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Effect of Biofertilizers and Organic Manures on Plant Growth, Flowering and Tuber Production of Dahlia (*Dahlia variabilis* L.) Cv. S.P. Kamala

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ABSTRACT

A field experiment was carried out to investigate the effect of bio-fertilizers and organic manures on plant growth, flowering and tubers production in dahlia (Dahlia variabilis L.) cv. S.P. Kamala, during November 2012 to March 2013 at Floriculture Research Field, Department of Horticulture, Sam Higginbottom Institute of Agriculture Technology and Sciences, Allahabad (U.P.). Different levels and combination of bio fertilizers and organic manures was applied to assess the vegetative, floral and yield characteristics of dahlia. The experiment was laid out in randomised block design with ten treatments and three replications. The maximum plant height (65.07 cm), number of primary branches (9.67), number of leaves (33.67), plant spread (43.73 cm), number of flowers (8.13), duration of flowering (10.53), flower yield ha^{-1} (33.65), weight of tuber (56.67 g), number of tubers (4.87) and tuber yield (13.80 t ha^{-1}) were produced in the treatment (T_8) Vermicompost @ 2.5 t ha^{-1} + Azotobacter @ 2.0 kg ha^{-1} + Phosphorous Solubilizing Bacteria @ 2.0 kg ha^{-1}.

Key words: *Azospirillum, Azotobacter, Farmyard manure, PSB and Vermicompost*

INTRODUCTION

Dahlia is a perennial herbaceous and important garden plant belongs to the family Asteracae. It is a showy flower with great variations in colour, size, shape and form *etc*[14]. The most important constraint limiting crop yield in developing nations worldwide, and especially among resource poor farmers, is soil infertility. This problem can be salve by using integrated nutrients management. Biofertilizers are important components of integrated nutrients management[6]. Today the use of chemical fertilizers and pesticides has caused tremendous harm to the environment as well as flower production. Most of the countries are using bio fertilizers to remove these problems.

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Bio-fertilizers are micro organisms that enrich the nutrients quality of soil. The main sources of bio fertilizers are bacteria, fungi and cynobacteria (blue green algae). Organic manures (FYM) and vermicompost is the excreta of earthworms, which is rich in humus and nutrients and provide a lot of advantage in association of microorganisms (*Azotobacter*, *Azospirillum*, PSB *etc*.), azotobacter dominant non-symbiotic nitrogen fixing heterotrophic bacterium found in Indian soils which come from the bio fertilizers to solve such problems as increased salinity of soil and chemical run off from the agricultural field[5] . Organic manure supplies food for microbes and makes soil porous, which is very favourable for the microbes. FYM is one of the traditional manure and is mostly readily available to the farmers. Hence, keeping in view the above facts and considered the potential of dahlia in sub-tropical region of Uttar Pradesh, a field trial on "Effect of biofertilizers and organic manures on plant growth, flowering and tuber production of dahlia (*Dahlia variabilis* L.) cv. S.P. Kamala" was commended during the cropping season from November 2012 to March 2013.

MATERIALS AND METHODS

The present investigation was carried out under Allahabad agro-climatic condition at the experimental field of the Department of Horticulture, Sam Higginbottom Institute of Agricultural, Technology and Sciences (Formerly Known as Allahabad Agriculture Institute Deemed University, AAI-DU) Allahabad, U.P. during November 2012 to March 2013. The soil of the experimental area was a fairly level land with sandy loam soil with uniform fertility status with low clay and high sand percentage with high P^H (7.2) and soil moderately fertile. The soil of the experimental plot was well prepared by repeated ploughing followed by planking to obtain a fine tilth. The soil ploughed 4 times by cultivator, harrowed, levelled and the weeds were manually uprooted from experimental field as per requirement. Twenty five days old seedlings with 3-5 leaves were transplanted in the main field. Every plot contains 9 seedlings at the spacing of 60 × 60 cm. All the different combination of bio-fertilizers and organic manures treatments viz.; T_0 Control (RDF – NPK 25:40:40 kg ha^{-1}); T_1 Farm Yard Manure (FYM) @ 5.0 t ha^{-1}; T_2 Vermicompost (VC) @ 2.5 t ha^{-1}; T_3 FYM @ 5.0 t ha^{-1} + VC @ 2.5 t ha^{-1}; T_4 Azotobacter @ 2.0 kg ha^{-1} + PSB @ 2.0 kg ha^{-1}; T_5 Azospirillum @ 2.0 kg ha^{-1} + PSB @ 2.0 kg ha^{-1}; T_6 VC @ 2.5 t ha^{-1} + Azospirillum @ 2.0 kg ha^{-1} + PSB @ 2.0 kg ha^{-1}; T_7 FYM @ 5.0 t ha^{-1} + Azotobacter @ 2.0 kg ha^{-1} + PSB @ 2.0 kg ha^{-1}; T_8 VC @ 2.5 t ha^{-1} + Azotobacter @ 2.0 kg ha^{-1}+ PSB @ 2.0 kg ha^{-1}; and T_9 FYM @ 5.0 t ha^{-1} + Azospirillum @ 2.0 kg ha^{-1} + PSB @ 2.0 kg ha^{-1} are randomly arranged and observations recorded at regular intervals from the experimental field. The qualitative and quantitative parameters characters were analyzed by the analysis of variance (ANOVA) technique. The critical difference values were calculated at 5 per cent level of significance[9].

RESULTS AND DISCUSSION

The results of the study regarding the effect of bio fertilizers and organic manures on crop characters of dahlia have been presented and possible interpretations have been made in here.

Plant height: Result showed the maximum plant height shows (Table 1) effect of plant growth at 30, 45 60 days after transplanting was significantly increased with increasing level of biofertilizer and organic manure at all successive stages of growth. produced maximum plant height (14.47 cm) at 30 DAT, (26.67cm) at 45 DAT and (65.07cm) at 60 DAT were recorded under the treatment receiving T_8 VC @ 2.5 t ha^{-1} + Azotobacter @ 2kg ha^{-1} + PSB @ 2.0 kg ha^{-1} which though at par with that of (14.07) at 30 DAT, (25.67) at 45 DAT and (64.13) at 60 DAT recorded in T_6 VC @ 2.5 t ha^{-1} + Azospirillum @ 2.0 kg ha^{-1} + PSB @ 2.0 kg ha^{-1}; showed increases over the rest of treatment. similar result was found Singh *et al*[12]., reported that the application of 50 kg N ha^{-1} as a basal dose in the form of FYM + 50 kg N ha^{-1} as a basal dose of urea recommended highest plant height (70.62 cm.)

Number of primary branches: Application of biofertilizers and organic manures on dahlia significant effect on number of primary branches showed in (Table 1). Results revealed that number of primary branches was greater in biofertilizers and organic manures applied in plots than control plots indicating effect of biofertilizers and organic manures on number of primary branches. Result further that the number of primary branches increased with T_8 VC @ 2.5 t ha^{-1} + Azotobacter @ 2kg ha^{-1} + PSB @ 2.0 kg ha^{-1}. The maximum number of primary branches (4.93) at 45 DAT and (9.67) at 60 DAT. This though at par with that of T6 VC @ 2.5 t ha-1 + Azospirillum @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1. Receiving showed significant increases over the rest of treatments including control. Gayathri *et al*[4]., reported that increased plant height, number of leaves, highest number of branches and highest flower yield per plant were obtained with the application of 75 per cent + VC + *Azotobacter* + PSB.

Number of leaves: Application of biofertilizers and organic manures on dahlia significant effect on number of leaves (Table 1). Results revealed that number of leaves was greater in biofertilizers and organic manures applied in plots than control plots indicating effect of biofertilizers and organic manures on number of leaves. Result further that the number of leaves increased with T_8 VC @ 2.5 t ha^{-1} + Azotobacter @ 2kg ha^{-1} + PSB @ 2.0 kg ha^{-1}. The maximum number of leaves (15.73) at 30 DAT, (29.733) at 45 DAT, (33.67) at 60 DAT. This though at par with that (15.13) at 30 DAT, (13.27) at 45 DAT and (32.73) at 60 DAT of T6 VC @ 2.5 t ha-1 + Azospirillum @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1; showed significant increases over the rest of treatments including (11.13) at 30 DAT, (23.47) at 45 DAT and (28.93) at 60DAT receiving in control. Sreenivas and Gowda[13] reported that the application of organic manure (FYM, Refuse compost, phosphocompost) with the recommended doses of NPK Effectively increased plant height, leaf.

Plant spread (cm): Result showed that plant spread (Table 1). The highest plant spread (30.07cm) at 30 DAT, (36.87cm) at 45 DAT and (43.73cm) at 60 DAT were recorded under the treatment receiving (T_8) VC @ 2.5 t ha^{-1} + Azotobacter @ 2kg ha^{-1} + PSB @ 2.0 kg ha^{-1}. Which though fallowed (29.13 cm) at 30 DAT, (35.40 cm) at 45 DAT and (42.33 cm) at 60 DAT recorded in T_6 VC @ 2.5 t ha^{-1} + Azospirillum @ 2.0 kg ha^{-1} + PSB @ 2.0 kg ha^{-1}; Mishra *et al*[7]., reported effect of biofertilizer on growth and yield of China Aster.

Days taken to first flower bud appearance: The result showed revealed that days taken to first flower bud appearance in (Table 2). The maximum days taken to first flower bud appearance was (56.93days) recorded in T_0 Control (RDF – NPK 25:40:40 kg ha^{-1}). (42.20 days) minimum days taken to first flower bud appearance recorded in treatment (T_8) VC @ 2.5 t ha^{-1} + Azotobacter @ 2kg ha^{-1} + PSB @ 2.0 kg ha^{-1}. Which was followed by (43.60 days) in T6 VC @ 2.5 t ha-1 + Azospirillum @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1 Binisha *et al*[3]., reported that the treatment combination of NPK along with *Azospirillum* was more effective in improving vegetative and floral character of *Dendrobium* than NPK alone.

Number of flowers per plant: The result of number of flowers per plant showed (Table 2). The highest number of flowers was observed in (T_8) VC @ 2.5 t ha^{-1} + Azotobacter @ 2kg ha^{-1} + PSB @ 2.0 kg ha^{-1} (8.13) followed by T6 VC @ 2.5 t ha-1 + Azospirillum @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1 (7.47). The lowest number of flowers was recorded in control plot (4.33). That was significantly different than the other treatments. Ahmed *et al*[1]., reported that the effect of N (as urea), farm yard manure (FYM) and P_2O_5 on the growth and flowering of D. Variabilis, D. Pinnata was investigated in Azad Kashmir, Pakistan.

Weight of single flower (g): Result revealed that weight of single flower increased (Table 2). The highest weight of single flower was observed in (T_8) VC @ 2.5 t ha^{-1} + Azotobacter @ 2kg ha^{-1} + PSB @ 2.0 kg ha^{-1} (82.73 g) followed by T6 VC @ 2.5 t ha-1 + Azospirillum @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1 (79.13 g). The lowest number of flowers was recorded in control plot (57.87 g). That

was significantly different than the other treatments.

Flower size across (cm): Result showed that flower size across increased with biofertilizers and organic manures (Table 2). The maximum flower size across was (16.80 cm) observed in treatment T_9 FYM @ 5.0 t ha^{-1} + Azospirillum @ 2.0 kg ha^{-1} + PSB @ 2.0 kg ha^{-1}. followed by (16.53 cm) in treatment (T_8) VC @ 2.5 t ha^{-1} + Azotobacter @ 2kg ha^{-1} + PSB @ 2.0 kg ha^{-1}. The lowest number of flowers was recorded in control plot (13.87 cm). That was significantly different than the other treatments. Ravichandran[11] reported that the improved flower yield, flower diameter and weight in *Crossandra infundibuliformis*, when treated with *Azospirillum* + recommended dose of nitrogen.

Flowering duration (days): Result revealed that the flowering duration significantly showed in (Table 2). The maximum duration of flowering (10.53) was recorded in T_8 VC @ 2.5 t ha^{-1} + Azotobacter @ 2kg ha^{-1} + PSB @ 2.0 kg ha^{-1} followed by (10.07) T_6 VC @ 2.5 t ha^{-1} + Azospirillum @ 2.0 kg ha^{-1} + PSB @ 2.0 kg ha^{-1}. The lowest flowering duration (8.07) was recorded in control plot. Ashwini et *al*[2]., reported that organic manures (FYM, Vermicompost,) and biofertilizers (Azotobacter, Azospirillum, PSB, VAM) effective on growth, flowering and yield of Dahlia.

Flower yield per plant (g): Result showed that flower yield per plant increased with biofertilizers and organic manures (Table 2). The maximum flower yield per plant was (673.05 g) observed in treatment (T_8) VC @ 2.5 t ha^{-1} + Azotobacter @ 2kg ha^{-1} + PSB @ 2.0 kg ha^{-1} followed by T_6 VC @ 2.5 t ha^{-1} + Azospirillum @ 2.0 kg ha^{-1} + PSB @ 2.0 kg ha^{-1} observed (590.92 g). The lowest flower yield per plant (12.54 g) was recorded in control plot. Naik *et al*[8]., reported that flower yield per hectare was highest (21.40 t/ha) with the treatment combination of N at 225 kg and P at 120 kg/ha.

Flower yield (t ha^{-1}): Result showed that flower yield (t ha^{-1}) increased with biofertilizers and organic manures (Table 3). The highest flower yield (t ha^{-1}) was recorded in (T_8) VC @ 2.5 t ha^{-1} + Azotobacter @ 2kg ha^{-1} + PSB @ 2.0 kg ha^{-1} (33.65) followed by T_6 VC @ 2.5 t ha^{-1} + Azospirillum @ 2.0 kg ha^{-1} + PSB @ 2.0 kg ha^{-1} observed (29.55). The lowest weight of tuber was (12.54) recorded in control plot. Prathiban *et al*[10]. Reported that FYM + Azospirillum followed by FYM + Azotobacter 200 and 150 kg levels of N/ha were statically on par with each other for flower yield.

Weight of tuber (g): Result showed that weight of tubers significantly increased with biofertilizers and organic manures (Table 3). The maximum weight of tuber was (56.67 g) observed in treatment (T_8) VC @ 2.5 t ha^{-1} + Azotobacter @ 2kg ha^{-1} + PSB @ 2.0 kg ha^{-1} followed by T_6 VC @ 2.5 t ha^{-1} + Azospirillum @ 2.0 kg ha^{-1} + PSB @ 2.0 kg ha^{-1} observed (54.20 g). The lowest weight of tuber was (26.27 g) recorded in control plot.

Number of tuber per plant: Result revealed that number of tubers per plant significantly increased with biofertilizers and organic manures (Table 3). The maximum number of tuber per plant was observed in treatment (T_8) VC @ 2.5 t ha^{-1} + Azotobacter @ 2kg ha^{-1} + PSB @ 2.0 kg ha^{-1} (4.87) followed by T_6 VC @ 2.5 t ha^{-1} + Azospirillum @ 2.0 kg ha^{-1} + PSB @ 2.0 kg ha^{-1} observed (4.53). The lowest number of tuber was (2.93) recorded in control plot.

Tuber yield per plant (g): Result showed that tuber yield per plant significantly increased with biofertilizers and organic manures (Table 3). The highest tuber yield per plant was (275.93 g) observed in treatment (T_8) VC @ 2.5 t ha^{-1} + Azotobacter @ 2kg ha^{-1} + PSB @ 2.0 kg ha^{-1} followed by T_6 VC @ 2.5 t ha^{-1} + Azospirillum @ 2.0 kg ha^{-1} + PSB @ 2.0 kg ha^{-1} observed (245.85 g). The lowest tuber yield per plant was (77.05 g) recorded in control plot.

Tuber yield (t ha^{-1}): Result showed that yield of tubers (t ha^{-1}) increased with biofertilizers and organic manures (Table 3). The highest tuber yield (t ha^{-1}) was recorded in (T_8) VC @ 2.5 t ha^{-1} + Azotobacter @ 2kg ha^{-1} + PSB @ 2.0 kg ha^{-1} (13.80) followed by T_6 VC @ 2.5 t ha^{-1} + Azospirillum @ 2.0 kg ha^{-1} + PSB @ 2.0

kg ha^{-1} observed (12.29). The lowest weight of tuber was (3.85) recorded in control plot.

Benefit cost Ratio: The maximum Gross Return (11, 75, 140), Net return (8, 47, 039) and benefit cost Ratio (1:3.58) were obtained from treatment (T_8) VC @ 2.5 t ha^{-1} + Azotobacter @ 2 kg/ha + PSB @ 2.0 kg/ha^{1}.

Table: 1 Effect of bio fertilizers and organic manures on vegetative growth of dahlia cv. S.P. Kamala

S. No.	Treatments	Plant height (cm)	Number of primary branches per plant	Number of leaves per plant	Plant spread (cm)
T_0	Control (RDF - NPK 25 : 40 : 40 kg ha-^{1})	54.47	4.13	28.93	31.73
T_1	Farmyard Manure (FYM) @ 5.0 t ha-1	57.40	4.73	30.93	35.27
T_2	Vermicompost (VC) @ 2.5 t ha-1	57.87	5.13	30.67	35.93
T_3	FYM @ 5.0 t ha-1 + VC @ 2.5 t ha-1	58.40	5.53	31.73	37.80
T_4	*Azotobacter* @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1	59.80	6.47	32.13	39.20
T_5	*Azospirillum* @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1	59.33	5.93	32.40	38.40
T_6	VC @ 2.5 t ha-1 + *Azospirillum* @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1	64.13	8.40	32.73	42.33
T_7	FYM @ 5.0 t ha-1 + *Azotobacter* @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1	61.73	7.93	33.13	40.80
T_8	VC @ 2.5 t ha-1 + *Azotobacter* @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1	65.07	9.67	33.67	43.73
T_9	FYM @ 5.0 t ha-1 + *Azospirillum* @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1	60.67	6.87	35.67	39.87
	S. Ed. (±)	0.24	0.19	0.15	0.31
	C. D. (P = 0.05)	0.51	0.39	0.32	0.64

Table: 2 Effect of bio fertilizers and organic manures on flowering attributes of dahlia cv. S.P. Kamala

S. No.	Treatments	Days taken to first flower bud appearance	Number of flowers per plant	Weight of single flower (g)	Flower size (cm)	Flowering duration (days)	Flower yield per plant (g)
T_0	Control (RDF - NPK 25 : 40 : 40 kg ha-1)	56.93	4.33	57.87	13.87	8.07	250.83
T_1	Farmyard Manure (FYM) @ 5.0 t ha-1	55.07	5.20	62.40	14.67	8.53	325.28
T_2	Vermicompost (VC) @ 2.5 t ha-1	53.87	5.73	65.13	15.07	9.13	373.28
T_3	FYM @ 5.0 t ha-1 + VC @ 2.5 t ha-1	51.47	5.87	67.20	15.20	9.33	394.09
T_4	*Azotobacter* @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1	48.53	6.27	71.47	15.40	9.67	447.85
T_5	*Azospirillum* @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1	51.07	6.00	69.13	15.93	9.53	414.84
T_6	VC @ 2.5 t ha-1 + *Azospirillum* @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1	43.60	7.47	79.13	15.73	10.07	590.92
T_7	FYM @ 5.0 t ha-1 + *Azotobacter* @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1	47.00	7.07	77.53	16.27	9.87	548.17
T_8	VC @ 2.5 t ha-1 + *Azotobacter* @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1	42.20	8.13	82.73	16.53	10.53	673.05
T_9	FYM @ 5.0 t ha-1 + *Azospirillum* @ 2.0 kg ha^{-1} + PSB @ 2.0 kg ha-1	48.13	6.73	74.07	16.80	9.73	498.89
	S. Ed. (±)	0.54	0.13	0.92	0.09	0.09	10.36
	C. D. (P = 0.05)	1.12	0.27	1.92	0.19	0.19	21.77

Table: 3 Effect of biofertilizers and organic manures on tuber production and benefit cost ratio of dahlia cv. S.P. Kamala

S. No.	Treatments	Weight of tuber (g)	Number of tubers per plant	Tuber yield per plant (g)	Tuber yield (t ha^{-1})	Benefit Cost Ratio
T_0	Control (RDF - NPK 25 : 40 : 40 kg ha-1)	26.27	2.93	77.05	3.85	1.36
T_1	Farmyard Manure (FYM) @ 5.0 t ha-1	29.07	3.27	95.23	4.76	1.74
T_2	Vermicompost (VC) @ 2.5 t ha-1	31.07	3.40	105.89	5.29	1.90
T_3	FYM @ 5.0 t ha-1 + VC @ 2.5 t ha-1	33.53	3.60	120.87	6.04	2.01
T_4	*Azotobacter* @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1	40.87	3.93	160.75	8.04	2.47
T_5	*Azospirillum* @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1	37.93	3.73	141.75	7.09	2.28
T_6	VC @ 2.5 t ha-1 + *Azospirillum* @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1	54.20	4.53	245.85	12.29	3.15
T_7	FYM @ 5.0 t ha-1 + *Azotobacter* @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1	53.53	4.40	235.79	11.79	3.08
T_8	VC @ 2.5 t ha-1 + *Azotobacter* @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1	56.67	4.87	275.93	13.80	3.58
T_9	FYM @ 5.0 t ha-1 + *Azospirillum* @ 2.0 kg ha-1 + PSB @ 2.0 kg ha-1	47.73	4.27	203.79	10.19	2.78
	S. Ed. (±)	0.92	0.06	4.88	0.24	-
	C. D. (P = 0.05)	1.94	0.12	10.25	0.51	-

CONCLUSION

On the basis of experimental findings it is concluded that the treatment T_8 (Vermicompost @ 2.5t/ha + Azotobacter @ 2.0 kg/ha + Phosphorous Solubilizing Bacteria @ 2.0 kg/ha) was found superior in respect of plant growth, flower yield (33.65 t ha^{-1}), tuber yield (13.80 t ha^{-1}) and Cost of cultivation (3,28,101 Rs ha^{-1}) along with highest benefit cost ratio of (3.58).

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