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Effect of bio-fertilizers on growth and flowering of *Dendrobium* var. Sonia

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ABSTRACT

Orchids are known for their long lasting and beautiful flowers which fetch a very high price in the international market. Dendrobium is the second largest member in the orchidaceae family with nearly 1600 valid species in the world. Application of chemical fertilizers alone in high does in the field makes adverse effects on soil health and environment also. Use of biofertilzer along with chemical fertilizers is beneficial as biofertilizers are the products containing living cells of different types of microorganisms which have an ability to enhance mineralization process. The present investigation was carried out to study the effect of different bio-fertilizers individually or in combinations on growth and flowering behavior of Dendrobium orchid (Dendrobium var. Sonia) under naturally ventilated hi-tech polyhouse. Three biofertilizers viz., Azospirillium, PSB and VAM were applied in nine different treatment combinations along with vermicompost. Uniform sized tissue cultured plants were established in cocoblock (30.48 × 22.86 sq.cm) and treatments were started after one year of plant growth. Significant variation was observed among the different treatments. Most luxuriant plant growth in terms of plant height (58 cm), number of leaves (12.7), leaf area (80.4 sq.cm) and number of pseudo bulbs (4.2 plant^{-1}) was found in vermicompost @ 500g pot^{-1} + PSB @ 2g pot^{-1} + Azospirillium @ 2g pot^{-1} whereas vermicompost @ 500g pot^{-1} + Azospirillium @ 2g pot^{-1} + VAM @ 2g pot^{-1} + PSB @ 2g pot^{-1} recorded excellent performance on flower production in terms of number of spikes plant^{-1} (7.5), number of flowers spike^{-1} (8.6), spike length (46.7 cm), flower length (10.38 cm), flower breath (10.01cm) and pedicel length (25.5 cm).

***Keywords*:** *Azospirillium*, hi-tech polyhouse, PSB, VAM and vermicompost

Floriculture is the field which is gaining importance both at the national and international market with the increase in demand for cut flowers. Orchid is an attractive flower having handsome looks among the flowers grown in the world due to its incredible range of diversity in terms of colour, shape, size, appearance and post-harvest life. Dendrobium is marvellous genus and very popular with amateurs for a very long period because of their large showy flowers (Wannajindaporn *et al*., 2014). Use of high doses of chemical fertilizers was cause environmental pollution which is harmful for flora, fauna and human beings. Bio-fertilizers have come out as a complementary to mineral fertilizers and keep a promise to improve the yield as well as quality of crops. Bio-fertilizers likes *Azospirillum*, PSB, VAM and vermicompost are suitable for application in different flower crops such as chrysanthemum, petunia, gladiolus and carnation *etc*. In chrysanthemum qualitative traits were improved by application of bio-fertilizers and bioinoculent (Airadevi., 2012). Prabhat *et al*. (2013) reported that treatment of arbuscular mycorrhiza, vermicompost and vermiwash were in combination enhanced qualitative and quantitative attributes of gladiolus cv. Prosperity. Bio-fertilizers application enhances flowering period compare to chemical fertilizer in petunia (Hoda and Mona, 2014). The flowering parameters were positively influenced by application of biofertilizers (*Azotobacter* sp. + *Azospirillum* sp.) in combination with nitrogen in gladiolus (Dalve *et al*., 2009) and in carnation (Gupta *et al*., 2004). Orchid has worldwide importance. It is the best profitable flower for farmers. In West Bengal it is mainly grown in Darjeeling and Kalimpong forest area (Bhattacharjee *et al*., 2003). But due to lack of suitable climate and agro-techniques, it cannot be grown in Southern parts of West Bengal. So there is immense opportunity to develop suitable agro-techniques for cultivation of dendrobium under southern zone of West Bengal with a view to enhance the quality produce and to popularize it amongst the stake holders. As a part of agro-techniques development for cut flower production, an experiment was conducted to study the effect of several bio-fertilizers on growth and flowering behaviour on Dendrobium orchids (*Dendrobium* var. Sonia) under ventilated high hi-tech polyhouse at Floriculture Farm, BCKV during 2015-16 and 2016-17.

MATERIALS AND METHODS

The present investigation was carried out under naturally ventilated hi-tech polyhouse that provided with artificially controlled temperature, humidity and sprinkler irrigation system. Three commercial formulations of bio-fertilizers viz., *Azospirillium* spp., PSB (*Bacillus polymyxa*) and VAM (*Glomus faciculatum*

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and *Gigaspora* spp.) were applied in nine different treatment combinations along with vermicompost. The experiment was laid out in Completely Randomized Design (CRD) replicated thrice and the statistical analysis of the data was carried out following Fisher's analysis of Variance Technique as described by Gomez and Gomez (1984). The details of treatments are summarized below. T_1: control= N: P: K (30:10:10 @ 0.1%), T_2= vermicompost @ (500g pot^{-1}), T_3 = vermicompost @ (500g pot^{-1}) + *Azospirillum* @ (2g pot^{-1}), T_4= vermicompost @ (500 g pot^{-1}) + VAM @ (2 g pot^{-1}), T_5= vermicompost @ (500g pot^{-1}) + PSB @ (2g pot^{-1}), T_6= vermicompost @ (500g pot^{-1}) + *Azospirillium* (2g pot^{-1}) + VAM @ (2g pot^{-1}), T_7 = vermicompost @ (500 g pot^{-1})+ VAM @ (2 g pot-1^{-1}) + PSB @ (2 g pot^{-1}), T_8= vermicompost @ (500g pot^{-1}) + PSB @ (2 g pot^{-1}) + *Azospirillium* @ (2 g pot^{-1}), T_9= vermicompost @ (500 gpot-1^{-1}) + *Azospirillium* @ 2 (g pot^{-1}) + VAM @ (2 g pot^{-1}) + PSB @ (2 g pot^{-1}). Uniform size tissue cultured plants were established in cocoblocks (30.48 × 22.86 sq.cm) and treatments were started after one year of plant growth. All the plants were sprayed with water soluble fertilizers N: P: K (30:10:10) @ 0.1% at weekly interval.

RESULTS AND DISCUSSION

Effect of bio-fertilizers on growth of orchid

Significant variations among the treatment combinations were noticed for all the vegetative parameters as summarized in the table 1. The most luxuriant plant growth in terms of plant height (58 cm) was recorded under the treatment of vermicompost @ 500 g pot^{-1} + PSB (2g pot^{-1}) + *Azospirillium* (2 g pot^{-1}) which was followed by (57 cm) vermicompost @ 500 g pot^{-1} + VAM (2 g pot^{-1}) + PSB (2g pot^{-1}) whereas the least plant height 33.33 cm was recorded in control. The maximum stem girth (4.6 cm) was noticed in vermicompost @ 500 g pot-1 + *Azospirillium* (2 g pot^{-1}) + VAM (2 g pot-1) + PSB (2 g pot^{-1}) which was at par with vermicompost @ (500 g pot^{-1}) + VAM @ (2 g pot^{-1}) + PSB @ 2 g pot^{-1} (4.6 cm). The maximum value for other vegetative growth parameters like leaf area (80.40 sq.cm), no. of leaves/pseudo bulb (12.67), no. of pseudo bulbs (4.2) and intermodal length (4.10 cm) were observed in vermicompost @ (500 g pot^{-1}) + PSB @ (2g pot^{-1}) + *Azospirillium* @ (2g pot^{-1}). Treatments vermicompost @ (500 g pot^{-1}) + *Azospirillium* (2g pot^{-1}) + VAM (2g pot^{-1}), vermicompost @ (500g pot^{-1}) + PSB @ (2g pot^{-1}), vermicompost @ (500g pot^{-1}) + VAM @ (2g pot^{-1}), vermicompost @ (500g pot^{-1}) + VAM (2g pot^{-1}) + PSB (2g pot^{-1}) and vermicompost @ 500g pot^{-1} was significantly better than control. Leaf production interval was the highest in vermicompost @ 500 g pot^{-1} (16.67 days) whereas the shortest interval was 11 days found in vermicompost @ 500g pot^{-1} + PSB @ 2g pot^{-1}. According to Binisha *et al*. (2002) application of NPK along with *Azospirillum* was more productive in enhancing vegetative and floral quality of *Dendrobium* than NPK alone. Prabhat Kumar *et al*. (2003) reported that application bio-fertilizers (VAM and phosphobacteria) enhancing vegetative growth parameter in China aster. Gayathri *et al*. (2004) also reported that combined application of biofertilizers significantly increased the number of leaves, leaves area and stem girth in limonium.

Effect of biofertilizer on flowering of orchid

Significant difference was also noticed among the treatments for reproductive characters as summarized in the table 2. The earliest flower emergence was noticed in control (82 days), whereas, the longest duration (94 days) was recorded in vermicompost @ 500g pot-1 + *Azospirillium* (2g pot^{-1}) + VAM (2g pot^{-1}) + PSB (2g pot^{-1}). It might be due to less vegetative growth occurred under control as compared to other bioinoculent treatments. So control completes its vegetative growth as early in comparison to other treatments so it reached to reproductive phase much early. Vermicompost @ (500g pot^{-1}) + *Azospirillium* (2g pot^{-1}) + VAM (2g pot^{-1}) + PSB (2g pot^{-1}) recorded excellent performance in flower production flower length (10.38 cm) and flower breath (10.01 cm). It had been found that all most all the treatments recoded flowering two times in a year-first flush being in June-July and second in September to October. Under this experiment vermicompost @ (500g pot^{-1}) + *Azospirillium* (2g pot^{-1}) + VAM (2g pot^{-1}) + PSB (2g pot^{-1}) recorded excellent performance in flower production in terms of no. of spikes per plant (7.50), no. of flowers per spike (8.6), spike length (46.67 cm), and pedicel length (25.53 cm). Bio-fertilizers like VAM, *Azospirillum* sp., PSB have registered minimum number of days to first flowering. Mandal (2006) observed that application of NPK @ 20:10:10 at 0.2% and VAM was comparatively better bio-fertilizer treatment for growth of spike, number of florets per spike, height of plant, vase-life of shoot, length of florets and field life of *Dendrobium* cv. Sonia 16. This result might be attributed due to the simulative effect of bio-fertilizers as vegetative growth as reported (Mah fouz and Sharaf-Eldin, 2007). In tuberose cv. Double (Chaudhary, 2009) observed that the bio-fertilizers application (Azotobacter, PSB and Arbuscular mycorrhiza) with lower N and P doses advanced the flowering and sprouting of bulbs and reduced the amount of chemical fertilizers. Similar observations were recorded in chrysanthemum (Airadevi, 2012). Prabhat *et al*. (2013) reported that spike length, number of florets, vase life, number of corms m^{-2} and weight of corms in gladiolus cv. Prosperity were enhanced by combined treatment of VAM, vermicompost and vermiwash.

Effect of biofertilizers on post-harvest quality of orchid

From the table 3 Longevity of spike in the field as well as vase-life in tap water at room condition was also

Table 1: Effect of bio-fertilizers on growth of orchids (Mean value over two years)

Treatments	Plant height (cm)	Pseudo bulb girth (cm)	Leaf area (sq.cm)	No. of leaves per pseudo bulbs	No. of pseudo bulbs plant^{-1}	Intermodal length (cm)	Interval of leaf production (day)
T_1	33.33	3.13	45.53	6.67	2.00	3.00	15.00
T_2	36.00	3.33	49.27	7.67	2.00	3.10	16.67
T_3	42.33	3.73	58.07	8.33	3.00	3.50	15.00
T_4	45.33	3.90	65.60	8.67	3.00	3.60	14.00
T_5	48.00	4.20	70.73	10.33	3.00	3.90	11.00
T_6	51.33	4.23	71.33	11.00	4.00	4.00	11.33
T_7	35.67	3.47	55.53	8.33	3.00	3.00	14.67
T_8	58.00	4.60	80.40	12.67	4.20	4.10	13.33
T_9	57.00	4.60	76.53	11.67	4.00	4.00	15.33
SEm(±)	**1.08**	**0.07**	**0.77**	**0.32**	**0.01**	**0.04**	**0.32**
LSD (0.05)	**3.24**	**0.22**	**2.31**	**0.94**	**0.03**	**0.13**	**0.98**

Note: T_1: Control (Inorganic fertilizer spray (N: P: K::30:10:10 @ 0.1%), T_2: Vermicompost @ 500 g pot^{-1}, T_3: Vermicompost @ 500 g pot^{-1} + Azospirillium @ 2g pot^{-1}, T_4: Vermicompost @ 500 g pot^{-1} + VAM @ 2 g pot^{-1}, T_5: Vermicompost @ 500 g pot^{-1} + PSB @ 2 g pot^{-1}, T_6: Vermicompost @ 500 g pot^{-1} + Azospirillium (2 g pot^{-1})+ VAM (2 g pot^{-1}), T_7: Vermicompost @ 500 g pot^{-1} + VAM (2 g pot^{-1}) + PSB (2 g pot^{-1}), T_8: Vermicompost @ 500 g pot^{-1} + PSB (2 g pot^{-1}) + Azospirillium (2 g pot^{-1}), T_9: Vermicompost @ 500 g pot^{-1} + Azospirillium (2 g pot^{-1})+ VAM (2 g pot^{-1}) + PSB (2 g pot^{-1})

Table 2: Effect of bio-fertilizers on flowering of orchids (Mean of two years)

Treatments	Days to flower	No. of spikes plant^{-1}	No. of flowers spike^{-1}	Spike length (cm)	Pedicel length (cm)	Flower length (cm)	Flower breadth (cm)
T_1	82.00	4.20	4.10	25.33	15.67	7.60	7.27
T_2	86.00	4.30	4.40	26.67	16.33	8.33	8.01
T_3	91.33	5.10	6.30	36.00	19.00	7.83	7.69
T_4	90.67	5.50	6.00	35.00	19.60	8.97	9.06
T_5	92.67	5.50	6.70	37.67	20.33	8.59	8.10
T_6	89.33	6.30	7.40	44.40	21.67	9.31	8.54
T_7	84.00	4.60	4.40	30.00	16.67	8.33	8.02
T_8	86.67	6.60	7.70	45.00	23.60	9.69	9.18
T_9	94.00	7.50	8.60	46.67	25.53	10.38	10.01
SEm(±)	**0.92**	**0.12**	**0.09**	**0.58**	**0.23**	**0.07**	**0.05**
LSD (0.05)	**2.74**	**0.34**	**0.29**	**1.74**	**0.68**	**0.23**	**0.16**

Table 3: Effect of bio-fertilizers on post-harvest parameter of orchids (Mean of two years)

Treatments	Vase-life (days)	Longevity of spike in the field in (days)	Dry matter production of 5 no. of florets (g)	Wilting of first flower (days)
T_1	19.07	26.33	1.5	10.33
T_2	20.33	30.00	1.6	11.00
T_3	23.00	35.33	2.9	13.00
T_4	24.33	31.67	2.7	12.00
T_5	26.33	36.67	3.1	14.00
T_6	26.00	34.00	3.4	13.67
T_7	21.47	30.67	1.5	11.00
T_8	29.67	41.00	4.1	15.33
T_9	29.00	37.33	3.7	14.00
SEm(±)	**0.66**	**0.84**	**0.064**	**0.54**
LSD (0.05)	**1.97**	**2.51**	**0.19**	**1.63**

significantly influenced by the application of different bio-fertilizers. Vermicompost @ 500g pot^{-1} + *Azospirillium* (2g pot^{-1}) + PSB (2g pot^{-1}) recorded maximum field life (41 days) as well as vase-life (29.67 days). Regarding dry matter production of flower, plant treated with vermicompost @ 500 g pot^{-1} + PSB (2 g pot^{-1}) + *Azospirillium* (2g pot^{-1}) combination obtained maximum dry matter of flower (4.1g per 5 florets) and lowest (1.5g per 5 flowers) was recorded in control and vermicompost @ 500g pot^{-1} + VAM (2g pot^{-1}) + PSB (2 g pot^{-1}). Regarding self-life of spike, vermicompost @ 500g pot^{-1} + PSB (2g pot^{-1}) + *Azospirillium* (2 g pot-1) recorded longest duration (15.3 days) for wilting of first flower, whereas least days (10.33 days) to wilting of first flower were observed in control. Combination of all three *i.e*., application of PSB, VAM and *Azospirillium* together had a positive impact. Chang *et al*. (2008) reported that the qualitative and quantitative characters and decrease the rate of occurrence of diseases in orchid by application of *Rhizoctonia* spp. Strain (BCRC930076 and BCRC930077). Mittal *et al*. (2010) reported that application of treatment % RDF + 4t ha^{-1} vermicompost + *Azatobactor* + *Azospirillium* + PSB was enhancing self-life and vase-life of African marigold compared to control. Seetha (1999) also reported that longer vase-life in gerbera flower harvested from plant treated with *Azospirillum*, VAM and 50% recommended dose of nitrogen, phosphorus and potassium.

For cultivation of *dendrobium* under southern West Bengal, environment friendly high-tech polyhouse is required. Instead of chemical fertilizer alone application of bio-fertilizers *viz*., vermicompot, PSB, VAM and *Azospirillum* in combination registered promising result when grown in coco-blocks. The treatment vermicompost @ 500g pot^{-1} + *Azospirillium* @ 2g pot^{-1} + VAM @ 2g pot^{-1} + PSB @ 2g pot^{-1} produced 7.5 spikes plant^{-1}.

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