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Effect of NPK Spray Formulation on Growth of Two Cultivars of Orchid (*Mokara* Sp.)

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Abstract: *A pot experiment was conducted at Plant Breeding and Biotechnology Laboratory of Agrotechnology Discipline, Khulna University, during the period from October 2012 to May 2013 to study the effect of NPK spray formulation on growth of two cultivars of Orchid (Mokara sp.). Four spray formulations: control (Tap water), spray formulation 1 (N:P:K = 90:45:45 or 2:1:1), spray formulation 2 (N:P:K = 135:90:45 or 3:2:1), spray formulation 3 (N:P:K = 180:135:90 or 4:3:2) and two cultivars (Mokara Diehard Red and Mokara Yellow Anne) were used as treatment variables. Layout system was Completely Randomized Design (CRD) under factorial arrangement with three replications. Spray formulation had significant influence on growth of the two cultivars tested. Significantly highest plant height was obtained (39.83 cm) at 290 DAP from Mokara Diehard Red Variety with spray formulation 3 compared to other spray formulations. Highest leaf area index (0.16) was obtained from Mokara Diehard Red Variety with spray formulation 3 at 290 DAP mainly due to increased number of leaf and total leaf area. Mokara Diehard Red cultivar with spray formulation 2 enhanced plant growths and resulted greater leaf number (21.33) and leaf length (26.83 cm) to other cultivars cultivated. Plant height as well as other growth parameters was gradually increased due to suitable treatment combination. Results of the study revealed that spray formulation 3 would be suitable for Mokara Diehard Red cultivars cultivation under pot condition.*

Keywords: *Spray, Formulation Cultivars, Growth and Treatment*

I. Introduction

Orchids are one of the momentous groups of flowering plants belong to the largest and most multiform family Orchidaceae. This family consists of about 700-800 genera and more than 25,000 species in the world (Singh and Roy, 2004). Among the flowering plants, orchids are excellent items for garden and can be grown in beds, pots, baskets etc. They are known for their loudly blooms and are found in diverse habitats. Orchids are the most fascinating variety and beautiful of all flowers due to its long life, attractive structures and excellent color (Sing and Voleti, 1995). Orchids have occupied top position among the flowering plants valued for cut flowers as well as pot plants. They exhibit an incredible range of diversity is in shape and size of their flowers. Orchid industry plays an important role as a source of foreign exchange. World-trade in floriculture today has turned over at about $ 76, 62,924 involving more than 150 countries (Manilal and Sathish, 2008).

Orchids vary in their growth habits. Orchids are divided into two types namely sympodial and monopodial on the basis of their growth habit (Royer, 2003). Mokara orchids are monopodial type. The monopodial orchids have indeterminate terminal growth. This type of orchid have aerial root and have no pseudo bulb (Hawkeye, 2005). Mokara orchids are inter-genic hybrids of arachnis × ascocentrum × vanda which have the largest number of colors compared to other orchids. It has an amazing diversity of plant habit flower form and color. It's commonly named by the smile orchid. Due to their delicacy and bright colors with its striking form of a starfish, Mokara are popular in wedding bouquets (Ghoshal and Das, 2008). Both the plants and the blooms vary greatly in shape and size, while the colors at the blooms range from white through flushes to yellow rose and to the deepest possible crimson purple. Orchids grow over wide ranges of climatic conditions. Majority of the cultivated orchids were native of tropical countries and found humid tropical forests of south and Central America (Chakrabarti, 1999). They are also distributed through Mexico, India, Myanmar, China, Thailand, Malaysia, Philippines and Australia (Rao, 2000). Orchids having flowers of charming beauty and good keeping qualities, they are the most wonderful items for indoor decorations (Patil, 2001). As cut flower and pot plants orchids are high demandable items. They are also in different purposes as fragrant, glue, medicine, drinks and flavoring. Orchids are marketed globally and the orchid industry has contributed substantially to the economy of many Asian countries (Laws, 1995). Thailand is now most important centre for

orchid trade and exports about over 100 million dollars in a year (Singh, 2008). There is a scope of large scale production of orchid in Bangladesh to meet the demand of international market and to earn foreign currency through export (Mondal, 2011). Orchids are mainly found in Madhupur (Tangail), Rangamati, Sylhet, Cox's Bazar, Bandarban, Chittagong and Hilly areas of Bangladesh.

Growth features are the first concern for better comprehending about the potential mood of orchid variety. The basic information esteems the growth character and agreeable physiological traits are the almost momentous contemplation for orchid cultivation. Orchid can not uptake nutrient significantly from root so foliar nutrient application is very widespread practice in orchid cultivation. Nitrogen, phosphorus and potassium with different concentration are commonly used as foliar spray.

Application of spray nutrient containing Nitrogen, phosphorus and potassium (NPK) with different concentration varied on the basis of growth period of plants. During vegetative period large quantities of nitrogen are required while during flowering nitrogen should be reduced and amount of phosphate increased. Urea, triple super phosphate and murate of potash were used as a source of nitrogen, phosphorus and potassium in spray formulation. Spray formulation was prepared by mixing of urea, triple super phosphate and murate of potash. Spray formulation of NPK plays a vital role in the growth of orchid. As the orchid are slow growing, slow release fertilizer mixtures can be used to get best result (Hagakl and Imamura, 2007). Orchid should be potted in small container according to the size of the plants. It prefers plastic pots which retain moisture longer than mud pots (Patil and Singh, 2003). To be a prosperous orchid producer its first concern in to comprehend the growth feature and deportment of orchid.

Literature discloses that there are a few research reports in Bangladesh on the effect of NPK spray formulation on growth features of orchid. By contemplate mentally above facts and ground the present study was attempted with following objectives:

1. To find out the suitable concentration of N, P and K in spray formulation for proper growth of two Mokara cultivars.

II. Materials And Methods

A pot experiment was conducted to study the effect of NPK spray formulation on growth of two cultivars of orchid (Mokara sp.) at net house of Plant Breeding and Biotechnology Laboratory of Agrotechnology Discipline, Khulna University, Khulna during the period from October 2012 to May 2013.

2.1 Experimental Material

Two cultivars of orchid (Mokara sp.) were collected from Dipto orchid nursery, Valuka, Mymensingh in the month of October 2012 and age of clone was about three months. These clones were separated from mother plants and cultured for eight months with carpenter dust as supporting materials in plastic pot.

2.2 Experimental site

The experiment was conducted in the net house of Plant Breeding and Biotechnology Laboratory of Agrotechnology Discipline, Khulna University, Khulna to determine the effect of nitrogen, phosphorus and potassium spray formulations on the growth of orchid (Mokara sp.).

2.3Experimental Design and Treatments

The experiment was laid out in factorial completely randomized design (CRD) with eight treatments and three replications. There were two factors used in this experiment viz. orchid cultivars and spray formulation. In the present experiment two cultivars of Mokara sp. and three spray formulations were used along with a control where only tap water was used.

Factor A: Two orchid cultivars

a. Mokara Diehard Red.

b. Mokara Yellow Anne.

Plate 1.Mokara Diehard Red.

Plate 2.Mokara Yellow Anne

Factor B: Four levels of spray formulation
a. Control (Tap water)
b. Spray formulation 1 (N:P:K = 90:45:45 or 2:1:1)
c. Spray formulation 2 (N:P:K = 135:90:45 or 3:2:1)
d. Spray formulation 3 (N:P:K = 180:135:90 or 4:3:2)

Thus, the total number of treatments was 8 (4×2) and each treatment was replicated 3 times. The experiment was conducted on 6 inches plastic pot.

Plate 3.Prepared NPK spray formulations.

2.4 Spray Nutrient Formulation

The spray solution was prepared by mixing of urea, triple super phosphate and murate of potash. Formulation was prepared by following guide line of BARI, where total amount of fertilizer to be 700 g/ 172 liters water was recommended for use as spray (Sanaullah, 2001). The formulation used in present research contained different ratio of nitrogen, phosphorus and potassium. The ratio of nitrogen, phosphorus and potassium varied over growth period of orchid. The total amount of nitrogen, phosphorus and potassium ratio required for 8 months was subdivided in respect of growth period.

Subdivision of spray formulation composition

Name of formulation	Spray formulation (N : P : K ratio)					
Control (S_0)	0.0	0.0	0.0	0.0	0.0	0.0
Spray formulation 1 (S_1)	10:5:5	12:6:6	14:7:7	16:8:8	18:9:9	20:10:10
Spray formulation 2 (S_2)	15:10:5	18:12:6	21:14:7	24:16:8	27:18:9	30:20:10
Spray formulation 3 (S_3)	20:15:10	24:18:12	28:21:14	32:24:16	36:27:18	40:30:20

Percentage of nitrogen, phosphorus and potassium in urea, triple super phosphate and murate of potash is 46.0, 48.0 and 60.0 respectively. In each times fresh formulation was prepared and spray once weekly with a hand sprayer at afternoon.

2.5 Water Management

Frequent application of water is essential in Orchid cultivation. In October 2012 – March 2013 watering was done once per day and February 2013- May 2013 watering was done twice per day by hand sprayer.

2.6 Shedding

As epiphytes most orchids avoid direct sunlight under natural condition, orchid prefer dappled shed. For maintaining shed a handmade shed was provided by gunny bags.

2.7 Plant Protection Measures

To control Brown rot, Twin 50 WP@20 mg/500 ml was sprayed at interval of 7 days that started from March 2013, soon after the appearance of infestation.

2.8 Collection of Data

Data were collected periodically during the growing period of orchid. The data were recorded on the following growth parameters.
a. Plant height
b. Stem diameter
c. Number of leaves plant^{-1}

d. Length of leaves
e. Width of leaves
f. Leaf area
g. Total leaf area
h. Leaf area index
i. Number of roots plant^{-1}
j. Root length
k. Root diameter

2.8.1 Plant height

The height of plant was measured in centimeter from ground level to top of the main stem by measuring scale at the interval of 40 days during the study period.

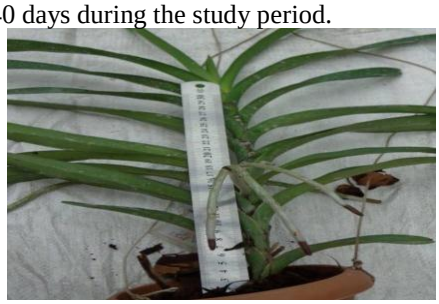

Plate 4. Plant height

2.8.2 Length of leaves

Length of leaves was measured with a measuring scale in centimeter of 5 randomly selected leaves from each pot at the interval of 40 days and their average was calculated and expressed in centimeter.

Plate 5. Length of leaves

2.8.3 Width of leaves

Width of leaves was measured with a measuring scale in centimeter of 5 randomly selected leaves from each pot at the interval of 40 days and their average was calculated and expressed in centimeter.

Plate 6. Width of leaves

2.8.4 Leaf area

The leaf area was determined by multiplying leaf length with leaf wide and expressed in square centimeter.

2.8.5 Total leaf area

Total leaf area was determined by summation of all leaf area and expressed as expressed in square centimeter.

2.8.6 Leaf area index

Leaf area index is the ratio of leaf area to ground area. Leaf area index was determined by dividing individual leaf area to individual ground area.

$$\text{Leaf area index} = \frac{\text{Total leaf area}}{\text{Total ground area}}$$

2.8.7 Stem diameter

Stem diameter was measured by digital slide calipers at the middle portion of stem and expressed in centimeter.

Plate 7. Stem diameter

2.8.8 Root length

Root length was measured with a measuring scale in centimeter of 5 randomly selected roots from each pot at the interval of 40 days and their average was calculated and expressed in centimeter.

Plate 8. Root length

2.8.9 Number of roots plant^{-1}

Number of roots plant^{-1} was measured by counting manually all roots in plant from each pot at the interval of 40 days.

2.8.10 Root diameter

Root diameter was measured by digital slide calipers at the middle portion of root and expressed in centimeter.

Plate 9. Root breadth

2.8.11 Number of leaves plant^{-1}

Number of leaves plant^{-1} was measured by counting manually all leaves in plant from each pot at the interval of 40 days.

2.9 Statistical Analysis

The collected data for growth parameters were statistically analyzed using MSTAT-C package programmes for variance (ANOVA) and mean difference was compared by Duncan's New Multiple Range Test (DMRT).

III. Results And Discussion

The presentation and discussion of results obtained from the experiments conducted during the period from October 2012 to May 2013 to study the effect of cultivar and spray formulation on the growth of two cultivars of orchid (Mokara sp.).

3.1 Plant height

The plant height varied significantly between the two cultivars of orchids namely MokaraDiheard Red (V_1) and Mokara Yellow Anne (V_2) (Table 1). At 90 DAP, plant height of MokaraDiheard Red (V_1) and Mokara

Yellow Anne (V_2) was (31.16 and 27.67 cm), respectively. At 130 DAP, plant height increased to (32.67 and 29.08cm), respectively. Plant height of MokaraDiheard Red (V_1) and Mokara Yellow Anne (V_2) reached at (34.15 and 30.81cm), respectively after 170 days. The maximum plant height of MokaraDiheard Red (V_1) was (37.88 cm) and the height of Mokara Yellow Anne (V_2) was comparatively lower about (33.44 cm) at 290 DAP (Table1). The rate of growth of orchids (Mokara sp.) affected with spray formulation application. These results agreed with the findings of Rajesh (2009). Plant height increased progressively with the advancement of study period. It revealed that the plant height of Mokara Yellow Anne increased rapidly than MokoraDiheard Red.

Different treatments of spray formulation had the significant effects on plant height (Table 2). At 90 DAP, the maximum plant height (29.75 cm) was recorded in spray formulation 3 (S_3) and the minimum (28.58 cm) in control (S_0). At 130 and 170 DAP, the maximum plant height (33.88 and 31.73 cm) was recorded in spray formulation 3 (S_3) and the minimum (29.33 and 30.23 cm) in control (S_0). At 210 DAP, the maximum plant height (35.47 cm) was recorded in spray formulation 3 (S_3) and the minimum (31.17 cm) in control (S_0) (Table 2). Plant height increased due to fertigation especially NPK spray formulation during vegetative period noticed by Naik et al. (2006). Plant height increased slowly in control and rapidly in spray formulation 3 (S_3) which indicated that different formulation as spray formulation had significant effect on plant height.

3.2 Stem diameter

Cultivars effect on stem diameter varied significantly (Table 1). At 90 DAP, the maximum stem diameter (1.17 cm) was found in cultivar Mokara Diehard Red and the minimum (0.90 cm) was found in Mokara Yellow Anne. Stem diameter increased gradually due to the passes of growing period and stem diameter (1.30 cm) reached in case of cultivar Mokara Diehard Red and (1.11 cm) in cultivar Mokara Yellow Anne at 290 DAP (Table 1). Kabir (2007) investigated that the liquid fertilizers had a significant effect on stem diameter, which was similar of my present findings. It concluded that Mokara Diehard Red (V_1) superior to Mokara Yellow Anne (V_2) in respect of stem diameter.

The stem diameter varied significantly due to the effect of spray formulation (Table 2). The maximum stem diameter (1.10 cm) was found in spray formulation 1 (S_1) and the minimum (0.98 cm) was found in control (S_0) at 90 DAP. It was gradually increased and reached (1.28 cm) in spray formulation 1 (S_1) at 290 DAP (Table 2). Therefore, among the spray formulations the spray formulation 1 (S_1) was more effective in respect of stem diameter at 290 DAP.

3.3 Number of leaves plant^{-1}

Significant variation was found in respect of number of leaves plant^{-1} (Table 3). At 90 DAP, the number of leaves plant^{-1} of MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2) were (13.50 and 10.92), respectively. At 130 and 170 DAP, the number of leaves plant plant^{-1} were (15.33, 12.92) and (17.33, 15.00) for MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2), respectively. Finally the number of leaves plant plant^{-1} was (23.17 and 21.58) in MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2), respectively after 290 DAP (Table 3). Sobhana and Rajeevan (1993) reported that number of leaves is influenced by spray formulation which was similar of the present findings. MokaraDiheard Red cultivar (V_1) produces more number of leaves compared to Mokara Yellow Anne cultivar (V_2). It might be cultivared impacts on growth of stem.

Number of leaves plant plant^{-1} varied significantly among the spray formulations (Table 4). At 90 DAP, the highest number of leaves plant plant^{-1} (12.83) was found in spray formulation 3 (S_3) and the lowest (11.83) was found in control (S_0) and spray formulation 1 (S_1). With the advancement of growing period of 130 DAP, the number of leaves (14.67) attained in spray formulation 2 (S_2) and spray formulation 3 (S_3) and the lowest (12.83) was found in control (S_0). At 250 DAP, the highest number of leaves (21.67) was in spray formulation 2 (S_2) and the lowest (17.00) was found in control (S_0). After 290 DAP, the highest number of leaves (24.17) was in spray formulation 2 (S_2) and the lowest (18.33) was found in control (S_0) (Table 4). Sobhana and Rajeevan (1993) reported that number of leaves is influenced by spray formulation. Thus number of leaves was relatively lower in control (S_0) compared to all others level of spray formulation. It might be impacts of spray formulation on cultivars.

3.4 Length of leaves

Significant variation was found in respect of length of leaves (Table 3).The length of leaves of MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2) were (22.15 and 19.18 cm), respectively at 90 DAP. At 130 DAP, length of leaves of MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2) were (22.86 and 20.23 cm), respectively. At 170 DAP and 210 DAP the plants reached (23.83 and 21.72 cm) and (24.92 cm and 22.92 cm) in respect of length of leaves in MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2), respectively. At 290 DAP, the maximum length of leaves (26.83 cm) and the minimum (25.02 cm) were found in Mokara Diehard Red and Mokara Yellow Anne cultivars

(Table 3). Sobhana and Rajeevan (1993) reported that the lengths of leaves are influenced by cultivars. It was observed during the whole study period that the length of leaves was relatively higher in MokaraDiheard Red cultivar (V_1) than Mokara Yellow Anne cultivar (V_2). Therefore, it was concluded that MokaraDiheard Red (V_1) better to Mokara Yellow Anne cultivar (V_2) in respect of leaf length.

Length of leaves varied significantly with spray formulation (Table 4). At 90 DAP, the highest length of leaves (21.12 cm) was found in spray formulation 2 (S_2) and the lowest (19.97 cm) was found in control. At 130 DAP, the maximum length of leaves (22.25 cm) was found in spray formulation 3 (S_3) and the minimum (19.97 cm) was found in control. At 210 DAP, the maximum length of leaves (25.28 cm) was found in spray formulation 3 (S_3) and the minimum (21.52 cm) was found in control. At 290 DAP, the maximum length of leaves (27.45 cm) was found in spray formulation 2 (S_2) and the minimum (22.45 cm) was found in control (Table 4). Sobhana and Rajeevan (1993) reported that spray formulation influenced on the vegetative characteristics of orchid plant especially in length of leaves. Length of leaves increased at slow rate with the advancement of study period. In every case, the lowest leaf length was observed in control and the highest in spray formulation 2 (S_2).

Table 1. Effect of cultivar on plant height and stem diameter

Cultivar	Plant height (cm) at DAP						Stem diameter (cm) at DAP					
	90	130	170	210	250	290	90	130	170	210	250	290
MokoraDiheard Red	31.16	32.67	34.15	35.46	36.67	37.88	1.17	1.20	1.22	1.24	1.27	1.30
Mokora Yellow Anne	27.67	29.08	30.81	32.32	33.44	34.77	0.90	0.94	0.98	1.03	1.07	1.11
Level of Significance	**	**	**	**	**	**	**	**	**	**	**	**
CV%	3.19	2.99	3.01	2.85	2.72	2.55	5.82	5.02	4.66	4.23	3.72	3.49

N. B. **= significant at 1% level of probability, DAP = Days after Planting.

Table 2. Effect of spray formulation on plant height and stem diameter

Spray Formulation	Plant height (cm) at DAP						Stem diameter(cm) at DAP					
	90	130	170	210	250	290	90	130	170	210	250	290
Control (S_0)	28.58	29.33c	30.23c	31.17d	32.05c	32.87d	0.98b	0.98b	1.00b	1.00b	1.00b	1.01b
Spray formulation 1 (S_1)	29.70	30.98b	32.50b	33.98c	35.17b	36.52bc	1.10a	1.14a	1.17a	1.20a	1.24a	1.28a
Spray formulation 2 (S_2)	29.63	31.47a	33.30a	34.93b	36.25a	37.52ab	1.04a	1.08a	1.12a	1.17a	1.21a	1.26a
Spray formulation 3 (S_3)	29.75	31.73a	33.88a	35.47a	36.77a	38.42a	1.03a	1.07a	1.12a	1.18a	1.22a	1.27a
Level of Significance	NS	**	**	**	**	**	*	**	**	**	**	**
CV%	3.19	2.99	3.01	2.85	2.72	2.55	5.82	5.02	4.66	4.23	3.72	3.49

N. B. In a column figures having similar letters do not differ significantly whereas figures having dissimilar letters differ significantly as per DMRT, **= significant at 1% level of probability, *=significant at 5% level of probability, NS = Non Significant, DAP = Days after Planting.

Table 3. Effect of cultivar on number of leaves plant^{-1} and length of leaves

Cultivar	Number of leaves plant^{-1} at DAP						Length of leaves (cm) at DAP					
	90	130	170	210	250	290	90	130	170	210	250	290
MokoraDiheard Red	13.50	15.33	17.33	19.17	21.33	23.17	22.15	22.86	23.83	24.92	25.68	26.83
Mokora Yellow Anne	10.92	12.92	15.00	16.92	19.08	21.58	19.18	20.23	21.72	22.92	23.97	25.02
Level of Significance	**	**	**	**	**	**	**	**	**	**	**	**
CV%	6.26	5.96	6.80	7.07	5.80	5.77	3.73	4.24	3.95	3.79	3.53	3.44

N. B.**= significant at 1% level of probability, DAP = Days after Planting.

Table 4. Effect of spray formulation on number of leaves plant^{-1} and length of leaves

Spray formulation	Number of leaves plant^{-1}at DAP						Length of leaves (cm) at DAP					
	90	130	170	210	250	290	90	130	170	210	250	290
Control (S_0)	11.83	12.83b	14.67 c	16.00	17.00d	18.33 d	19.97 c	20.32 d	20.97d	21.52d	22.02d	22.45d
Spray formulation 1 (S_1)	11.83	14.33a	16.33 ab	18.33 c	21.00c	23.00 c	20.55 b	21.62 c	22.68c	23.97c	24.97c	26.38c
Spray formulation 2 (S_2)	12.33	14.67a	16.83 a	19.00 a	21.67a	24.17 ab	21.12 a	22.00 ab	23.60ab	24.92a b	26.00a b	27.45a
Spray formulation 3 (S_3)	12.83	14.67a	16.83 a	18.83 ab	21.17ab	24.00 a	21.03 a	22.25 a	23.87a	25.28a	26.30a	27.43ab
Level of Significance	NS	**	**	**	**	**	*	**	**	**	**	**
CV%	6.26	5.96	6.80	7.07	5.80	5.77	3.73	4.24	3.95	3.79	3.53	3.44

N. B. In a column figures having similar letters do not differ significantly whereas figures having dissimilar letters differ significantly as per DMRT, *= significant at 1% level of probability, *=significant at 5% level of probability, NS = Non Significant, DAP = Days after Planting.

3.5 Width of leaves

No significant variation was found in respect of width of leaves at different days after planting (Table 5). The width of leaves recorded at 90,130,170, 210, 250 and 290 DAP varied significantly between the cultivars. The width of leaves of MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2) were (2.50 and 2.44 cm), respectively at 90 DAP. At 130 DAP, the width of leaves of MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2) were (2.57 and 2.52 cm), respectively. At 170 DAP and 210 DAP, the plants terminated at (2.65 and 2.61 cm) and (2.73 and 2.68 cm) in respect of width of leaves in MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2), respectively. At 290 DAP, the width of leaves of MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2) were (2.90 and 2.86 cm), respectively (Table 5). The NPK spray formulation influenced to increase width of leaves. It was observed during the whole study period that the width of leaves was relatively higher in MokaraDiheard Red cultivar (V_1) than Mokara Yellow Anne cultivar (V_2).

Significant variation was observed in spray formulation (Table 6). At 90 DAP, the highest width of leaves (2.55 cm) was in spray formulation 3 (S_3) and the lowest (2.31 cm) was found in control. At 130 DAP, the maximum width of leaves (2.64cm) was found in spray formulation 3 (S_3) and the minimum (2.35 cm) was found in control. At 210 DAP, the maximum width of leaves (2.82 cm) was found in spray formulation 3 (S_3) and the minimum (2.42 cm) was found in control. At 290 DAP, the maximum width of leaves (3.03 cm) was found in spray formulation 3 (S_3) and the minimum (2.50 cm) was found in control (Table 6). Different ratio of spray formulations had significant effect on width of leaves. Those are agreed with the finding of Yin-Tung (2006). Width of leaves increased at slow rate with the advancement of study period. The NPK spray formulation influenced to increased width of leaves. It was observed during the whole study period that width of leaves was relatively higher in spray formulation 3 than control.

3.6 Leaf area

The leaf area was significantly varied by cultivars (Table 5). At 90 DAP, the leaf area of MokaraDiheard Red (V_1) and Mokara Yellow Anne (V_2) were (55.54 and 46.88 cm^2), respectively. At 170 DAP, the leaf area increased to (63.27 and 56.80 cm^2), respectively for those two cultivars. Leaf area increased gradually and finally at 290 DAP, leaf area reached at (78.34 and 71.96 cm^2) in those two cultivars, respectively (Table 5).

Leaf area varied significantly due to spray formulation (Table 6). After 90 days of planting the maximum average leaf area (53.73 cm^2) was found in spray formulation 3 (S_3) and the minimum (46.68 cm^2) was found in control. At 130 DAP, the maximum leaf area (58.64 cm^2) was found in spray formulation 3 (S_3) and the minimum (47.87 cm^2) was found in control. Leaf area gradually increased due to increase of age of the plants. Finally at 290 DAP, the maximum leaf area (83.26 cm^2) was found in spray formulation 3 (S_3) and the minimum (55.82 cm^2) was found in control (Table 6). Sobhana and Rajeevan (1993) reported that spray formulation enhanced the growth of the length of leaves, number of leaves per plant as well as leaf area which was similar of the present findings. Spray formulation enhanced to increase leaf area and plant grows vigorously due to absorbed more nutrients from spray formulation.

3.7 Total leaf area

The total leaf area was significantly varied due to cultivars (Table 7). At 90 DAP, the total leaf area of MokaraDiheard Red (V_1) and Mokara Yellow Anne (V_2) were (749.35 and 512.72 cm^2), respectively. At 170 DAP, the total leaf area increased to (1100.96 and 856.68 cm^2), respectively for those two cultivars studied. Finally at 290 DAP, total leaf area reached at (1833.21 and 1584.64 cm^2) in those two cultivars, respectively

(Table 7). The maximum total leaf area was higher in MokaraDiheard Red cultivar (V_1) than Mokara Yellow Anne cultivar (V_2). It might be higher total leaf area due to higher number of leaves per plant, length of leaves and width of leaves in cultivar studied.

Significant variation was observed in respect of total leaf area due to spray formulation (Table 8). After 90 days after planting, the maximum total leaf area (695.38 cm^2) was found in spray formulation 3 (S_3) and the minimum (553.31 cm^2) was found in control. At 130 DAP, the maximum total leaf area (866.59 cm^2) was found in spray formulation 3 (S_3) and the minimum (619.12 cm^2) was found in control. Total leaf area gradually increased due to changes of growth period and finally at 190 DAP, the maximum total leaf area (1986.745 cm^2) was found in spray formulation 3 (S_3) and the minimum (1036.49 cm^2) was found in control (Table 8). Fadelah (2007) noticed that the length of leaves, width of leaves as well as total leaf area increased after spraying of NPK spray formulation at certain interval which was similar to present results. Total leaf area was higher in spray formulation 3 than control. The possible reason might be that plant responds actively on spray formulation and facilitated to increase number of leaves per plant, length of leaves and width of leaves and ultimately increase of total leaf area.

3.8 Leaf area index

Leaf area index varied significantly between the two cultivars studied (Table 9). The leaf area index of MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2) were (0.05 and 0.04), respectively at 90 DAP. At 130 DAP, the leaf area index of MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2) were (0.06 and 0.05), respectively. At 210, 250 and 290 DAP, these were (0.10, 0.08, 0.12) and (0.10, 0.14, 0.12) in MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2), respectively (Table 9). Between the two cultivars the leaf area index was higher in MokaraDiheard Red cultivar (V_1) than Mokara Yellow Anne cultivar (V_2). It might be higher total leaf area and lower ground area in MokaraDiheard Red cultivar (V_1) than Mokara Yellow Anne cultivar (V_2) at different days after planting.

Significant variation was observed in spray formulation in respect of leaf area index (Table 10). At 90 DAP, the highest leaf area index (0.05) was found in spray formulation 2 (S_2) and spray formulation 3 (S_3) and the lowest (0.04) was found in control and spray formulation 1 (S_1). Leaf area index increased gradually and at 210 DAP, the highest leaf area index (0.10) was found in spray formulation 2 (S_2) and spray formulation 3 (S_3) and the lowest (0.06) was found in control. Finally at 290 DAP, the highest (0.15) was found in spray formulation 2 (S_2) and spray formulation 3 (S_3) and the lowest (0.08) was found in control (Table 10). Data revealed that rate of increasing in leaf area index was more in spray formulation 2 (S_2) and spray formulation 3 (S_3) than control. The variation in leaf area index might occur due to the variation in total leaf area and ground area.

Table 5. Effect of cultivar on width of leaves and leaf area

Cultivar	Width of leaves (cm) at DAP						Leaf area (cm^2) at DAP					
	90	130	170	210	250	290	90	130	170	210	250	290
MokoraDiheard Red	2.50	2.57	2.65	2.73	2.80	2.90	55.54	58.77	63.27	68.15	72.22	78.34
Mokora Yellow Anne	2.44	2.52	2.61	2.68	2.76	2.86	46.88	51.11	56.80	61.10	66.64	71.96
Level of Significance	NS	NS	NS	NS	NS	NS	**	**	**	**	**	**
CV%	6.29	6.31	5.60	4.68	3.86	3.82	7.78	8.20	7.69	7.92	6.04	5.99

N. B. **= significant at 1% level of probability, NS = Non Significant, DAP = Days after Planting.

Table 6. Effect of spray formulation on width of leaves and leaf area

Spray formulation	Width of leaves (cm) at DAP						Leaf area (cm^2) at DAP					
	90	130	170	210	250	290	90	130	170	210	250	290
Control (S_0)	2.31c	2.35b	2.40b	2.42b	2.46b	2.50b	46.68c	47.87d	50.30d	52.22c	54.26d	55.82d
Spray formulation 1 (S_1)	2.54a	2.63a	2.73a	2.81a	2.90a	3.02a	52.32b	57.02b	61.97bc	67.47b	72.51c	79.85c
Spray formulation 2 (S_2)	2.47b	2.55a	2.66a	2.76a	2.85a	2.97a	52.11b	56.23c	62.77b	67.37b	74.20b	81.68b
Spray formulation 3 (S_3)	2.55a	2.64a	2.73a	2.82a	2.92a	3.03a	53.73a	58.64a	65.10a	71.42a	76.74a	83.26a
Level of Significance	*	**	**	**	**	**	*	**	**	**	**	**
CV%	6.29	6.31	5.60	4.68	3.86	3.82	7.78	8.20	7.69	7.92	6.04	5.99

N. B. In a column figures having similar letters do not differ significantly whereas figures having dissimilar letters differ significantly as per DMRT, **= significant at 1% level of probability, *=significant at 5% level of probability, DAP = Days after Planting.

Table 7. Effect of cultivar on total leaf area

Cultivar	Total leaf area (cm^2) at DAP					
	90	130	170	210	250	290
MokoraDiheard Red	749.35	906.04	1100.96	1311.00	1555.73	1833.21
Mokora Yellow Anne	512.72	662.48	856.68	1041.68	1289.16	1584.64
Level of Significance	**	**	**	**	**	**
CV%	11.27	10.72	9.11	8.99	7.78	7.79

N. B. **= significant at 1% level of probability, DAP = Days after Planting.

Table 8. Effect of spray formulation on total leaf area

Spray formulation	Total leaf area (cm^2) at DAP					
	90	130	170	210	250	290
Control (S_0)	553.31d	619.12d	742.22d	841.04d	928.24d	1036.49d
Spray formulation 1 (S_1)	625.44c	822.12bc	1013.50c	1238.04bc	1524.79c	1839.22c
Spray formulation 2 (S_2)	650.02ab	829.21ab	1058.83b	1281.83b	1608.26ab	1973.22ab
Spray formulation 3 (S_3)	695.38a	866.59a	1100.74a	1344.46a	1628.48a	1986.75a
Level of Significance	**	**	**	**	**	**
CV%	11.27	10.72	9.11	8.99	7.78	7.79

N. B. In a column figures having similar letters do not differ significantly whereas figures having dissimilar letters differ significantly as per DMRT, **= significant at 1% level of probability, DAP = Days after Planting.

3.9 Number of roots plant^{-1}

Number of roots plant^{-1} varied significantly between the two cultivars (Table 9). At 90 DAP, the number of roots plant^{-1} of MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2) were (2.50 and 2.08), respectively. At 130 DAP and 170 DAP, the number of roots plant^{-1} was increased (3.75 and 3.08) and (5.33 and 4.92) in MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2), respectively. Finally the number of roots plant^{-1} (11.58 and 10.75) was found in MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2), respectively after 290 days after planting (Table 9).

Spray formulation varied significantly in respect of number of roots plant^{-1} (Table 10). At 90 DAP, the highest number of root plant^{-1} (2.50) was found in spray formulation 2 (S_2) and the lowest (2.08) was found in control. With the advancement of time, number of roots increased gradually and at 250 DAP, the highest number of roots (10.17) was found in spray formulation 2 (S_2) and the lowest (5.33) in control. Finally after 290 days, the highest (12.67) number of roots plant^{-1} was found in spray formulation 2 (S_2) and the lowest (7.00) in control (Table 10). Spray formulation had significant effect on number of roots plant^{-1}. Spray formulation 2 (S_2) produced more roots than control. Possible reason could be that plant absorbed more nutrients from spray formulation and facilitate to increase number of roots plant^{-1}.

3.10 Root length

Significant variation was found in respect of root length between two cultivars (Table 11). The root length of MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2) were (6.56 and 6.26 cm), respectively at 90 DAP. Root length increased progressively and at 170 DAP and 210 DAP, the plants noticed the root length (6.75 and 6.46 cm) and (6.84 and 6.56 cm) respectively. Finally at 290 DAP, the maximum (7.06 cm) and the minimum (6.80 cm) were found in MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2), respectively (Table 11). Therefore, it revealed that MokaraDiheard Red cultivar (V_1) was superior to Mokara Yellow Anne cultivar (V_2) in respect of root length.

Root length varied significantly due to spray formulation (Table 12). At 90 DAP, the highest root length (6.92 cm) was found in spray formulation 3 (S_3) and the lowest (5.77 cm) in control. At 130 DAP, the maximum root length (7.05 cm) was found in spray formulation 3 (S_3) and the minimum (5.82 cm) in control. Root length increase gradually and at 250 DAP, the maximum root length (7.37 cm) was found in spray formulation 3 (S_3) and the minimum (6.02 cm) in control. Finally at 290 DAP, the maximum root length (7.52

cm) in spray formulation 2 (S_2) and the minimum (6.08 cm) in control (Table 12). Root length increased at slowly with the advancement of time. In every case, the lowest root length was observed in control and the highest in spray formulation 2 (S_2). It might be that spray formulation accelerated root growth.

3.11 Root diameter

Cultivars effect on root diameter varied significantly (Table 11). The root diameter of MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2) were (0.54 and 0.43 cm), respectively at 90 DAP. At 130 DAP, the root diameter of MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2) were (0.59 and 0.48 cm), respectively. At 170 DAP and 210 DAP, the maximum root diameter (0.64 and 0.55 cm) and (0.67 and 0.60 cm) were found in MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2), respectively. Root diameter increased gradually and finally at 290 DAP the root breadth in MokaraDiheard Red cultivar (V_1) and Mokara Yellow Anne cultivar (V_2) were (7.06 and 6.80 cm), respectively (Table 11). It was observed during the wholes period of the study that the root diameter was relatively higher in MokaraDiheard Red cultivar (V_1) than Mokara Yellow Anne cultivar (V_2). Therefore, it concluded that MokaraDiheard Red cultivar (V_1) better to Mokara Yellow Anne cultivar (V_2) in respect of root diameter.

Root diameter significantly due to the effect of spray formulation (Table 12). At 90 DAP, the highest root diameter (0.50 cm) was found in spray formulation 3 (S_3) and the lowest (0.45 cm) in control. At 130 DAP, the maximum root diameter (0.58 cm) was found in spray formulation 3 (S_3) and the minimum (0.48 cm) in control. Root diameter increased progressively at 250 DAP, the maximum root diameter (0.65cm) in spray formulation 3 (S_3) and the minimum (0.50 cm) in control. Finally at 290 DAP, the maximum root diameter (0.78 cm) was found in spray formulation 3 (S_3) and the minimum (0.56 cm) in control (Table 12). In every case, the lowest root diameter was observed in control and the highest in spray formulation 3 (S_3). Possible reason could be that spray formulation accelerated on root growth.

Table 9.Effect of cultivar on leaf area index and number of roots plant^{-1}

Cultivar	Leaf area index at DAP						Number of roots plant^{-1} at DAP					
	90	130	170	210	250	290	90	130	170	210	250	290
MokoraDiheard Red	0.05	0.06	0.08	0.10	0.12	0.14	2.08	3.08	4.92	6.42	8.17	10.75
Mokora Yellow Anne	0.04	0.05	0.06	0.08	0.10	0.12	2.50	3.75	5.33	7.17	9.17	11.58
Level of Significance	**	**	**	**	**	**	*	*	*	*	*	*
CV%	13.24	9.69	10.27	9.29	7.92	7.53	23.57	23.14	15.43	13.10	12.46	8.77

N. B.**= significant at 1% level of probability, *=significant at 5% level of probability, DAP = Days after Planting.

Table 10.Effect of spray formulation on leaf area index and number of roots plant^{-1}

Spray formulation	Leaf area index at DAP						Number of roots plant^{-1} at DAP					
	90	130	170	210	250	290	90	130	170	210	250	290
Control (S_0)	0.04b	0.06a	0.05c	0.06c	0.07c	0.08c	2.00c	2.50c	3.33c	4.17d	5.33d	7.00c
Spray formulation 1 (S_1)	0.04b	0.05b	0.07b	0.09b	0.11b	0.14b	2.33b	3.50b	5.50b	7.50bc	9.50bc	12.50ab
Spray formulation 2 (S_2)	0.05a	0.06a	0.08a	0.10a	0.12a	0.15a	2.50a	3.83a	5.83a	7.67b	9.67b	12.67a
Spray formulation 3 (S_3)	0.05a	0.06a	0.08a	0.10a	0.12a	0.15a	2.33b	3.83a	5.83a	7.83a	10.17a	12.50ab
Level of Significance	*	**	**	**	**	**	NS	*	**	**	**	**
CV%	13.24	9.69	10.27	9.29	7.92	7.53	23.57	23.14	15.43	13.10	12.46	8.77

N. B. In a column figures having similar letters do not differ significantly whereas figures having dissimilar letters differ significantly as per DMRT, **= significant at 1% level of probability, *=significant at 5% level of probability, NS = Non Significant, DAP = Days after Planting.

Table 11. Effect of cultivar on root length and root diameter

Cultivar	Root length (cm) at DAP						Root diameter (cm^2) at DAP					
	90	130	170	210	250	290	90	130	170	210	250	290
MokaraDiheard Red	6.56	6.64	6.75	6.84	6.94	7.06	0.54	0.59	0.64	0.67	0.70	0.74
Mokara Yellow Anne	6.26	6.36	6.46	6.56	6.68	6.80	0.43	0.48	0.55	0.60	0.63	0.68
Level of Significance	*	*	*	*	NS	NS	**	**	**	**	**	**
CV%	5.00	5.02	4.90	4.83	4.96	4.80	9.50	9.04	7.92	6.56	6.03	5.52

N. B. **= significant at 1% level of probability, *=significant at 5% level of probability, NS = Non Significant, DAP = Days after Planting.

Table 12. Effect of spray formulation on root length and root diameter

Spray formulation	Root length (cm) at DAP						Root diametert (cm^2) at DAP					
	90	130	170	210	250	290	90	130	170	210	250	290
Control (S_0)	5.77d	5.82d	5.88d	5.94d	6.02d	6.08d	0.45c	0.48c	0.50c	0.52d	0.55d	0.56c
Spray formulation 1 (S_1)	6.28c	6.39c	6.51bc	6.62bc	6.74c	6.88c	0.48b	0.55b	0.61b	0.65bc	0.69bc	0.75b
Spray formulation 2 (S_2)	6.67ab	6.75b	6.87b	6.98b	7.11ab	7.25ab	0.48b	0.55b	0.61b	0.66b	0.71b	0.75b
Spray formulation 3 (S_3)	6.92a	7.05a	7.15a	7.25a	7.37a	7.52a	0.50a	0.58a	0.65a	0.69a	0.73a	0.78a
Level of Significance	**	**	**	**	**	**	NS	*	**	**	**	**
CV%	5.00	5.02	4.90	4.83	4.96	4.80	9.50	9.04	7.92	6.56	6.03	5.52

N. B. In a column figures having similar letters do not differ significantly whereas figures having dissimilar letters differ significantly as per DMRT, **= significant at 1% level of probability, *=significant at 5% level of probability, NS = Non Significant, DAP = Days after Planting.

IV. Conclusion

From the above results it might be concluded that cultivar and spray formulation influenced on growth of orchid. The growth of orchid positively influenced by spray formulation 3 with Mokara Diehard Red cultivar under net house condition in plastic pot. The best combination of Mokara Diehard Red cultivar with spray formulation 3 was found suitable for the growth of orchid at pot condition. Considering the findings of the present study, further studies in the following areas may be suggested:This study was conducted to observe only vegetative growth of two Mokara cultivars. Further investigation is needed to find out the efficacy at spray formulation on reproductive stage of Mokara cultivars.

References

[1]. A. Sobhana and P.K. Rajeevan, Performance of certain epiphytic species in central Kerala. Indian Journal of Orchid Society. 7(1&2) 1993: 31-35.
[2]. A.A. Fadelah, Field performance of micropropagatedMokara orchid hybrids. International Journal of Bioscience, 3(6) 2007: 12-18.
[3]. A.D. Hawkeye, Growth behavior of cultivated orchids. In: Commercial Flowers. 34(2) 2005: 65-68.
[4]. A.N. Rao, Orchids. In: Plant Tissue and Organ Culture. (Brad Press Pub. Co. Ltd. New York, 2000) 122.
[5]. B. Sing and S.R. Voleti, Research and achievements, Division of floriculture and landscaping. (Indian Agricultural Research Institute, New Delhi, 1995) 15-17.
[6]. F. Singh, Orchids trade and economic return. Indian Journal of Orchid Society. 5(2) 2008: 28-32.
[7]. F.M. Mondal, Orchid cultivation and export. 3 edition. (Surovi Pub. Co. Ltd. Dhaka, Bangladesh, 2011) 1.
[8]. I. Rajesh, Seasonal effect of macronutrients on the growth and development of orchid (Mokara sp.) Indian Journal of Ornamental Horticulture. 13(2) 2009: 87-94.
[9]. K.K. Ghoshal and A. Das, Floral morphology and behavior of some cultivated orchids. Journal of Environment and Ecology, 7(1) 2008: 140-144.
[10]. M. Sanaullah, Orchids (Cultivation procedure of Dendrobium spp.). (Nilima Printer Pub. Co. Ltd., Dhaka, 2001) 9-32.
[11]. N. Laws, Cut flowers vs orchid in the world market. International Journal of Floriculture. 5(1) 1995: 10-12.
[12]. P. Singh and S.K. Roy, Regeneration of indigenous orchid of Vanda sp. Plant Tissue Culture. 14(11) 2004: 55-61.
[13]. P.V. Patil, Orchids of India as commercial flowers. 2 edition. (Nayaprokash Pub. Co. Ltd. Kolkata, India, 2001) 180.
[14]. S. Chakraborti, RokomaryPhoolChash. (Nirmol book agency , 89. Mohatma Gandhi Road, Kolkata,1999)12-14.
[15]. S. Manilal and R. Sathish, Characterization of crop growth variable in some selected orchid cultivars of Assam. Indian Journal of Plant Physiology. 6(2) 2008: 166-171.
[16]. S. Patil and R. Singh, Effect of containers on growth and development of orchid. Journal of Hill Research. 12(1) 2003: 63-66.
[17]. S.J. Royer, An Orchid handbook, Michigan orchid society. (Jacob Press Pub. Co. Ltd. New York, 2003) 34.
[18]. S.K. Naik, D. Barman and R.S. Upadhyay, Correlation studies on nutrient content of epiphytic orchids and associated substratum. Journal of Ornamental Horticulture. 9(2) 2006: 133-135.
[19]. T. Kabir, Orchid. 2 edition. (ShilpaTaruprokashani, 27110, Taimahal road, block-c, Muhammmadpur, Dhaka-1207, 2007) 22-26.
[20]. W. Yin-Tung, Yamamoto Dendrobium sp. Web (URL) address: www.yamamoto dendro biums.com, 2006. Accessed on January 2013.
[21]. Y. Hagakl and J.S. Imamura, NPK requirements of Vanda miss joaquin orchid plants. M. Sc. Thesis department of horticulture, Hawaii institute of tropical agriculture and human resources, university of Hawaii, 2007: 34-36.