Environment & Ecology 35 (3B) : 2199—2204, July—September 2017
Website: environmentandecology.com ISSN 0970-0420

Effect of Major and Micronutrients on Yield, Vase Life, Soil and Leaf Nutrient Content of Bird of Paradise (*Strelitzia reginae* L.)

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Received 12 October 2016 ; Accepted 14 November 2016 ; Published online 2 December 2016

Abstract A field experiment was conducted during 2015-16 to standardize nutrient requirement of bird of paradise comprising twelve treatment combinations with varied levels of nitrogen, phosphorus and potassium in combination with micronutrients. The results indicated that, application of 62.5 : 25 : 62.5 g NPK / plant / year along with foliar application of $ZnSO_4$ (0.5%) and Boron (0.25%) resulted significantly maximum yield per plant (9.02), yield per hectare (0.40 lakh cut flowers) and benefit cost ratio (2.81). Same treatment showed maximum cumulative water uptake (41.14 g), fresh weight of flowers (141.10 g), vase life (14.61 days) and minimum cumulative transpiration loss (16.72 g). Soil nutrient status (N, P, K, Zn and B) and leaf nutrient content (N, P, Zn and B) were also highest in the same treatment.

Keywords Bird of paradise, Macronutrients, Micronutrients, Nutrient content, Vase life.

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Introduction

In recent years some of the unexploited cut flower crops are gaining popularity because of their attractive size, form, color and keeping quality. Among them, bird of paradise has got its own importance both in domestic and international market due to its attractive, remarkably shaped crested head of bird and combination of orange and purple colored flower cluster. Therefore, the crop is cultivated in many parts of the world in order to produce cut flowers for both domestic and international markets. Bird of paradise belongs to family Strelitziaceae and the genus *Strelitzia*. It is indigenous to South Africa and blooming period is from September to May. It is an evergreen perennial herbaceous plant, grown in the regions having moderate subtropical climate.

Proper plant nutrition is essential for successful production of flower crops in open and also under protected conditions. Inadequate plant nutrition causes serious disorders and may eventually lead to decline of plant vigor and yield. Integrated supply of micronutrients with macronutrients in adequate

Table 1. Effect of NPK and micronutrients combinations on cut flower yield per plant and per hectare per six months of bird of paradise. Control–50 : 20 : 50 g NPK / plant / year.

Treatments	Cut flower yield per six months per Plant	Hectare (Lakh)
T_1 – 37.5 : 15 : 37.5 g NPK / plant / year	6.24	0.27
T_2 – 50 : 20 : 50 g NPK / plant / year	6.98	0.31
T_3 – 62.5 : 25 : 62.5 g NPK / plant / year	7.53	0.33
T_4 – 37.5 : 15 : 37.5 g NPK / plant / year+$ZnSO_4$ (0.5%)	7.24	0.32
T_5 – 50 : 20 : 50 g NPK / plant / year+$ZnSO_4$ (0.5%)	7.72	0.34
T_6 – 62.5 : 25 : 62.5 g NPK / plant / year+$ZnSO_4$ (0.5%)	8.17	0.36
T_7 – 37.5 : 15 : 37.5 g NPK / plant / year+Boron (0.25%)	7.15	0.31
T_8 – 50 : 20 : 50 g NPK / plant / year + Boron (0.25%)	7.60	0.33
T_9 – 62.5 : 25 : 62.5 g NPK / plant / year + Boron (0.25%)	7.83	0.34
T_{10} – 37.5 : 15 : 37.5 g NPK / plant / year+$ZnSO_4$ (0.5%)+ Boron (0.25%)	7.38	0.32
T_{11} – 50 : 20 : 50 g NPK / plant / year+$ZnSO_4$ (0.5%)+ Boron (0.25%)	8.35	0.37
T_{12} – 62.5 : 25 : 62.5 g NPK / plant / year + $ZnSO_4$ (0.5%)+ Boron (0.25%)	9.02	0.40
SEm±	0.15	0.01
CD @ 5%	0.46	0.03

amount and suitable proportions is one of the most important factors that control the plant growth in flower crops. Studies to assess the nutrient requirement of bird of paradise grown under open field condition in India are meager. A suitable nutrition dose will certainly help in deciding the ideal quantities and period of fertilizer application for higher yield and quality flower production in bird of paradise. Hence,

Table 2. Effect of NPK and micronutrients combinations on cumulative water uptake, fresh weight, transpiration loss of flowers and vase life. Control–50 : 20 : 50 g NPK / plant / year.

Treatments	Cumulative water uptake (g)	Cumulative fresh weight (g)	Cumulative transpiration loss (g)	Vase life (days)
T_1 – 37.5 : 15 : 37.5 g NPK / plant / year	26.62	120.80	25.50	7.87
T_2 – 50 : 20 : 50 g NPK / plant / year	27.41	123.13	25.15	9.27
T_3 – 62.5 : 25 : 62.5 g NPK / plant / year	29.74	132.42	24.16	12.33
T_4 – 37.5 : 15 : 37.5 g NPK / plant / year+$ZnSO_4$ (0.5%)	29.03	125.43	24.79	9.76
T_5 – 50 : 20 : 50 g NPK / plant / year+$ZnSO_4$ (0.5%)	32.46	128.67	22.92	12.02
T_6 – 62.5 : 25 : 62.5 g NPK / plant / year+$ZnSO_4$ (0.5%)	33.04	134.53	21.89	13.38
T_7 – 37.5 : 15 : 37.5 g NPK / plant / year+Boron (0.25%)	30.17	124.30	24.54	9.22
T_8 – 50 : 20 : 50 g NPK / plant / year+Boron (0.25%)	32.08	127.34	22.61	11.70
T_9 – 62.5 : 25 : 62.5 g NPK / plant / year+Boron (0.25%)	34.58	133.60	20.84	13.04
T_{10} – 37.5 : 15 : 37.5 g NPK / plant / year+$ZnSO_4$ (0.5%)+ Boron (0.25%)	30.96	126.80	24.11	10.20
T_{11} – 50 : 20 : 50 g NPK / plant / year+$ZnSO_4$ (0.5%)+ Boron (0.25%)	38.11	135.23	19.25	13.72
T_{12} – 62.5 : 25 : 62.5 g NPK / plant / year+$ZnSO_4$ (0.5%)+ Boron (0.25%)	41.14	141.10	16.72	14.61
SEm±	0.73	1.79	0.66	0.36
CD @ 5%	2.16	5.27	1.93	1.07

Table 3. Available NPK, DTPA extractable Zn and available B in soil of bird of paradise as influenced by NPK with combination of micronutrients. DATI=Days After Treatment Imposition, Control–50 : 20 : 50 g NPK / plant / year.

Treatments	Available N (kg/ha)		Available P (kg/ha)		Available K (kg/ha)	
	90 DATI	180 DATI	90 DATI	180 DATI	90 DATI	180 DATI
T_1 – 37.5 : 15 : 37.5 g NPK / plant	269.16	259.16	43.54	38.21	215.54	195.87
T_2 – 50 : 20 : 50 g NPK / plant	314.93	292.71	56.16	50.11	243.36	235.69
T_3 – 62.5 : 25 : 62.5 g NPK / plant	378.72	329.72	62.52	54.45	263.52	243.89
T_4 – 37.5 : 15 : 37.5 g NPK / plant + $ZnSO_4$ (0.5%)	272.68	284.84	44.41	40.46	220.81	198.66
T_5 – 50 : 20 : 50 g NPK / plant + $ZnSO_4$ (0.5%)	315.11	298.15	54.47	50.50	246.90	228.84
T_6 – 62.5 : 25 : 62.5 g NPK / plant + $ZnSO_4$ (0.5%)	380.42	330.42	62.70	54.93	266.21	244.42
T_7 – 37.5 : 15 : 37.5 g NPK / plant + Boron (0.25%)	272.18	286.35	44.28	40.28	216.15	198.21
T_8 – 50 : 20 : 50 g NPK / plant + Boron (0.25%)	314.38	297.11	54.38	50.29	244.99	228.71
T_9 – 62.5 : 25 : 62.5 g NPK / plant + Boron (0.25%)	380.38	330.38	62.57	54.57	264.36	244.16
T_{10} – 37.5 : 15 : 37.5 g NPK / plant + $ZnSO_4$ (0.5%)+Boron (0.25%)	274.76	289.10	44.57	40.57	223.24	200.37
T_{11} – 50 : 20 : 50 g NPK / plant + $ZnSO_4$ (0.5%)+Boron (0.25%)	316.39	296.39	54.69	50.73	248.73	229.07
T_{12} – 62.5 : 25 : 62.5 g NPK / plant + $ZnSO_4$ (0.5%)+Boron (0.25%)	383.86	337.53	63.69	56.36	269.66	244.59
SEm±	10.02	8.14	1.85	1.50	5.55	4.71
CD @ 5%	29.40	23.89	5.44	4.41	16.28	13.82

Table 3. Continued.

Treatments	DTPA extractable Zn (ppm)		Available B (ppm)	
	90 DATI	180 DATI	90 DATI	180 DATI
T_1 – 37.5 : 15 : 37.5 g NPK / plant	3.75	3.36	3.24	3.20
T_2 – 50 : 20 : 50 g NPK / plant	3.90	3.51	3.37	3.32
T_3 – 62.5 : 25 : 62.5 g NPK / plant	4.25	3.84	3.44	3.38
T_4 – 37.5 : 15 : 37.5 g NPK / plant + $ZnSO_4$ (0.5%)	6.11	6.03	4.03	3.96
T_5 – 50 : 20 : 50 g NPK / plant +$ZnSO_4$ (0.5%)	6.44	6.05	4.19	4.12
T_6 – 62.5 : 25 : 62.5 g NPK / plant +$ZnSO_4$ (0.5%)	6.61	6.53	4.27	4.19
T_7 – 37.5 : 15 : 37.5 g NPK / plant +Boron (0.25%)	4.42	4.35	5.27	5.16
T_8 – 50 : 20 : 50 g NPK / plant +Boron (0.25%)	4.59	4.50	5.43	5.31
T_9 – 62.5 : 25 : 62.5 g NPK / plant +Boron (0.25%)	4.60	4.49	5.62	5.50
T_{10} – 37.5 : 15 : 37.5 g NPK / plant +$ZnSO_4$ (0.5%)+Boron (0.25%)	6.15	6.06	5.35	5.23
T_{11} – 50 : 20 : 50 g NPK / plant +$ZnSO_4$ (0.5%)+Boron (0.25%)	6.47	6.35	5.52	5.37
T_{12} – 62.5 : 25 : 62.5 g NPK / plant +$ZnSO_4$ (0.5%)+Boron (0.25%)	6.71	6.58	5.74	5.60
SEm±	0.21	0.30	0.19	0.18
CD @ 5%	0.63	0.89	0.57	0.54

a study was carried out to standardize suitable dose of nutrients for bird of paradise under Eastern dry zone of Karnataka.

Materials and Methods

The field experiment was conducted on three year

Table 4. NPK, Zn and B in leaf of bird of paradise as influenced by NPK with combination of micronutrients. DATI=Days After Treatment Imposition, Control–50 : 20 : 50 g NPK / plant / year.

Treatments	N (%)		P (%)		K (%)	
	90 DATI	180 DATI	90 DATI	180 DATI	90 DATI	180 DATI
T_1 – 37.5 : 15 : 37.5 g NPK/plant/year	1.83	1.86	0.16	0.18	2.54	2.58
T_2 – 50 : 20 : 50 g NPK / plant/year	2.28	2.34	0.25	0.27	2.65	2.70
T_3 – 62.5 : 25 : 62.5 g NPK / plant/year	2.82	2.87	0.40	0.43	2.92	2.97
T_4 – 37.5 : 15 : 37.5 g NPK/plant/year + $ZnSO_4$ (0.5%)	1.91	2.04	0.19	0.22	2.58	2.57
T_5 – 50 : 20 : 50 g NPK / plant /year + $ZnSO_4$ (0.5%)	2.32	2.38	0.29	0.32	2.72	2.75
T_6 – 62.5 : 25 : 62.5 g NPK / plant/year+ $ZnSO_4$ (0.5%)	2.85	2.93	0.42	0.45	2.95	3.02
T_7 – 37.5 : 15 : 37.5 g NPK / plant/ year+ Boron (0.25%)	1.88	2.01	0.17	0.19	2.55	2.55
T_8 – 50 : 20 : 50 g NPK / plant/ year + Boron (0.25%)	2.31	2.36	0.26	0.28	2.69	2.71
T_9 – 62.5 : 25 : 62.5 g NPK / plant/ year+ Boron (0.25%)	2.83	2.89	0.41	0.44	2.93	2.98
T_{10} – 37.5 : 15 : 37.5 g NPK / plant /year+ $ZnSO_4$ (0.5%)+Boron (0.25%)	1.97	2.06	0.22	0.24	2.62	2.62
T_{11} – 50 : 20 : 50 g NPK / plant/year + $ZnSO_4$ (0.5%)+Boron (0.25%)	2.35	2.40	0.32	0.34	2.75	2.79
T_{12} – 62.5 : 25 : 62.5 g NPK / plant /year+ $ZnSO_4$ (0.5%)+Boron (0.25%)	2.96	3.19	0.44	0.48	3.02	3.11
SEm±	0.17	0.18	0.01	0.02	0.07	0.07
CD @ 5%	0.49	0.55	0.04	0.06	0.22	0.22

Table 4. Continued.

Treatments	Zn (ppm)		B (ppm)	
	90 DATI	180 DATI	90 DATI	180 DATI
T_1 – 37.5 : 15 : 37.5 g NPK / plant/year	23.58	23.62	17.25	17.29
T_2 – 50 : 20 : 50 g NPK / plant/year	24.60	24.66	18.36	18.42
T_3 – 62.5 : 25 : 62.5 g NPK / plant/year	25.59	25.68	19.59	19.67
T_4 – 37.5 : 15 : 37.5 g NPK / plant/year + $ZnSO_4$ (0.5%)	37.37	37.44	17.43	17.83
T_5 – 50 : 20 : 50 g NPK / plant/year + $ZnSO_4$ (0.5%)	38.58	38.68	18.48	18.58
T_6 – 62.5 : 25 : 62.5 g NPK / plant/year + $ZnSO_4$ (0.5%)	40.44	40.56	19.70	19.81
T_7 – 37.5 : 15 : 37.5 g NPK / plant/year + Boron (0.25%)	23.64	23.73	21.26	21.37
T_8 – 50 : 20 : 50 g NPK / plant/year + Boron (0.25%)	24.78	24.86	22.19	22.30
T_9 – 62.5 : 25 : 62.5 g NPK / plant/year+Boron (0.25%)	25.80	25.89	23.24	23.35
T_{10} – 37.5 : 15 : 37.5 g NPK / plant/year+$ZnSO_4$ (0.5%)+ Boron (0.25%)	37.43	37.51	22.04	22.13
T_{11} – 50 : 20 : 50 g NPK / plant/year+$ZnSO_4$ (0.5%)+ Boron (0.25%)	41.34	41.45	24.61	24.74
T_{12} – 62.5 : 25 : 62.5 g NPK / plant/year +$ZnSO_4$ (0.5%)+ Boron (0.25%)	43.24	43.37	26.13	26.27
SEm±	0.50	0.44	0.47	0.49
CD @ 5%	1.48	1.30	1.38	1.46

old bird of paradise plants at Regional Horticultural Research and Extension Center University of Horticultural Sciences campus, Gandhi Krishi Vignana Kendra, Bengaluru during 2015-16. The treatments consisting of three NPK fertilizer levels (37.5 : 15 : 37.5 g, 50 : 20 : 50 g and 62.5 : 25 : 62.5 g NPK / plant / year)

with combination of two micronutrients [$ZnSO_4$ (0.5%) and Boron (0.25%)] were assessed along with FYM @ 5 kg/plant. The experiment was laid out in randomized complete block design (RCBD) and replicated thrice. Uniform and healthy plants planted at a spacing of 1.5 m × 1.5 m ; were selected for the experiment. Nitrogen and potash were applied to the soil in split doses at three months interval whereas, phosphorus was applied as basal dose. The micronutrients zinc and boron were applied as foliar spray at monthly interval.

Weeding and plant protection measures were taken up as and when required. From each treatment five plants were selected at random for recording growth parameters (plant height, plant spread, number of leaves, leaf length, leaf width and number of suckers per plant), quality parameters (flower spathe length, stalk thickness, number of florets per spathe, stalk length, and flower graders) and yield parameters (yield/plant and yield/ha).

Results and Discussion

The results indicated that, plants supplied with different levels of NPK with combination of micronutrients showed significant differences among the different treatment combinations. The treatment combination of 62.5 : 25 : 62.5 g NPK / plant year+$ZnSO_4$ (0.5%) + Boron (0.25%) resulted maximum flower yield per plant (9.02) and per hectare (0.40 lakh cut flowers) (Table 1). The increase in yield parameters might be due to the reason that better nitrogen availability, better root proliferation which in turn increased the uptake of nutrients. Phosphorus is associated with phosphorylation and is a constituent of energy rich compounds like ATP, ADP and NADH. These energy rich metabolites ultimately increased the number of flowers and weight [1—2]. Potassium is involved in photo and oxidative phosphorylation thus, augmenting the energy requirement for growth and yield [3—4]. Zinc helps in inflorescence development and translocation of metabolites to itself or to the site of bud development [5—6]. Boron helps in the translocation of sugars [7].

Maximum cumulative water uptake (41.14 g), fresh weight (141.10 g), vase life (14.61 days) and minimum cumulative transpiration loss (16.72) (Table 2) were recorded in the treatment combination of 62.5 : 25 : 62.5 g NPK /plant/year+$ZnSO_4$ (0.5%) + Boron (0.25%). This might be due to higher levels of NPK with combination of zinc and boron might have showed higher tolerance to vase bacteria and thus exhibit slow development of vascular occlusion [8]. Boron helps in the accumulation of simple carbohydrates and nitrogen compounds in plants as a prime component. The variations with respect to flower weight among treatments might also be the result of higher water and carbohydrates level in the flower. Lower transpiration loss is due to the strongest stems, due to the contribution of boron in building up of cell wall [9]. Increase in vase life might also be due role of boron in regulation of K/Ca ratio in plants which in turn helped in increased water uptake and reduced transpiration loss of water during vase life period, which ultimately resulted prolonged vase life of flowers. Increase in vase life of flowers in $ZnSO_4$ spray might be attributed to the role of zinc in improving water relations and the increased water uptake. The results of the current findings were in accordance with earlier reports [8—10].

Nutrient uptake was maximum under the highest level of nutrition (62.5 : 25 : 62.5 g NPK/plant/year) along with micronutrients and decreased with the decrease in nutrients levels and without micronutrient application in both soil (Table 3) and plant parts (Table 4). A gradual increase of nutrient contents and uptake was recorded with increasing the nitrogen fertilizer rate in chrysanthemum [11].

Thus, it could be concluded that application of higher levels of NPK along with foliar application of micronutrients showed higher yield, maximum vase life, highest soil nutrient status and leaf nutrient content and maximum benefit cost ratio and it can be considered as the best treatment for better growth of *Strelitzia reginae*.

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