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Influence of nitrogen levels on *Dracaena sanderiana* L. varieties in dry zone, Sri Lanka

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Abstract

An experiment was carried out to determine the effect of graded nitrogen levels on three dracaena (Dracaena sanderiana L.) varieties viz. 'Gold', 'Victory' and 'White' at the Eastern University, Sri Lanka . Plants were grown at 70% shade house. Nitrogen doses used were 0.5, 1.0, 1.5, 2.0 g/plant/ month. Completely randomized design was used as experimental arrangement. Measurements were taken at monthly interval and data were analyzed statistically. The results revealed that dracaena varieties showed highest performances in measured growth parameters such as plant height, leaf area and plant biomass at 1.0 and 1.5 g/plant/month nitrogen levels significantly (p<0.05). Lower (0.5g/plant/month) and higher (2.0 g/plant/month) nitrogen levels reduced the growth of dracaena varieties. Polynomial regression analysis showed that, optimum nitrogen level for maximum biomass production of dracaena varieties is in the range of 1.11 – 1.15 g/plant/month. Therefore, this experiment concluded that, nitrogen in the range of 1.11 – 1.15 g/plant/month is optimum for the growth of dracaena varieties in the dry zone, Sri Lanka at 70% shade level.

Keywords: Biomass, dracaena, leaf area, nitrogen levels, polynomial regression analysis.

Introduction

Dracaena (*Dracaena sanderiana* L.) is a famous foliage plant with great demand in the global markets. In Sri Lanka, large scale dracaena nurseries are available[1] and it is commercially produced for export markets. However, the commercial growers are facing difficulties of poor productive potential because of reduced growth rate of plants. Fertilizer management is important for foliage crops as it influences growth and quality. The major nutrient required for optimum growth of plants is nitrogen. Nitrogen affects both, leaf colour and variegation, the basic quality parameters in foliage plants[2].

Application of optimum amount of nitrogen is important to achieve better growth and high quality foliage. Optimum amount of nitrogen for dracaena varieties have not been recommended for different agro climatic regions of Sri Lanka. Gold', 'Victory' and 'White' are popular diversities of Dracaena in Sri Lanka. Accordingly this experiment was carried out to quantify the effect of different levels of nitrogen application on vegetative growth and quality of dracaena varieties and to find the optimum nitrogen level for the growth of dracaena varieties in the dry zone, Sri Lanka.

Materials and methods

The experiment was done to evaluate the results of graded nitrogen doses (0.5, 1.0, 1.5, 2.0 g/plant/month) on three dracaena varieties viz. Gold', 'Victory' and 'White' at the Crop Farm, Faculty of Agriculture, Eastern University, Vantharumoolai (7.7976°N, 81.5820°E), Sri Lanka. Average temperature and relative humidity during the experimental period was 34 ± 2°C and 64 ± 4%, respectively. Uniform sized, rooted and one-month old cuttings were obtained from conventional propagation techniques.

The rooted cuttings were planted in polybags. Poly bags were filled with potting media containing of loam soil, compost, cattle manure, and sand (ratio 4: 2: 1: 1 at volume basis).

Completely randomized design (CRD) was used as experimental arrangement. Each treatment contained 30 replications. An experimental unit consisted of one plant. The treatments were arranged in 70% shade level as recommended by Srikrishnah *et al*.[3]. 30 plants were allocated in 1m^2 area. The phosphorous and potassium levels were kept constant throughout the experiment (Table-1).

Other agronomic management practices were followed uniformly. The crop was grown for six months. Plant height (cm), leaf area (cm^2) and dry weight of plant biomass (g) were recorded at monthly interval and destructive sampling was practiced. Statistical Analysis System (SAS) was used to perform Analysis of Variance to define significant ($p<0.05$) differences among treatments. Tukey's test was used for the comparison of treatment means at the 0.05 probability level.

The polynomial type of production function was applied[4] to determine the optimum nitrogen level for different dracaena varieties in dry zone, using the equation:

$Y = b_1 + b_2X + b_3X^2 + e$

Y = depended variable; X = in depended variable; e = error term; $b_1 > 0$; $b_2 > 0$ and $b_3 < 0$ where b_1 is the intercept, b_2 is the slope of curve and b_3 is the curvature of the curve. The optimum level of nitrogen was determined as follows:

$$\frac{dY}{dX} = b_2 + 2b_3 X = 0$$

Results and discussion

Plant height: Height of plant was influenced by the nitrogen levels and the varieties significantly ($p<0.05$) (Figure-1). Variety 'Gold' grown at a nitrogen level 1.5 g/plant/month (g/p/m) had significantly ($p<0.05$) highest plant height among all the treatments and the lowest plant height was noted in variety 'Victory' grown in 2.0 g/p/m nitrogen level at 5 MAP.

Table-1: Different levels of nutrients applied to plants in the experiment.

Treatments	Nitrogen (g/ plant)	Phosphorous (g/ plant)	Potassium (g/ plant)	Frequency of application
N1	0.5	0.5	1.0	Monthly
N2	1.0	0.5	1.0	Monthly
N3	1.5	0.5	1.0	Monthly
N4	2.0	0.5	1.0	Monthly

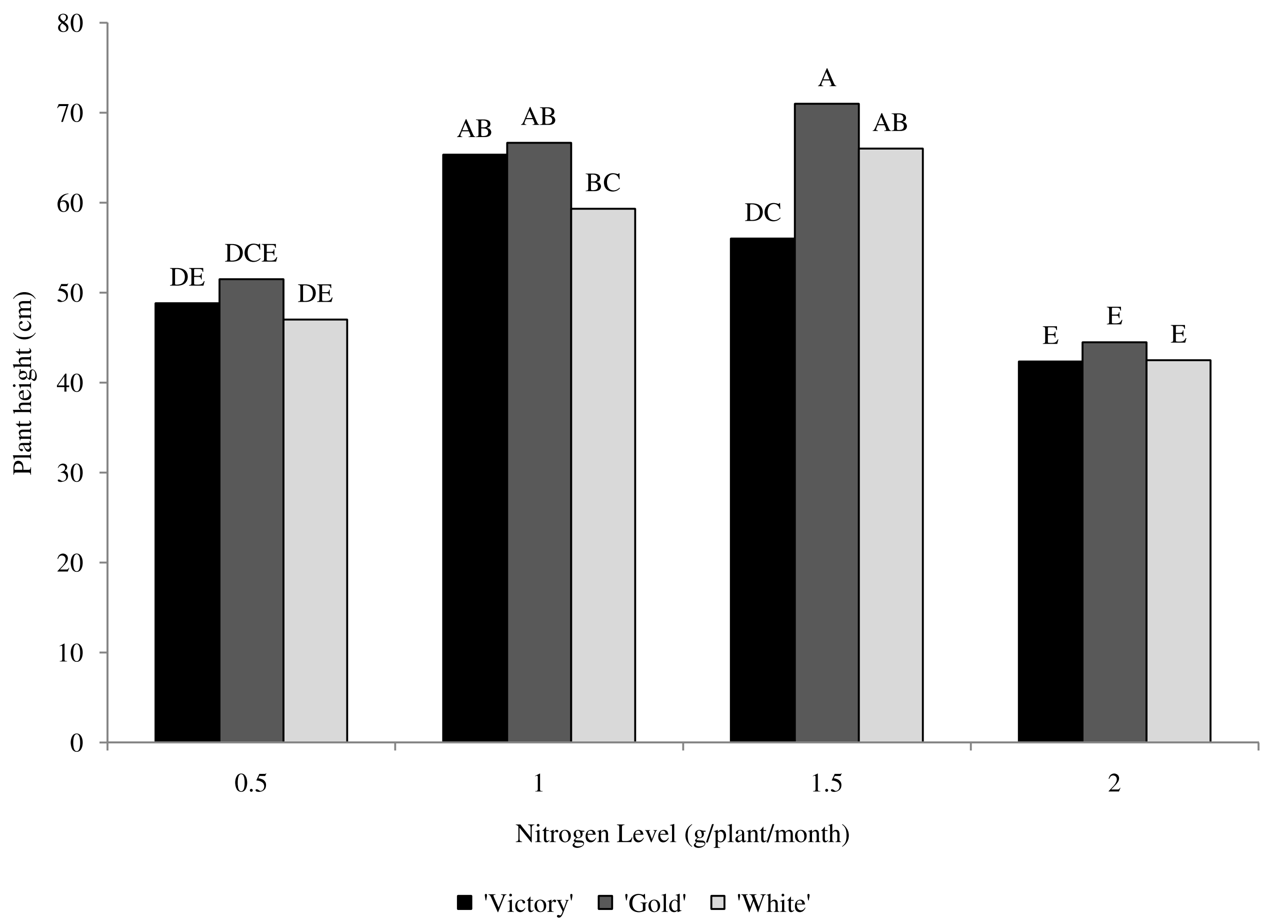

Figure-1: Effect of graded nitrogen levels on plant height of dracaena varieties at 5 months after planting. Bars on the graph with the same letter are not significantly different according to the Tukey test at 5% probability level. (n=3).

All dracaena varieties used in this experiment had lowest plant height at nitrogen level 0.5 g/p/m when compared to plants grown at nitrogen levels 1.0 and 1.5 g/p/m at 5 MAP. Limitation of nitrogen can considerably reduce the growth of plants. This might be the reason for lowest plant height observed in this nitrogen level. Blumenthal *et al.*[5] stated that, nitrogen is essential for improved growth and maximum yield; therefore it must be added in organic or inorganic form.

Growth parameters were increased with increasing nitrogen levels. It is because of the role of nitrogen in encouraging vegetative growth of plants. Nitrogen is an essential component of the proteins, nucleic acids and nucleotides that are vital to the plant metabolic function[6]. Height of varieties 'Gold' and 'White' increased with increasing doses of nitrogen up to 1.5 g/p/m while, height of 'Victory' increased up to 1.0 g/p/m nitrogen. This might be due to optimum level of nitrogen in the soil, which encouraged the favorable growth of plants. Hussain *et al.*[7] reported that in asparagaus varieties height increased up to optimum nitrogen level, which has shown positive response and let the plants grow according to genetic makeup. Further cytokinin controls shoot development in plants[8]. Higher nitrogen nutrition increased the delivery of cytokinins in the plants[9].

Dracaena varieties grown at nitrogen level 2.0 g/p/m had shown lowest plant height and reduced growth rate in this study. No differences were observed between the plant height of varieties in this nitrogen level significantly ($p<0.05$). In dracaena varieties, nitrogen would be toxic and suppress the growth at the higher levels. Further higher concentration of nitrogen could cause hormonal imbalance in plants which in turn reduced plant growth. These might be the reasons for this result and necessitate confirmation. Haynes *et al.*[10] indicated that, excessive nitrogen reduced plant height by suppressing growth. Britto and Kronzucker[11] also reported that, nitrogen toxicity cause growth suppression in plants. Ramachandra[12] reported that, plant height and growth rate of china aster (*Callistephus chinensis*) reduced at higher levels of nitrogen.

Leaf area: Leaf area of dracaena varieties were significantly ($p<0.05$) influenced by nitrogen levels (Figure 2). Variety 'Gold' grown at a nitrogen level 1.5 g/p/m produced significantly ($p<0.05$) highest leaf area among all the treatments, while the lowest leaf area was produced by 'White' provided with nitrogen 2.0 g/p/m at 5 MAP.

Dracaena varieties grown at nitrogen level 0.5 g/p/m developed lower leaf area compared to those grown at nitrogen levels 1.0 and 1.5 g/p/m at 5 MAP. Lower than optimum supply of nitrogen to these plants reduced their vegetative growth and subsequently leaf area. Nitrogen has a positive effect on the leaf expansion and total number of leaves[13]. Uhart and Andrade[14] reported that the rate of leaf emergence was reduced shortly during the nitrogen deficiencies and leaf expansion rate and leaf area duration was powerfully reduced.

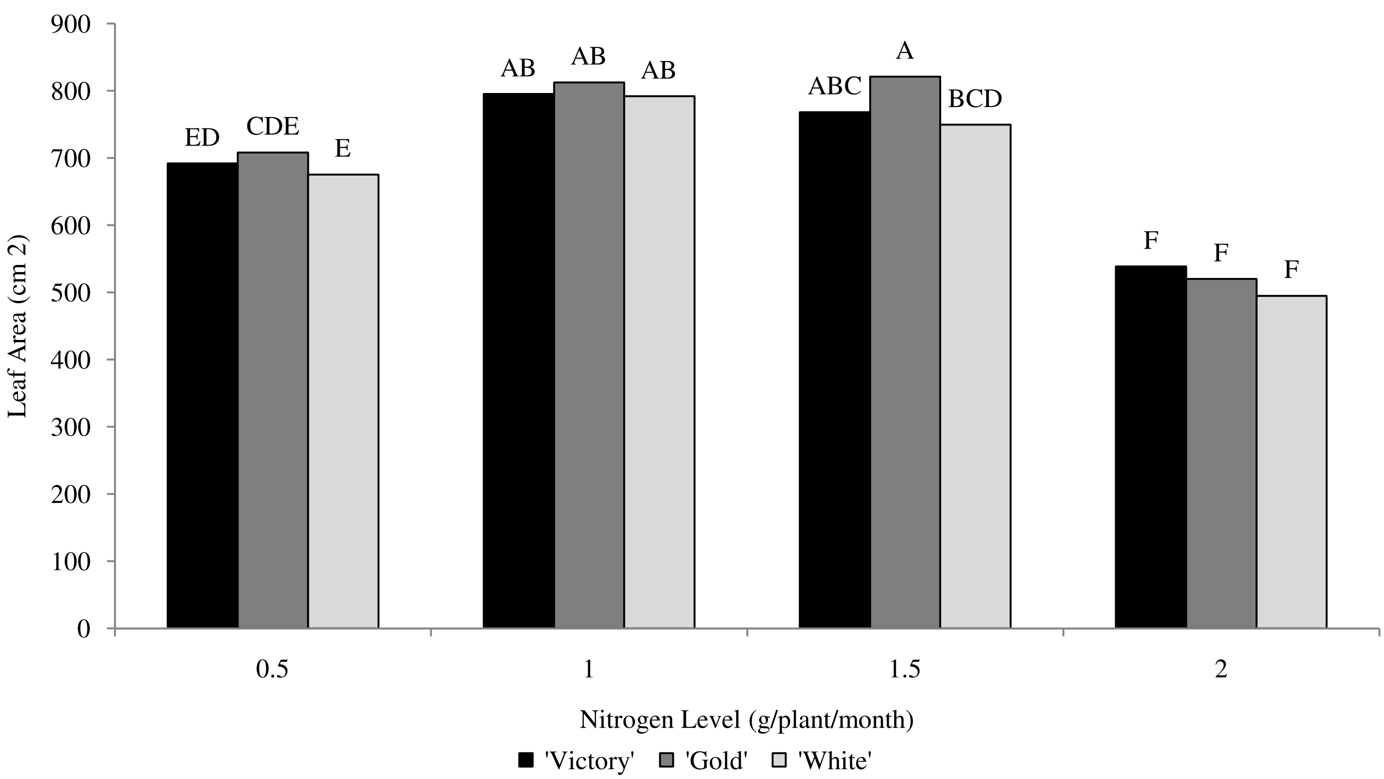

Figure-2: Effect of graded nitrogen levels on leaf area per plant of dracaena varieties at 5 months after planting. Bars on the graph with the same letter are not significantly different according to the Tukey test at 5% probability level. (n=3).

Nitrogen influences every aspect of leaf development viz. leaf initiation, leaf formation and leaf area duration. Plants grown at nitrogen levels 1.0 and 1.5 g/p/m would have received optimum amount of nitrogen. Therefore, they developed maximum leaf area than plants grown at other nitrogen levels in this experiment. Squire *et al.*[15] stated that, increased leaf expansion rate and aid for increased interception of solar radiation by the canopy are the main effects of nitrogen fertilizer. Boroujerdnia and Ansari[16] pointed out that, vegetative growth of plants was improved by the nitrogen fertilizer application by increasing the number of leaves and leaf area.

Dracaena varieties grown at nitrogen level 2.0 g/p/m had produced lowest leaf area. High levels of nitrogen may have reduced the rate of leaf formation and development in dracaena varieties. It may be due to inhibitory effect of nitrogen at higher concentration. Ramachandra[12] reported that in Chinese aster (*Callistephus chinensis*) leaf area increased up to the level of 120 kg nitrogen per ha and reduced at the higher nitrogen levels. Duble[17] also reported that, leaf area of turf grasses is reduced by excess nitrogen in soil.

Plant responses to both high and low soil nitrogen are important[11]. Nitrogen plays a major role in plant physiological processes such as respiration, photosynthesis, translocation and biomass accumulation. Evans[18] pointed out that, there was a close relation between photosynthetic capacity of leaves and nitrogen. It is reasonable, because the Calvin cycle and thylakoids proteins symbolize the major part of leaf nitrogen. Sinclair and Horie[19] reported that, leaf nitrogen content influenced crop biomass accumulation. However, higher photosynthetic activity does not always achieved by higher nitrogen application[20]. Growth encouraged by nitrogen supply is joint with protein synthesis which is done at the cost of carbohydrates. If nitrogen supply is higher than the rate of carbohydrate production, plants' carbohydrate reserves would be depleted. This type of plants will face the hazard of ammonium toxicity and also the plants with insufficient carbohydrates to stimulate the conversion from ammonium to amides or amino acids[21]. Therefore, excess nitrogen supply would suppress the leaf growth of dracaena varieties.

Plant biomass: Nitrogen levels had influence on the biomass of dracaena varieties significantly ($p<0.05$) (Figure-3). Variety 'Gold' grown at a nitrogen level 1.5 g/plant/month (g/p/m) showed highest plant biomass in all the treatments, while the lowest plant height was observed on 'White' along with nitrogen level of 2.0 g/p/m at 5 MAP.

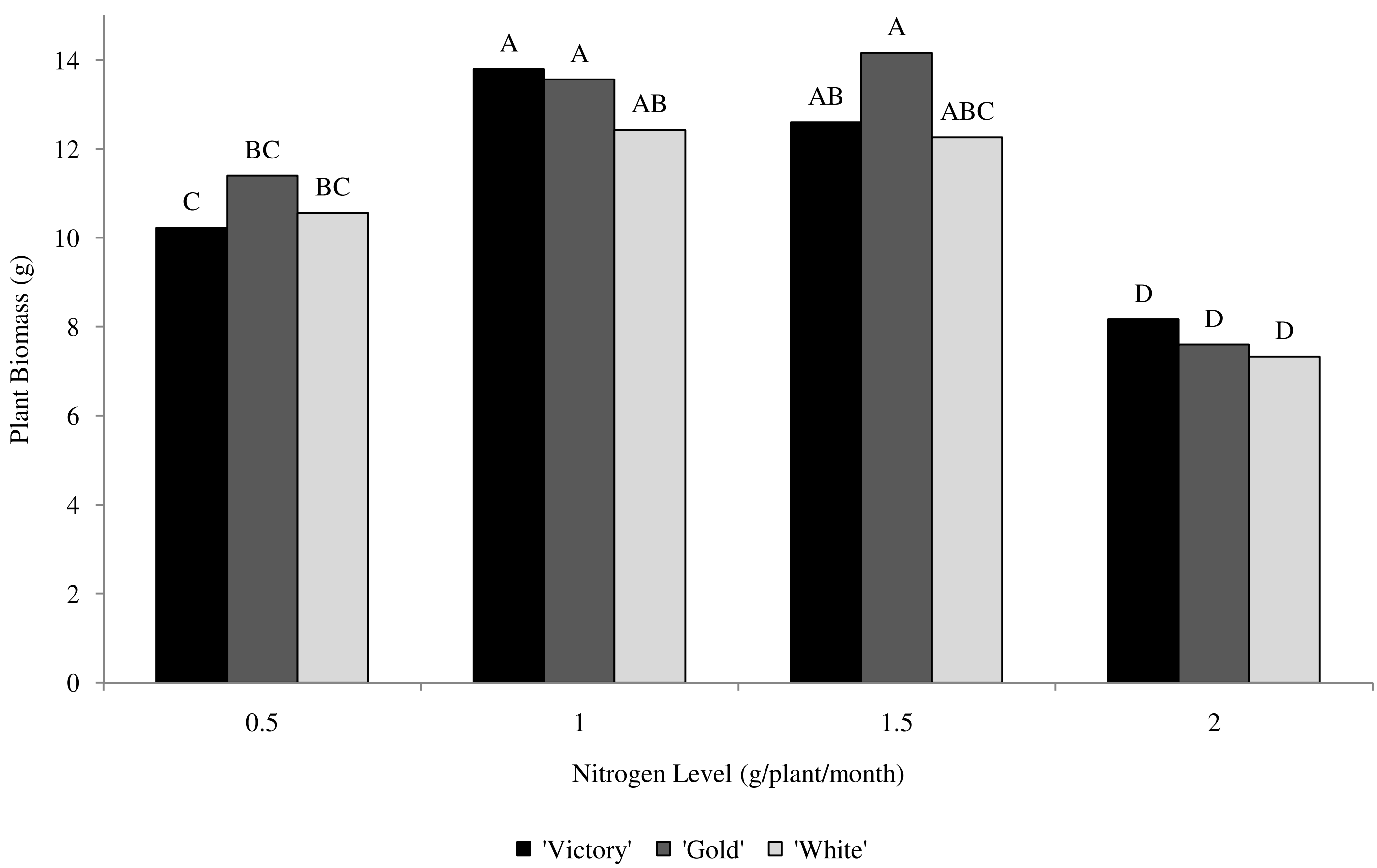

Figure-3: Effects of graded nitrogen levels on biomass of dracaena varieties at 5 months after planting. Bars on the graph with same letters are not significantly different according to the tukey test at 5% probability level. (n=3).

Dracaena varieties grown up at nitrogen level 0.5 g/p/m produced significantly ($p<0.05$) lower biomass than plants that, received nitrogen levels 1.0 and 1.5 g/p/m. Dracaena plants grown at 0.5 g/p/m nitrogen level would have had deficiency in nitrogen. Therefore, plants at this nitrogen level produced lower biomass. Adequate supply of nitrogen is associated with high photosynthetic activity[22]. Uhart and Andrade[14] reported that, radiation interception, radiation use efficiency and dry matter production were affected by nitrogen deficiencies. They also mentioned that, the partitioned dry matter to sinks was also diminished by nitrogen shortages. Pompelli *et al.*[23] reported that the concentrations of chlorophylls and total carotenoids were reduced due to nitrogen deficiency. It would cause reduction of photosynthesis in nitrogen deficient plants.

Highest biomass was formed significantly ($p<0.05$) in Dracaena varieties grown at nitrogen levels 1.0 and 1.5 g/p/m than other nitrogen levels. Further no significant ($p<0.05$) differences were recorded in the biomass of dracaena varieties at these nitrogen levels. Plants grown at these nitrogen levels would have received optimum amount of nitrogen supply. As such high level of their vegetative growth rate and assimilation of carbon were achieved. Leaf area of the plants was also higher at these nitrogen levels. Increased leaf area could contribute for enhanced photosynthesis and subsequently plant biomass accumulation. Optimum nitrogen availability enhances largest leaf area and leads to higher photoassimilates production and dry matter accumulation[16]. Takebe *et al.*[24] mentioned that the combination of nitrogen with plant dry matter formed during photosynthesis viz. glucose, ascorbic acid, amino acids and protein increases the leaf dry weight.

Dracaena varieties grown at nitrogen level 2.0 g/p/m had produced significantly ($p<0.05$) the lowest plant biomass than other nitrogen levels in this experiment at 5 MAP. Dracaena varieties, which were grown at nitrogen level 2.0 g/p/m received comparatively higher nitrogen dosage. Excess availability of nitrogen would have interfered with the carbon assimilation of plants. Excessive nitrogen can affect the source-sink relationship in plants[25]. Tabatabaie and Malakouti[26] reported that, in lettuce (*Lactuca sativa* L.); the yield was increased with increasing level of nitrogen considerably, while decreased amount of yield was observed at highest nitrogen dose. Rincon *et al.*[27] also reported that in lettuce, the yield was increased with increasing nitrogen level up to 100 kg ha^{-1}, however a reduction in yield was recorded at the nitrogen levels 150 and 200 kg ha^{-1}. Onasanya *et al.*[28] pointed out that, excess nitrogen can reduce yield in maize. As such over dosage of nitrogen fertilization could reduce biomass accumulation.

Determination of optimum nitrogen level for dracaena varieties using polynomial regression model: Biomass is a measure of plant productivity. The relationship between plant biomass of dracaena varieties and nitrogen levels is shown in Figure 4. Polynomial models provided the best fit for regression of plant biomass of dracaena varieties and nitrogen levels which was resulted from the regression analysis.

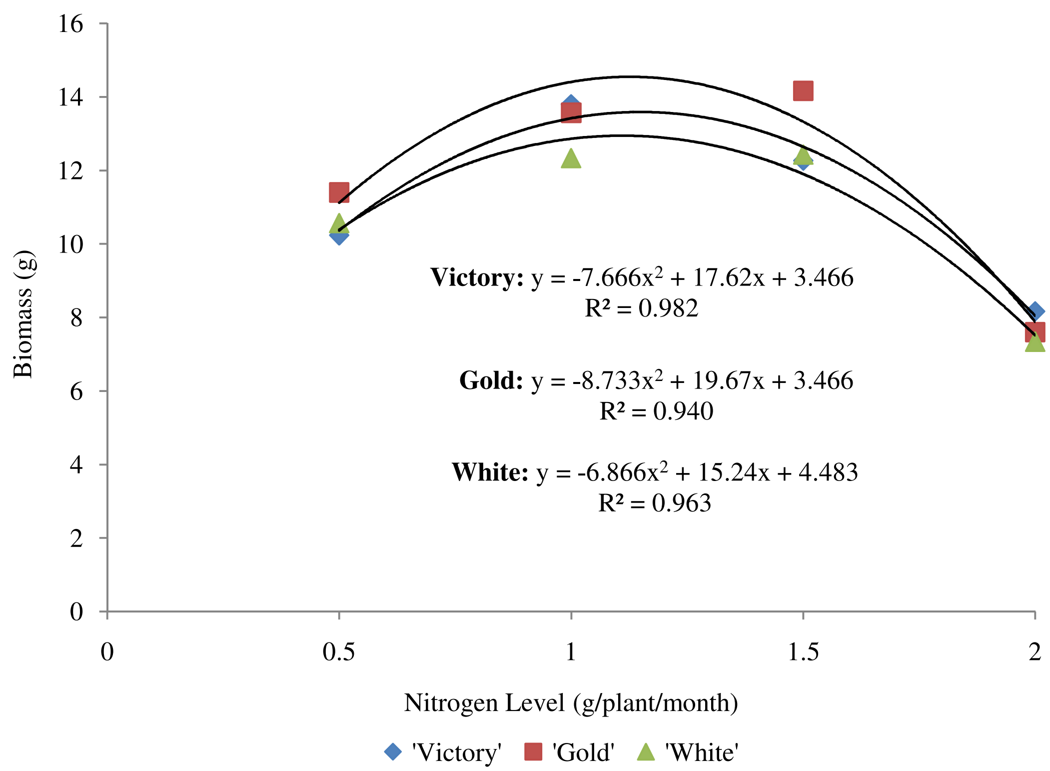

Figure-4: The relationship between plant biomass of different dracaena varieties and different levels of nitrogen at 5 MAP. (n=3).

Significant ($p<0.05$) relationship was observed between plant biomass of dracaena varieties and nitrogen levels at 5 MAP. The response of biomass of different varieties at 5 MAP to nitrogen levels described by the following equations:

Victory: $y = -7.666x^2 + 17.62x + 3.466$ (1)
Gold: $y = -8.733x^2 + 19.67x + 3.466$ (2)
White: $y = -6.866x^2 + 15.24x + 4.483$ (3)

Where **y** = plant biomass (g) at 5 MAP and **x** = nitrogen level (g/plant/month).

The optimum nitrogen level of dracaena varieties for maximum biomass production obtained from this study from quadratic equations is between 1.11 – 1.15g nitrogen/plant/month. This was calculated by equalizing the first derivative of the curve to zero (Figure-4 and equations-1, 2 and 3).

Conclusion

Therefore this experiment concluded that nitrogen in the range of 1.11 – 1.15 g/plant/month is optimum for growing dracaena varieties namely 'Gold', 'Victory' and 'White' in the dry zone, Sri Lanka at 70% shade level.

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