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Research Article

INFLUENCE OF PGR AND MICRONUTRIENTS FOLIAR SPRAY ON TUBEROSE (*Polianthes tuberosa*) UNDER PROTECTED AND OPEN CONDITIONS

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Abstract- Plant growth regulator and micronutrients has great impact on quality and quantity of tuberose, an experiment was designed at Ranchi (Jharkhand) during the year 2012 and 2013 on foliar spray of PGR (plant growth regulator) and micronutrients in tuberose under protected and open conditions. The experiment consisted of twelve treatments i.e.T_1-GA_3 (Gibberellic acid),T_2-MH (Maleic hydrazide),T_3-(Boron),T_4-(Zinc),T_5-(GA_3+Boron), T_6-(GA_3+Zinc), T_7-(MH+Boron), T_8-(MH+Zinc), T_9-(Boron+Zinc), T_{10}-(GA_3+Boron+Zinc), T_{11}-(MH+Boron+Zinc) and T_{12} (water spray). Vegetative growth characters such as leaf length (65.02cm and 56.92cm, respectively), leaf number (62.61 and 57.61, respectively) leaf breadth (2.22cm and 2.08 cm, respectively) and flowering characters as spike length (117.59cm and 87.38cm, respectively), number of spikes per plant (2.70 and 1.33, respectively), number of florets per spike(59.10 and 40.57, respectively) were recorded maximum with foliar spray of GA_3 (100ppm) +B (100ppm) +Zn (10ppm). However, maximum chlorophyll content (0.219 and 0.192, respectively) and diameter of florets (5.14 cm and 4.18cm, respectively) in polyhouse and open conditions were with foliar application of MH (500ppm) +B (100ppm) +Zn (10ppm).

Keywords- Micronutrients, Foliar spray, Gibberellic acid, Maleic hydrazide, Polyhouse.

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Introduction

Flower cultivation has been practiced in India since earlier times, but in the past two decades, it has attained commercial importance. In the recent scenario cultivation of flowers is considered as economically viable business venture as it has higher prospective per unit area than most of the field crops and farmers shifted towards income giving floricultural crops and production of various flower based products such as essential oils, perfumes, herbal cosmetics, medicines, incense sticks, herbal colours and food items like gulkand from rose petals.

In India, several flowers are grown for example tuberose, jasmine, marigold, chrysanthemum, crossandra, aster, rose, carnation, gerbera, gladiolus etc. During the year, 2010-11 the total area under floriculture production in India was 253.65 thousand hectares with a production of 1.652 million tonnes loose flowers and 750.66 million cut flowers [10]. Among the vital showy bulbous plants grown in India, tuberose (*Polianthes tuberosa)* occupies a major place due to its pleasant appearance and presence of valuable essential oils which is of paramount important in perfume industry. It belongs to family Amaryllidaceae and is native of Mexico. The plants of tuberose are herbaceous with perpetual growth habit for 2-3 years in favouorable climatic conditions. It has light green, sword shaped, grassy long leaves which are tapered towards the base and tip while wider in the middle. At present, the total area under tuberose cultivation in the country is estimated to be about 20,000 hectares [27]. It has a great economic potential for cut-flower trade and essential oil industry [19]. The most common constituents of tuberose are geraniol, nerol, benzyl alcohol, methyl-benzoate, methylanthranilate and ethnol [22]. The flowers are widely used for table decoration, floral ornaments, cut flower, fragrance and essential oil. The long spikes of flowers are excellent for cut flowers and people like their sweet fragrance [4].

The bulbs of tuberose have some medicinal properties. An alkaloid lycorine is found in the bulb which causes vomiting. Two steroidal sapogenin, hecogenin and a small amount of tigogenin (poly fructosan) have been isolated from the bulbs. The bulbs of tuberose are diuretic and emetic.

Materials and Methods

The experiment was carried out during rainy season in the consecutive years 2011 and 2012 at floriculture section of the Department of Horticulture, Birsa Agricultural University, Kanke, Ranchi (Jharkhand). The experimental site comes under the seventh Agro-climatic region i.e. Eastern plateau and hills. The experiment was laid out in randomized block design with three replications and twelve treatments. Uniform sized (1.5-2.0cm), healthy sprouted bulbs of tuberose (*Polianthes tuberosa*) cv. Calcutta Single which were free from insect and diseases were procured from the Department of Horticulture, Birsa Agricultural University, Kanke, Ranchi. Bulbs were treated with 0.2% solution of bavistin and were sown in the plots of size 1m x1m at spacing of 25x20 cm both under protected and open conditions. Well rotten FYM @ 20 t/ha was applied 15 days prior to planting and recommended dose of inorganic fertilizer NPK @200:80:120 kg/ha was applied at the time of planting of the treated bulbs. Single and combined doses of plant growth regulators and micronutrients were applied thrice; first application was done at 40 days after planting then at 15 days interval. The field was irrigated regularly to keep the soil moisture in good condition. Hoeing and weeding was done at 15 days interval to keep the soil weed free. Observations on leaf length and leaf number were recorded after 135 days of planting, leaf breadth was taken when the leaf was completely matured i.e. after 90 days of planting and chlorophyll content of the leaf was recorded at spike emergence stage with the method described by [3]. Similarly, observations on days to spike emergence, days to flowering, length of spike, number of spike, number

of florets per spike and vase life in tap water were recorded.

Results and Discussion

There was significant influence of integrated application of micronutrients and plant growth regulators on vegetative growth parameters of tuberose [Table-1]. The combined effect of GA_3(100ppm) +Boron(100ppm)+Zinc (10ppm) showed maximum leaf length of 65.02cm in polyhouse and 56.92cm in open conditions, respectively and minimum leaf length was obtained with application of MH (500ppm) under both the conditions. Gibberellic acid when applied as foliar spray elongate plant's cell and tissues, boron is involved in all metabolic activities and regulation of other nutrients and zinc being a precursor of tryptophan, increased cell division leads to increased leaf length. The results are in conformity with [29] on *Dahlia pinnata* and [5] on tuberose with GA_3 and micronutrients.

Table-1 *Effect of plant growth regulators and micronutrients on vegetative parameters of tuberose*

Treatments		Leaf length (cm) 135 DAP Pooled		Leaf no. (135 DAP) Pooled		Leaf breadth (cm) Pooled		Chlorophyll content (mg/g) Pooled	
		Polyhouse	Open	Polyhouse	Open	Polyhouse	Open	Polyhouse	Open
T_1	GA_3(100ppm)	59.60	49.00	45.02	40.14	1.84	1.74	0.188	0.163
T_2	MH(500ppm)	40.76	35.88	33.19	27.43	1.78	1.45	0.211	0.168
T_3	Boron(100ppm)	55.60	45.72	42.51	37.30	1.8	1.84	0.167	0.140
T_4	Zinc(10ppm)	55.31	46.98	43.90	38.88	1.87	1.88	0.169	0.148
T_5	GA_3(100ppm)+Boron(100ppm)	60.03	52.71	52.11	45.35	1.96	1.84	0.179	0.158
T_6	GA_3(100ppm) +Zinc(10ppm)	60.79	53.52	54.26	49.68	2.021	1.92	0.190	0.159
T_7	MH(500ppm)+Boron(100ppm)	50.88	42.60	36.37	33.00	1.84	1.71	0.197	0.191
T_8	MH(500ppm)+Zinc(10ppm)	50.83	43.40	38.18	34.39	1.91	1.75	0.197	0.164
T_9	Boron(100ppm) +Zinc(10ppm)	62.41	49.29	51.79	46.96	2.01	1.90	0.193	0.158
T_{10}	GA_3(100ppm)+Boron(100ppm)+Zinc(10ppm)	65.02	56.92	62.61	57.61	2.22	2.08	0.208	0.158
T_{11}	MH(500ppm)+Boron(100ppm)+Zinc(10ppm)	56.69	45.48	41.65	35.47	1.95	1.70	0.219	0.192
T_{12}	Control(water spray)	46.87	39.85	34.31	31.35	1.52	1.33	0.136	0.124
CD (5%)		7.42	7.45	4.12	8.03	0.18	0.37	0.041	0.014

MH inhibits cell division by reducing nucleic acid biosynthesis [18]. Thus application of MH (500ppm) might cause minimum leaf length. The maximum mean number of leaves 62.61 in polyhouse and 57.61in open conditions, respectively were recorded with application of GA_3 (100ppm) +Boron (100ppm) +Zinc (10ppm) followed by GA_3 (100ppm) + Zinc (10ppm). When gibberellic acid along with boron and zinc were applied simultaneously they showed more number of leaves. The increase may be due to cell division and enhancing activity of gibberellic acid and zinc on apical meristem as both are responsible for activation of enzymes involved in the synthesis of IAA [1] and [13] found higher leaf number in gerbera with foliar spray of a solution containing Zn, B, Fe and Mn. The results are in line with [9] on gladiolus, [14] on tuberose with GA_3 (300ppm) and [11] on gladiolus with boron. In cut flowers, air temperature influences the emission and growth of leaves as reported by [17] and inside polyhouse maximum air temperature was maintained which might have favoured the growth of new leaves. The combined effect of GA_3(100ppm) +Boron(100ppm)+Zinc (10ppm) showed maximum increase in the mean width of leaves(2.22cm and 2.08 cm, respectively) under polyhouse and open conditions while minimum mean leaf breadth under both conditions was recorded with application of control i.e. water spray. Growth regulators and micronutrients might have acted synergistically over each other as a result gibberellic acid led to formation of hormones as by- product in the leaves and micronutrients i.e. zinc led to cell division while boron facilitates transport of carbohydrates in the plants which could result in the expansion of leaves. Inside polyhouse the leaf breadth was more than in open conditions. The higher leaf breadth might be due to increased level of photosynthesis because of increased number of leaves and plant spread. The results are in accordance with the findings of [12] in jasmine, [16] in gerbera, and [25] in gerbera.

MH (500ppm) + Boron (100ppm) +Zinc (10ppm) recorded the highest mean total chlorophyll content of 0.195 and 0.219 mg/g respectively [Fig-1] in open and polyhouse conditions. Maleic hydrazide may have caused induction of grana while boron resulted in increase in nutrient content i.e. N, P, K, Fe, Mn in leaves, among these Fe and Mn are essential elements of chlorophyll formation and zinc is a part of enzyme which regulate plant growth which led to maximum total chlorophyll content. These findings are in concurrence with [6]. The chlorophyll content of all the treatments in tuberose leaves grown in polyhouse was more than the open condition. Inside polyhouse favourable climatic conditions stimulates more photosynthesis which leads to more grana production as well as more utilization of nutrients due to boron and zinc. Therefore, more chlorophyll formation had taken place inside polyhouse in comparision to open conditions. The same trend was reported by [26] on broccoli.

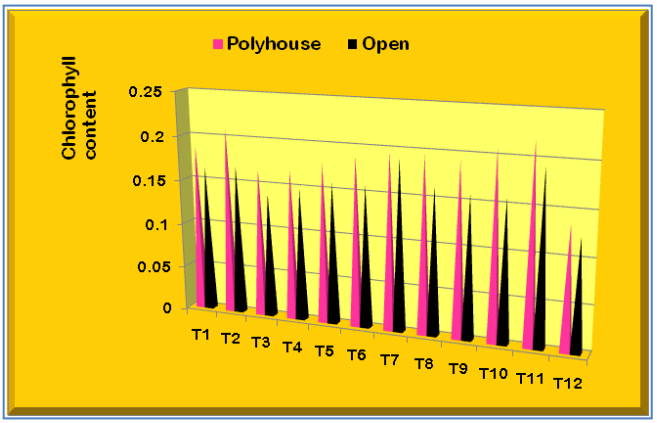

Fig-1 Effect of PGR and micronutrients on chlorophyll content

Collective application of micronutrients and plant growth regulators has intense effect on flowering characters of tuberose as depicted in [Table-2] and [Table-3]. GA_3 (100ppm) + Boron (100ppm) jointly recorded minimum 116.34 days and 98.13 days for spike emergence under polyhouse and open conditions, respectively. This might be due to the breaking of dormancy by GA_3 and boron is necessary for carbohydrate transport, water relation and photosynthesis within the plant. The effect of gibberellic acid in inducing the formation of hydrolytic enzymes may be a factor, which regulates the mobilization of reserves, ultimately resulting in early sprouting with GA_3 [8]. Therefore, combined effect of gibberellic acid and boron might have attributed to early emergence of spike. Earliest days to flowering (135.16days in polyhouse and 118.76 days in open conditions) with combined application of 100ppm gibberellic acid and 100ppm boron may possibly be due to the earlier spike emergence with this treatment. Maximum mean spike length (117.59cm in polyhouse and 87.38 cm in open conditions) and maximum number of spikes per plant [Fig-2] was attained by the combined application of 100ppm gibberellic acid, 100ppm boron and 10ppm zinc may be due to increase

in cell elongation, cell division or both induced by gibberellins [24] as well as cell differentiation at all growing tips of plants by boron and nitrogen metabolism by zinc.

Table-2 *Effect of plant growth regulators and micronutrients on flowering parameters of tuberose*

Treatments		Days to spike emergence Pooled		Days to flowering Pooled		No. of spikes per plant Pooled		Length of spike (cm) Pooled	
		Polyhouse	Open	Polyhouse	Open	Polyhouse	Open	Polyhouse	Open
T_1	GA_3(100ppm)	119.14	108.99	140.96	128.91	2.21	1.16	104.77	83.41
T_2	MH(500ppm)	135.59	124.81	163.38	152.33	1.40	1.00	83.09	63.89
T_3	Boron(100ppm)	122.33	104.56	144.43	128.43	2.10	1.03	103.67	81.46
T_4	Zinc(10ppm)	127.54	108.70	149.96	130.96	1.93	1.00	102.38	78.26
T_5	GA_3(100ppm)+Boron(100ppm)	116.34	98.13	135.16	118.78	2.46	1.23	112.27	86.83
T_6	GA_3(100ppm) +Zinc(10ppm)	118.63	110.11	140.16	128.41	2.16	1.00	112.40	84.68
T_7	MH(500ppm)+Boron(100ppm)	131.51	114.67	156.78	138.85	1.76	1.00	92.5	71.94
T_8	MH(500ppm)+Zinc(10ppm)	133.49	122.05	159.10	145.75	1.60	1.00	90.28	73.83
T_9	Boron(100ppm) +Zinc(10ppm)	123.05	109.70	143.68	130.45	1.93	1.00	104.33	84.09
T_{10}	GA_3(100ppm)+Boron(100ppm)+Zinc(10ppm)	117.78	99.52	137.59	118.76	2.70	1.33	117.59	87.38
T_{11}	MH(500ppm)+Boron(100ppm)+Zinc(10ppm)	127.85	116.49	153.15	139.35	1.96	1.00	93.83	81.04
T_{12}	Control(water spray)	139.02	136.09	166.39	161.49	1.50	1.00	85.72	69.16
CD (5%)		15.04	14.08	13.11	13.70	0.49	0.23	10.93	17.66

Table-3 *Effect of plant growth regulators and micronutrients on flowering parameters of tuberose*

Treatments		Florets no. per spike Pooled		Florets wt. per spike Pooled		Florets diameter (cm) Pooled		Flowering duration(days) Pooled	
		Polyhouse	Open	Polyhouse	Open	Polyhouse	Open	Polyhouse	Open
T_1	GA_3(100ppm)	53.97	36.16	52.14	34.11	3.95	3.36	21.58	18.18
T_2	MH(500ppm)	41.93	29.63	41.89	30.15	4.23	3.32	17.94	13.44
T_3	Boron(100ppm)	53.74	35.22	51.38	34.75	4.09	3.56	22.29	17.07
T_4	Zinc(10ppm)	53.13	33.68	48.81	31.55	3.83	3.10	21.07	16.8
T_5	GA_3(100ppm)+Boron(100ppm)	56.04	40.21	57.16	40.06	4.37	3.92	23.48	19.74
T_6	GA_3(100ppm) +Zinc(10ppm)	55.34	38.21	53.99	36.49	4.22	3.47	21.94	19.67
T_7	MH(500ppm)+Boron(100ppm)	50.27	28.49	49.95	33.06	4.68	4.00	20.10	16.11
T_8	MH(500ppm)+Zinc(10ppm)	48.63	29.27	48.56	29.78	4.26	3.85	18.72	15.8
T_9	Boron(100ppm) +Zinc(10ppm)	56.09	34.54	55.15	34.58	4.12	3.51	22.80	17.74
T_{10}	GA_3(100ppm)+Boron(100ppm)+Zinc(10ppm)	59.10	40.57	58.64	38.84	4.85	4.08	25.85	20.01
T_{11}	MH(500ppm)+Boron(100ppm)+Zinc(10ppm)	48.95	35.18	51.34	36.11	5.14	4.18	22.7	16.63
T_{12}	Control(water spray)	38.20	26.23	33.27	23.46	3.22	2.18	15.50	10.75
CD (5%)		7.30	7.48	8.82	7.59	0.27	0.93	4.15	5.20

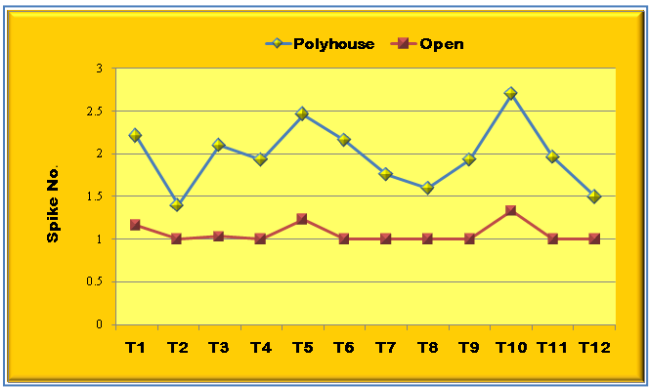

Fig-2 Effect of PGR and micronutrients on number of spikes per plant

Foliar spray of 100ppm gibberellic acid, 100ppm boron and 10 ppm zinc in combination recorded maximum number [Fig-3] and weight of florets of florets per spike in polyhouse and open conditions, respectively. This may be due to the combined effect of plant growth regulator and micronutrients which enhance the better partitioning of photosynthates to developing reproductive sinks and due to more accumulation of photosynthates, higher number of flowers as well as weight of flowers per spike may occur. Boron is utmost important in fertilization and flowering processes of crops as reported by [21] while zinc being a precursor of tryptophan activates cell division. The result was in line with [7] on rose with GA_3 (45ppm), [23] on tuberose with GA_3 (200 ppm), [28] on sterlizia with GA_3 (100 or 200ppm), [9] on gladiolus with boron and zinc in combination and [11] on gladiolus with boron.

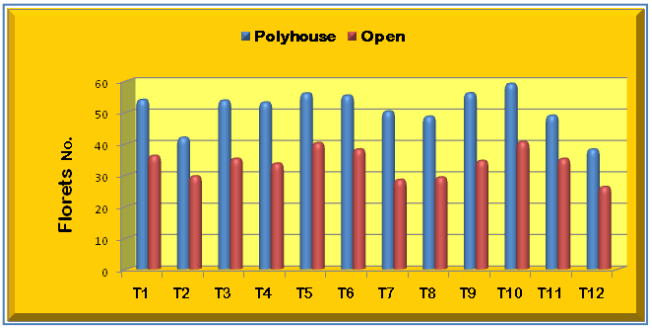

Fig-3 Effect of PGR and micronutrients on number of florets per spike

Diameter of florets was significantly increased due to all foliar application treatments as compared with control. However, the largest mean diameter of florets was found in plants sprayed with 500ppm maleic hydrazide in combition with 100ppm boron and 10ppm zinc. This could be due to the inhibiting role of maleic hydrazide on other growth parameters and accumulation of photosynthates, activity of boron in sugar translocation and stimulation of hormone synthesis by zinc. The result was in line with [25] on gerbera with GA_3 (100 ppm), [15] on sunflower with boron, [9] on gladiolus with boron and zinc in combination, [2] on carnation with sangral (containing 14ppm Zn and 72 ppm Boron).

Plant sprayed with100ppm gibberellic acid, 100ppm boron, and 10ppm zinc in mixed doses was retained maximum number of days in field under both conditions due to favorable effect of GA_3 and micronutrients on carbohydrate accumulation and metabolic activities.

Conclusions

It may be concluded from the above study that application of 100ppm gibberellic acid, 100ppm boron and 10ppm zinc in combination performed the best in respect of both vegetative and flowering characters in tuberose. It was also concluded that performance of tuberose in respect of all the parameters in the polyhouse was better in comparison to open conditions.

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Abbreviations:

PGR: Plant growth regulator

Conflict of Interest: None declared

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