

Performance of Spray Formulations on Morpho-Physiological Features and Growth of Orchid Cultivars

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Abstract: The experiment was conducted in the field laboratory of the Department of Crop Botany, Bangladesh Agricultural University (BAU), Mymensingh during the period of November, 2009 to September, 2010 to investigate the effect of spray formulations of NPK fertilizer on morpho-physiological characters and growth of two orchid cultivars. The two factor experiment was laid out in the Completely Randomized Block Design (RCBD) with three replications. The two factors are cultivars (Mokara Diheard Red and Mokara Yellow Anne) and four spray formulations (F_0 , F_1 , F_2 , F_3). Data were collected on plant height, leaf length, leaf width, total leaf area, leaf area index, stem diameter, number of leaf, chlorophyll content, crop growth rate (CGR) and relative growth rate (RGR). Results revealed that the morphological and growth parameters of Mokara Diheard Red and Mokara Yellow Anne were significantly varied. Mokara Diheard Red performs better in chlorophyll content, CGR and RGR. Mokara Yellow Anne was superior in respect of leaf area index, total leaf area, leaf number and stem diameter. It was observed that the maximum increment of total leaf area, leaf area index, leaf number and stem diameter were found in spray formulation-3 (F_3) and the lowest were in control (F_0). Spray formulation-2 (F_2) showed maximum increment of plant height, crop growth rate and relative growth rate over control (F_0). So, the morpho-physiological features of orchid are significantly affected by spray formulation and the composition of spray formulation-2 (F_2) and spray formulation-3 (F_3) might be better for growth of orchid.

Key words: Orchid, Spray formulation, Mokara Diheard Red, Mokara Yellow Anne and growth

I. Introduction

Orchids are the most fascinating, varied and beautiful of all flowers due to its attractive structure and excellent color of petal (Singh and Voleti, 1995). Orchids having flowers of wonderful beauty and it has very good keeping qualities. They are the most wonderful items for indoor decoration (Patil, 2001). As cut flower and pot plants orchid is high demandable item. They are also used in different purposes as fragrant, glue, medicine, drinks and flavoring (Goh *et al.*, 1992). 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 (Chowdhury, 1975). Orchid sticks produced in our country have great demand in local markets. The production can not meet the demand because of its slow growth. The growth of orchid is very slow and foliar nutrient application is very common practice in orchid cultivation as orchid cannot take nutrient significantly through root. Orchids possess aerial root which absorb moisture and nutrient from air. The growth of orchid can be enhanced by foliar feeding. Foliar spray nutrients mainly contain nitrogen (N), phosphorus (P), and potassium (K) with different concentration. Application of spray nutrient containing N-P-K with different concentration varied on the basis of growth stage of plants. Urea, TSP and MoP are used as a source of nitrogen (N), phosphorus (P) and potassium (K) in spray nutrients, respectively. Spray nutrients solution is prepared by mixing of Urea, TSP and MoP that plays important roles in growth and development of orchid. The schedule of application of spray formulation recommended by Bangladesh Agricultural Research Institute (BARI) is too much variable in every week that is very difficult to maintain. This problem can be overcome by rescheduling the time of application of spray formulation.

So, an experiment was undertaken to determine the effect of spray formulation on morpho-physiological feature and growth of two orchid cultivars as well as to select suitable concentration of N, P and K in spray formulation for proper growth of orchid.

II. Materials And Method

Experimental Material

Two cultivars of orchid named Mokara Dihard Red and Mokara Yellow Anne were collected from Dipto orchid nursery, Valuka, Mymensingh.

Experimental Site

The experiment was conducted in field laboratory of Crop Botany Department, Bangladesh Agriculture University, Mymensingh.

Experimental Treatments

There are two factors used in this experiment known as variety and formulation of spray nutrients.

Factor A: Two orchid cultivars viz. Mokara Diehard Red (V₁) and Mokara Yellow Anne (V₂)

Factor B: Three levels of spray nutrient with control (F₀) viz, Spray Formulation 1 (F₁), Spray Formulation 2 (F₂), Spray Formulation 3 (F₃)

Thus, the total number of treatments was 8 (4x2) and each treatment was replicated three times. The spray solutions were prepared by mixing of Urea, Tripple Super Phosphate (TSP) and Muriate of Potash (MoP). Formulation was prepared by following the thumb rule of BARI where total amount of fertilizer to be 700 g per 172 litre water was recommended for use as spray. Spray formulation used in early stages contained higher N and gradually reduced in later stages.

Table1. Composition of spray formulation.

Formulation	Total urea, TSP and MoP 70 g per 17.2 liter water at N : P : K ratio			
F ₀ (Control)	0.0	0.0	0.0	0.0
F ₁	15:20:25	20:20:25	20:25:30	10:30:25
F ₂	10:15:20	15:20:25	10:25: 25	10:25:30
F ₃	5:15:10	10:15:10	10:20:15	15:20:20
Duration of spray	Up to 45 DAP	From 45 DAP to 90 DAP	From 90 DAP to 135 DAP	From 135 DAP to 180 DAP

% of N, P and K in Urea, TSP and MoP is 46.0, 48.0 and 60.0 respectively. In each times fresh formulation was prepared and sprayed once weekly with a hand sprayer in the afternoon.

Collection of Data

Data were collected periodically on Plant height (cm), leaf length (cm), leaf width (cm), individual leaf area (cm²), total leaf area (cm²), leaf area Index (LAI), stem diameter (cm), number of root/plant, number of leaf/plant, chlorophyll content in leaf, fresh weight (g) of plant sample and dry weight (g) of plant sample.

Experimental Design and Statistical Analysis

The experiment was laid out in Completely Randomized Block Design (RCBD) with 8 treatments and each treatment was replicated three times. The collected data analyzed by following the analysis of variance (ANOVA) technique and mean differences were separated by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984) using a computer operated programme named MSTAT-C (Russel, 1986).

III. Results And Discussion

Morphological parameters

Plant height

Plant height significantly varied between the two cultivars of orchids. At 45 DAP, plant height of Mokara Diheard Red and Mokara Yellow Anne were 24.88 cm and 19.75 cm, respectively. Maximum plant height of Mokara Diheard red and Mokara Yellow Anne were 32.19 cm and 27.44 cm, respectively at 180 DAP (Table 1). It was observed that plant height increased progressively with the advancement of age and growth stages. Plant height increased rapidly in Mokara Yellow Anne than Mokara Diheard Red comparatively (Table1). The differences in plant height might be due to genetic makeup of orchid cultivars. Different nutrients of spray have significant affect on plant height. F₂ spray formulation performs better in plant height than other formulation (Table 2). Interaction effect of variety and spray formulation is significantly varied. Plant height increased rapidly in V₂F₂ among all treatments (Table 3). So, it is said that composition of F₂ spray formulation is mostly suitable for plant height. Kuksal *et al.* (1997) reported that nitrogen application at higher rates increased plant height. Plant height increased linearly with increase in N, with application of P further increasing height (Hlgakl and Imamura, 1987).

Total Leaf Area

Varietal effect of total leaf area was significant. The leaf area ranged from 523.55- 1346.96 cm² and 565.16-1540.38 cm² in Mokara Diheard red and Mokara Yellow Anne, respectively over growing period (Table 1). From table it was observed that the total leaf area increment was higher in V₂ than V₁. Similarly, F₃ Spray formulation was much effective for enhancing the total leaf area (Table 2) and in case of interaction effect, maximum total leaf area increment was recorded in V₂F₃ (Table 3). The variation in leaf area might occur due to the variation in number of leaves and their size which might be affected by spray formulation. The result obtained from the present study is consistent with the results of Sharma and Haloi (2001) who stated that variation in leaf area might be attributed to the difference in number of leaves.

Leaf Area Index

In comparison between two varieties degree of increasing of leaf area index was more in V₂ than V₁. Thus varietal effect of leaf area index was significant and V₂ may be considered as superior over V₁ in respect of leaf area index (Table 1). It was also observed that degree of increasing of leaf area index was more in F₃ spray formulation (Table 2) and in case of interaction effect, maximum leaf area index increment was recorded in V₂F₃ (Table 3). The variation in leaf area index might occur due to the variation of leaf area and their expansion. As total leaf area was higher in F₃, so leaf area index also higher in F₃. The results obtained from the present study was consistent with the result of Sharma and Haloi (2001) who stated that variation in leaf area index could be attributed to the change in leaf number and leaf size. The results obtained from the present study also supported by Chandra and Das (2000).

Leaf Number

The leaf number ranged from 10.25-17.58 and 12.66-21.25 in Mokara Diheard red and Mokara Yellow Anne, respectively over growing period. Production of leaf number was higher in Mokara Yellow Anne than Mokara Diheard Red (Table 1). Similarly, Production of leaf number was higher in F₃ spray formulation than other formulation (Table 2). Since level of nutrient concentrations in spray solution was altered over growth stage and number of leaves also increased with alteration of nutrient concentrations in spray formulation, so it might be concluded that spray nutrients have significant effect on leaf production. So, it is also said that composition of F₃ spray formulation was very effective for growth of leaf. The present result supports the report of Singh and Kohli (1999). Leaf number varied significantly due to the interaction effect between variety and formulation. The variation in total number of leaves might be concerned with genetically variation, physiological function and growth characters of plant.

Stem Diameter

In Mokara Diheard Red, the average stem diameter per plant was 0.81 and 1.25 cm at 45 and 180 DAP, respectively. In Mokara Yellow Anne, the average stem diameter per plant was 0.96 and 1.43 at 45 and 180 DAP, respectively (Table 1). In comparison between two varieties degree of increasing of stem diameter was more in Mokara Yellow Anne than Mokara Diheard Red. F₃ spray formulation performs better for increasing stem diameter than other formulation which indicates that spray formulation containing N, P, and K have little effect on stem diameter (Table 2). The interaction between variety and formulation on stem diameter was varied significantly. Maximum increasing of stem diameter was recorded V₂F₂ (Table 3).

Physiological and Growth parameters

Chlorophyll Content

At 90 DAP, the total chlorophyll content was higher in Mokara Diheard Red than Mokara Yellow Anne (Table 1). At 90 DAP, the total chlorophyll content (22.73 mg/g) was highest in F₃ and the lowest was 11.96 mg/g in control (F₀), respectively (Table 2). The interaction between variety and spray formulation on total chlorophyll content was varied significantly. At 45 DAP, the highest total chlorophyll content (25.3 mg/g) was found in V₁F₃ and the lowest (8.68 mg/g) was recorded in V₁F₀. At 90 DAP, the highest total chlorophyll content (26.31 mg/g) and the lowest chlorophyll content (9.88 mg/g) were found in V₁F₃ and V₁F₀, respectively (Table 3). It is found that in all cases, chlorophyll content was lowest in control plants indicated that N, P and K in spray formulation has significantly affect on chlorophyll content.

Crop Growth Rate

The crop growth rate (CGR) in Mokara Diheard Red and Mokara Yellow Anne assessed from 45 to 180 DAP and it was observed that growth rate of orchid was very low. The crop growth rate of Mokara Diheard red was 0.29 g plant⁻¹/day and of Mokara Yellow Anne was 0.17 g plant⁻¹/day during the study period. Mokara Diheard red might be considered superior over Mokara Yellow Anne in respect of growth rate (Fig 1). Different spray formulations have significant effect on growth rate. The crop growth rate among different spray

formulation ranged from 0.14-0.29 g plant⁻¹/day. The maximum crop growth rate (0.29 g plant⁻¹/day) was found in F₂ spray formulation and the minimum crop growth rate (0.14 g plant⁻¹/day) was in control (F₀) (Table 2) which indicated that spray nutrients formulation containing N, P and K directly affected on crop growth rate. The interaction between variety and spray formulation on crop growth rate was varied significantly. The maximum crop growth rate (0.37 g plant⁻¹/day) recorded from V₁F₂ and the minimum crop growth rate (0.12 g plant⁻¹/day) was recorded from V₂F₀ (Table 3).

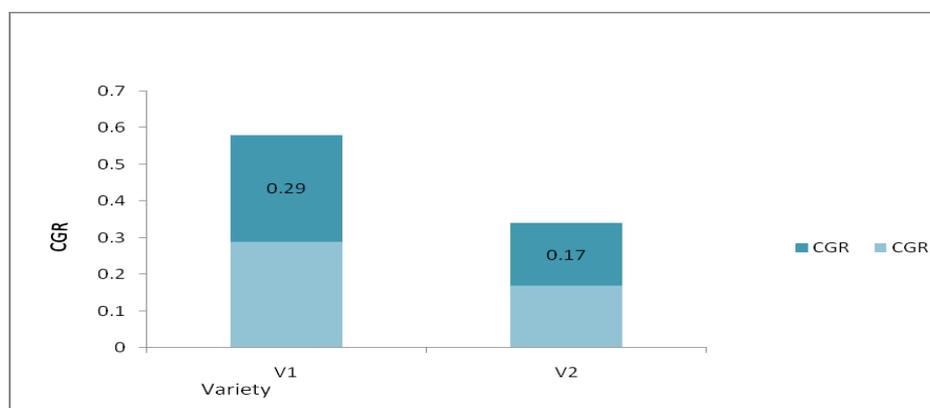


Fig. 1: Varietal effect of spray formulation on crop growth rate(CGR gplant⁻¹.day)

Mokara Diehard Red = V₁, Mokara Yellow Anne =V₂

Relative Growth Rate

The relative growth rate of Mokara Diheard red was 6.88 mg g⁻¹/day and of Mokara Yellow Anne was 5.89 mg g⁻¹/day (Table 1). Different spray formulations have significant effect on relative growth rate. The relative growth rate among different spray formulation ranged from 6.04-6.76 mg g⁻¹/day. The maximum relative growth rate was (6.76 mg g⁻¹/day) found in F₂ and the minimum (6.04 mg g⁻¹/day) was recorded from the control (Table 2) which indicated that spray formulation containing N, P and K significantly affected the relative growth rate. The interaction between cultivars to spray formulation on relative growth rate was varied significantly. The maximum relative growth rate (7.14 mg g⁻¹/day) was found in V₂F₃ and minimum growth rate (4.96 mg g⁻¹/day) was recorded from control V₁F₀ (Table 3)

Table1. Main effect of variety on Plant height, total leaf area, leaf area index , leaf number , Stem diameter, CGR, RGR and total chlorophyll content Contd.

Variety	Plant Height (cm) at DAP				Total leaf area (cm ²) at DAP				Leaf number at DAP			
	45	90	135	180	45	90	135	180	45	90	135	180
V ₁	24.88	27.23	29.68	32.19	523.55	735.01	1029.82	1346.96	10.25	12.41	15.00	17.58
V ₂	19.75	22.28	24.95	27.44	565.16	809.6	1169.59	1540.38	12.66	15.33	18.41	21.25
CV	16.91	14.63	12.88	12.09	11.62	14.41	12.91	12.08	14.69	11.77	10.37	8.48
LS	**	*	**	**	**	*	*	**	**	**	**	**

Variety	Stem diameter (cm) at DAP				CGR (g plant ⁻¹ /day)	RGR (mg g ⁻¹ /day)	Total chlorophyll content (mg/g)		Leaf area index at DAP			
	45	90	135	180			45 DAP	90 DAP	45	90	135	180
V ₁	0.81	0.97	1.10	1.25	0.29	5.89	16.72	19.11	0.47	0.66	0.94	1.21
V ₂	0.96	1.11	1.27	1.43	0.17	6.88	13.32	17.9	0.5	0.74	1.05	1.39
CV	13.56	11.23	8.37	8.12	17.82	8.50	0.44	2.03	11.62	14.25	12.61	12.77
LS	NS	NS	NS	NS	**	**	**	**	**	**	*	*

Table 2. Main effect of spray formulation on Plant height, total leaf area, leaf area index, leaf number, Stem diameter, CGR, RGR and total chlorophyll content Contd...

Spray formulation	Plant height (cm) at DAP				Total leaf area (cm ²) DAP				Leaf area index at DAP			
	45	90	135	180	45	90	135	180	45	90	135	180
F ₀	22.76 b	24.20	25.51 b	26.88 b	562.3 a	691 b	965.9 b	1298.0 3 c	0.46 a	0.63 b	0.89 b	1.17 b
F ₁	24.15 a	25.91	28.8 a	31.90 a	549.0 1 a	789.0 6 ab	1135.1 ab	1482.4 2 a	0.49 a	0.71 a	1.02 a	1.34 a
F ₂	21.71 b	24.45	27.71 a	30.58 a	558.0 2 a	844.5 9 a	1160.4 6 a	1470.2 a	0.5 a	0.76 a	1.05 a	1.33 a
F ₃	21.63 b	24.46	27.25 a	29.9 a	508.0 9 b	764.5 7 ab	1137.3 7 ab	1524.0 3 a	0.45 a	0.68 a	1.02 a	1.37 a
CV	16.91	14.63	12.88	12.09	11.62	14.41	12.91	12.08	11.6 2	14.25	12.61	12.77
LS	*	NS	*	**	*	**	*	*	NS	*	*	**

Legend: V₁ = Mokara Diheard Red , V₂ = Mokara Yellow Anne, DAP = Days After Planting , Spray Formulation 1 (F₁), Spray Formulation 2 (F₂), Spray Formulation 3 (F₃), LS= Level of significant , **= Significant at 1% level, *= Significant at 5% level,

Spray formula tion	Leaf number at DAP				Stem diameter (cm) at DAP				Total Chlorophyll content (mg/g)		CGR(g plant ⁻¹ /day)	RGR (mg g ⁻¹ /day)
	45	90	135	180	45	90	135	180	45DAP	90DAP		
F ₀	11.83 a	13.50	16.50 a	19.50	0.81	1.0	1.16	1.27	9.02 d	11.96 d	0.14 c	6.04 d
F ₁	12.83 a	14.16	17.86 a	19.33	0.96	1.08	1.21	1.37	17.1 b	21.05 b	0.21 b	6.12 c
F ₂	11.66 a	14.50	17.16 a	19.83	0.83	0.97	1.13	1.3	14.75 c	17.80 c	0.29 a	6.76 a
F ₃	10.50 b	13.33	15.00 b	19.00	0.93	1.11	1.25	1.41	19.22 a	22.73 a	0.28 a	6.62 b
CV	14.69	11.77	10.37	8.48	13.56	11.23	8.37	8.12	0.44	2.03	13.2	6.50
LS	*	NS	*	NS	NS	NS	NS	NS	**	**	**	**

Table 3. Interaction effect of variety to spray formulation on Plant height, total leaf area, leaf area index, leaf number, stem diameter, CGR, RGR and total chlorophyll content

Variety x spray formulati on	Plant height (cm) at DAP				Total leaf area (cm ²) DAP				Leaf area index at DAP			
	45	90	135	180	45	90	135	180	45	90	135	180
V ₁ F ₀	25.46 a	26.96 a	28.10 a	29.56 b	613.7 ab	756.19 bc	984.15 bc	1256.78 b	0.55 ab	0.68 b	0.93 bc	1.14 b
V ₁ F ₁	26.80 a	29.53 a	32.00 a	35.1 a	478.0 c	708.82 bc	1022.99 bc	1369.14 ab	0.43 c	0.64 b	0.92 bc	1.24 ab
V ₁ F ₂	24.40 a	26.93 a	30.0 a	32.86 a	488.54 c	688.64 bc	979.26 bc	1274.78 b	0.44 c	0.62 b	0.88 bc	1.15 b
V ₁ F ₃	22.86 ab	25.50 a	28.63 ab	31.23 a	513.96 abc	786.39 bc	1132.9 abc	1487.13 ab	0.46 bc	0.69 b	1.02 bc	1.33 ab
V ₂ F ₀	20.06 b	21.43 b	22.93 b	24.20 b	510.9 abc	625.80 c	947.66 c	1339.29 ab	0.45 bc	0.59 b	0.85 c	1.21 ab
V ₂ F ₁	19.50 ab	22.3 b	25.6 ab	28.70 b	620.02 ab	869.31 ab	1247.20 ab	1595.7 ab	0.56 a	0.78 ab	1.13 ab	1.44 ab
V ₂ F ₂	19.03 b	21.96 b	25.43 ab	28.30 b	627.50 a	1000.5 4 a	1341.67 a	1665.61 a	0.56 a	0.90 a	1.21 a	1.51 a
V ₂ F ₃	20.40 b	23.43 ab	25.86 ab	28.56 b	502.22 bc	742.75 bc	1141.85 abc	1560.93 ab	0.45 bc	0.67 b	1.03 bc	1.41 ab
CV	16.91	14.63	12.88	12.09	11.62	14.41	12.91	12.08	11.62	14.25	12.6 l	12.77
LS	**	*	*	*	**	**	*	*	**	*	*	**

Legend: V₁ = Mokara Diheard Red , V₂ = Mokara Yellow Anne, DAP = Days After Planting , Spray Formulation 1 (F₁), Spray Formulation 2 (F₂), Spray Formulation 3 (F₃), LS= Level of significant , **= Significant at 1% level, *= Significant at 5% level, Contd.

Variety x spray formulation	Leaf number at DAP				Stem diameter (cm) at DAP				Chloro. content (mg/g)		CGR (g plant ⁻¹ /day)	RGR (mg g ⁻¹ /day)
	45	90	135	180	45	90	135	180	45D AP	90D AP		
V ₁ F ₀	12.0 abc	13.33 bc	15.66 b	18.0 cd	0.75 b	0.93 b	1.11 b	1.2 b	8.68 h	9.88 g	0.17 de	4.96 g
V ₁ F ₁	9.0 c	11.33 c	14.33 b	16.66 d	0.88 ab	1.0 ab	1.08 b	1.26 b	17.7 b	20.52 c	0.28 bc	6.03 f
V ₁ F ₂	10.33 bc	12.66 c	15.33 b	17.66 cd	0.76 b	0.91 b	1.08 b	1.2 b	15.21 d	19.79 d	0.37 a	6.48 c
V ₁ F ₃	9.66 c	12.33 c	14.66 b	18.0 bcd	0.85 ab	1.03 ab	1.15 b	1.33 ab	25.3 a	26.31 a	0.35 ab	6.1 e
V ₂ F ₀	11.66 abc	13.66 bc	17.33 ab	21.0 ab	0.88 ab	1.06 ab	1.21 ab	1.35 ab	9.36 g	14.05 f	0.12 e	7.13 a
V ₂ F ₁	14.66 a	17.0 a	20.0 a	22.0 a	1.05 a	1.16 a	1.35 a	1.48 a	16.51 c	21.58 b	0.15 de	6.21 d
V ₂ F ₂	13.0 ab	16.33 ab	19.0 a	22.0 a	0.90 ab	1.03 ab	1.17 ab	1.4 ab	14.30 e	15.82 e	0.22 cd	7.05 b
V ₂ F ₃	11.33 bc	14.33 abc	17.33 ab	20.0 abc	1.01 a	1.2 a	1.35 a	1.5 a	13.13 f	19.15 d	0.21 cd	7.14 a
CV	14.69	11.77	10.37	8.48	13.56	11.23	8.37	8.12	0.44	2.03	17.82	5.50
LS	*	**	*	*	*	**	**	**	**	**	NS	**

IV. Summary And Conclusion

The experiment was conducted in grill house of the Department of Crop Botany, BAU, during the period of 30 November, 2009 to 30 September, 2010 to determine the effect of spray nutrients on morpho-physiological features and growth of orchid. The experiment comprised of two orchid cultivars and four levels of spray nutrients with control. The experiment was laid out in Completely Randomized Block Design (RCBD) with 8 treatments and each treatment was replicated three times. Data were taken on some selected parameters and statistical analyses were performed by using MSTAT-C program. The results of the experiment were summarized below.

Results revealed that all the studied parameters were significantly influenced by spray formulation consists of N, P and K. Results showed that morpho-physiological features like plant height, leaf length, leaf wide, leaf area, leaf number, leaf area index, stem diameter, number of root and growth parameters viz. crop growth rate, relative growth rate, chlorophyll content in leaf were affected by spray formulation. The effect of cultivars on those morpho-physiological and growth features also significant. Data revealed that increasing plant height, leaf wide, leaf area, leaf number, leaf area index, stem diameter, number of root and RGR was higher in Mokara Yellow Anne. CGR, leaf length, total chlorophyll content were higher in Mokara Diheard red.

Different Spray formulation with different ratio of N, P and K also significantly affected morpho-physiological features and growth parameters. Leaf length was slightly affected by spray formulation. Degrees of increasing leaf length, number of root were higher in spray formulation-1 (F₁). Rate of increasing of plant height, crop growth rate, relative growth rate were more in spray formulation-2 (F₂). Rate of increasing of leaf width, total leaf area, leaf number, leaf area index, stem diameter and total chlorophyll content were more in spray formulation-3 (F₃).

Plant height, stem diameter, total leaf area and CGR were best in V₂F₂ among all treatments. Leaf area, leaf area index and RGR were best in V₂F₃ among all treatments. Leaf length and leaf width were best in V₂F₁ and V₂F₃, respectively. Chlorophyll content was superior in V₁F₃ among all treatments.

Based on experimental results it may be concluded that

- i) The morphological and physiological attributes was significantly affected by spray formulation.
- ii) Spray formulation-2 (F₂) was the best for growth of orchid.
- iii) The ratio of N, P and K at 10:15: 20, 15:20:25, 10:25:25, and 10:25:30 for spray formulation might be the best for growth of orchid.

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