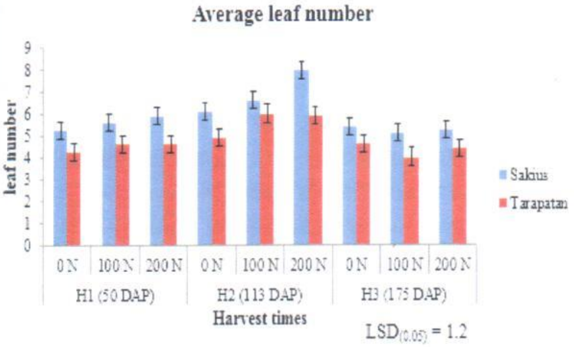
a)



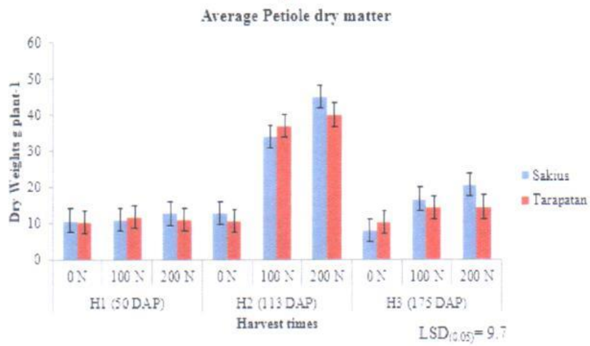
b)



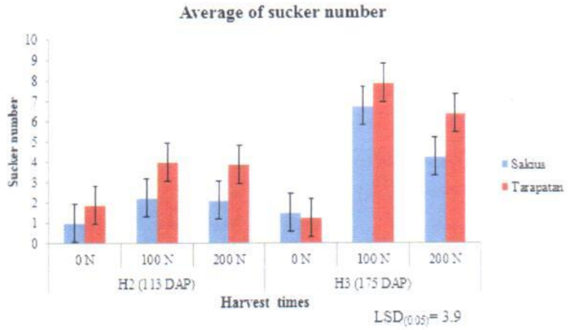
c)


Average leaf number
leaf number
Sakius
Tarapatan
0 N
100 N
200 N
H1 (50 DAP)
H2 (113 DAP)
H3 (175 DAP)
Harvest times
LSD(0.05) = 1.2

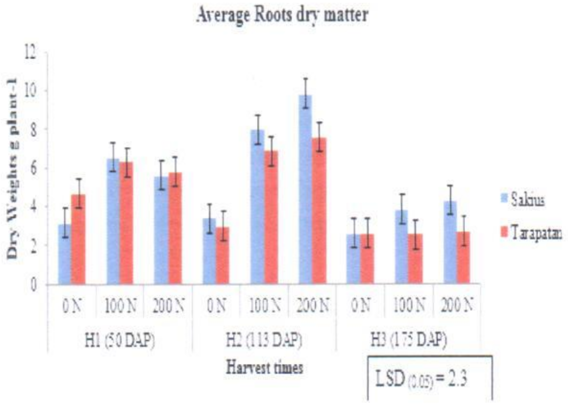
f)


Average Petiole dry matter
Dry Weights g plant-1
Sakius
Tarapatan
0 N
100 N
200 N
H1 (50 DAP)
H2 (113 DAP)
H3 (175 DAP)
Harvest times
LSD(0.05)= 9.7

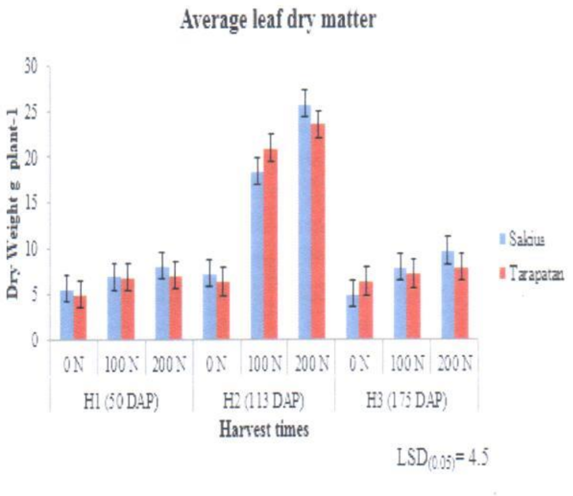
d)


Average of sucker number
Sucker number
Sakius
Tarapatan
0 N
100 N
200 N
H2 (113 DAP)
H3 (175 DAP)
Harvest times
LSD(0.05)= 3.9

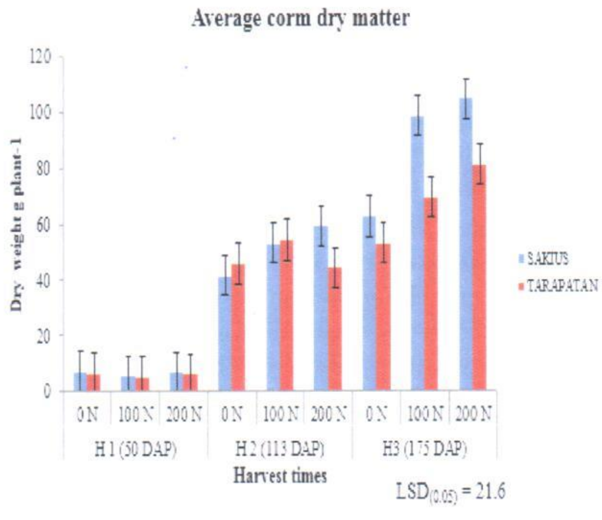
g)


Average Roots dry matter
Dry Weights g plant-1
Sakius
Tarapatan
0 N
100 N
200 N
H1 (50 DAP)
H2 (113 DAP)
H3 (175 DAP)
Harvest times
LSD (0.05) = 2.3

e)


Average leaf dry matter
Dry Weight g plant-1
Sakius
Tarapatan
0 N
100 N
200 N
H1 (50 DAP)
H2 (113 DAP)
H3 (175 DAP)
Harvest times
LSD(0.05)= 4.5

h)


Average corm dry matter
Dry weight g plant-1
SAKIUS
TARAPATAN
0 N
100 N
200 N
H1 (50 DAP)
H2 (113 DAP)
H3 (175 DAP)
Harvest times
LSD(0.05) = 21.6