International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2017; 5(6): 1860-1863

Received: 04-09-2017
Accepted: 05-10-2017

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Influence of bio fertilizers, pre harvest spray of chemicals and organic liquid fertilizers on postharvest physiology of gerbera

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Abstract
An experiment was carried out to study the individual and interaction effect of bio fertilizers (*Azotobacter* and VAM) as soil application and chemicals (spermine and salicylic acid @ 25 and 50 ppm each) and organic liquid fertilizers (banana pseudo stem sap @ 0.5% and 1.0% and vermiwash @ 4%) as foliar spray on gerbera var. Alcatraz. Among the individual effects plants inoculated with bio fertilizers resulted in enhanced postharvest life of gerbera flowers as compared to uninoculated. Further, pre harvest foliar spray with spermine @ 25 ppm improved the postharvest physiology and vase life of gerbera which was followed by vermiwash @ 4%. Further, among the interaction effects, treatment combination of bio fertilisers along pre harvest foliar spray of spermine @ 25 ppm recorded minimum change in fresh weight of the flower (21.02%), higher water uptake by the flower (28.96 ml), total soluble sugar (39.90 mg/g), protein (30.72 mg/g), catalase activity (7.55 mM/min/g protein), peroxidase activity (48.19 mM/min/g protein) in the petal tissue and extended the vase life (9.29 days), which was followed by treatment combination of bio fertilizers along the vermiwash @ 4%. Thus, the treatment combinations of bio fertilizers along the foliar spray of spermine @ 25 ppm and vermiwash @ 4% improved the postharvest physiology and enhanced the vase life of gerbera.

Keywords: Spermine, fresh weight, protein, catalase, peroxidase

Introduction
Gerbera (*Gerbera jamesonii* Bolus ex. Hook) is occupying its place as a popular cut flower in Indian Floriculture and can be commercially grown throughout the world under varied agro climatic conditions (Lhoste, 2002) [11]. According to the global trends in floriculture, Gerbera is one among top five cut flowers in national and international flower markets (Zheng *et al*., 2016) [26]. Postharvest life of any horticultural produce is majorly influenced by number of preharvest factors. Preharvest factors like nutritional scheduling and use growth regulators can definitely influence the postharvest physiology and vase life of the flower. Bio fertilizers are the cheapest source of fertilizers which are gaining momentum. *Azotobacter* being a diazotroph, the beneficial response on crops is known due to its atmospheric nitrogen fixing ability (Yoneyama *et al*., 2009) [24], as nitrogen is the component of protein, nucleic acids and chlorophyll, increased nitrogen supply to the plant will influence the amount of protein, amino acids, protoplasm and chlorophyll formation in the plant (Jnawali *et al*., 2015) [8]. Therefore adequate supply of nitrogen is necessary for potential quality of flowers. Further, researchers revealed that bio chemical analysis of *Azotobacter* inoculated plants showed higher protein and amino acid content than uninoculated (Lopez *et al*., 2005). Mycorrhizal symbiosis supplies the plants roots with nutrients, secretes organic acids also increase the phytoavailability of micronutrients (Reddy, 2008) [18]. Apart from enhancing the growth, higher foliar concentrations of soluble sugars, proteins and amino acids in plants with VAM symbiosis have been reported (Subramanian and Charest, 1995). Spermine is a new class growth regulator comes under the group of polyamine involved in many physiological activities like association with sugar and carbohydrate synthesis, retained fresh weight of the flowers (Farahi *et al*., 2012) [5] and contribute in prevention of degradation of macromolecules *viz*., starch, protein and lipids (Graham *et al*., 1994) [7]. Further, vermiwash contains soluble nitrogen, phosphorus and potash along some enzyme cocktail (Zambare *et al*., 2008) [25]. Role of different bio fertilizers, chemicals and natural growth substances as a pre harvest spray in improving the postharvest physiology of gerbera has not been explored so far.

Hence, this experiment was planned to study the influence of bio fertilizers, chemicals and organic liquid fertilizers on postharvest physiology of gerbera.

Material and Methods

Experiment was conducted under naturally ventilated polyhouse located at greenhouse complex, Dept. of Floriculture and Landscape Architecture, ACHF, NAU, Navsari. Experiment was laid out in completely randomised design with factorial concept. Factor one (B) consisted of two levels one being without bio fertilizers (B_0) and another with bio fertilizers (B_1) (*Azo* @ 1 l/ha + VAM @ 2g/plant) and factor two consists of 7 levels of foliar sprays, 25 ppm spermine (C_1), 50 ppm spermine (C_2), 25 ppm salicylic acid (C_3), 50 ppm salicylic acid (C_4), 0.5% banana pseudo stem sap (C_5), 1.0% banana pseudo stem sap (C_6) and 4% vermiwash (C_7). Thus, there were 14 treatment combinations and were repeated thrice. Bio fertilizers *viz*., *Azotobacter* was given in the form of drenching and VAM was applied in the pits at the time of planting. Foliar spray of respective treatments were sprayed one month after transplanting and repeated at six months interval. Change in fresh weight was recorded in terms of flower weight on particular day (%) and calculated with the formula:

$$\text{Change in fresh weight (\%)} = \frac{\text{(Initial FW-FW on particular day)}}{\text{Initial FW}} \times 100$$

Water uptake by the flowers was calculated as per the formula:

Uptake of water (ml) = Initial water (400 ml) - Remaining water (ml)

Total soluble sugars (mg/g), phenols (mg/g) and protein in the petal tissue (mg/g) were estimated by the methods given by Franscistt *et al*. (1971) [6], Malik and Singh (1980) [14] and Lowry *et al*. (1951) [13] respectively. Catalase and peroxidase activity in the petal tissue was analysed by the method described by Costa *et al*. (2002) [3]. Anthocyanin content (mg/g) in the petal tissue was estimated as described by Swain and Hillis (1959) [22]. Vase life was expressed in terms of days from the date of harvest to the day showed the sign of wilting. The experimental data pertaining to all the characters studied were subjected to statistical analysis of variance technique as described by Panse and Sukhatme (1967).

Results and Discussion

Data presented in Table 1 and 2 revealed that among the individual effects, flowers harvested from the plants treated with bio fertilizers (B_1) and foliar spray of spermine @ 25 ppm (C_1) recorded minimum change in fresh weight, higher water uptake, retained TSS, phenols, protein content and maximum catalase and peroxidase activity and anthocyanin content in the petal tissue. Further, the same individual effects enhanced the vase life of gerbera as compared to other levels of the factors.

As per the data depicted in Table 1, maximum water uptake (28.96 ml) and minimum change in fresh weight (21.02%) was recorded with the interaction of biofertilisers and foliar spray of spermine at 25 ppm (B_1C_1). Further, the same interaction effect of B_1C_1 recorded maximum total soluble sugars (39.90 mg/g), higher phenol (1.33 mg/g) and protein content (30.73 mg/g) in the petal tissue of gerbera. Improved bio chemical parameters might be due to enhanced overall food and nutrient status of the flowers and greater development of conducting tissues facilitated more uptake of water and minimum change in fresh weight of flower in inoculated plants. Similar findings with bio fertilizers were observed in gladiolus (Meenakshi *et al*., 2015) [16] and freesia (Scagel, 2010) [19]. Spermine acts as a growth regulator and involved in many physiological activities like association with sugar and carbohydrate synthesis (Farahi *et al*., 2012) [5]. Fresh weight retention is dependent on maintenance of carbohydrate level and water uptake. Spermine is known for its anti-senescence effect during ageing sequence of plant tissue (Kaur-sawhney *et al*., 1982) [9] that indirectly retains fresh weight, water uptake in flowers as studied earlier in gerbera (Bagni and Tassoni, 2006) [1]. Highly retained fresh weight might have restricted the degradation of macromolecules viz., starch, proteins, nucleic acid, lipids and stimulate their synthesis (Graham *et al*., 1994; Kock, 1996; Eason *et al*., 1997) [7, 10, 4] in the petal cells and thus contributed to maintained higher levels of TSS. Higher TSS levels and phenol content decreased proteolysis in petal tissue of gerbera, thereby maintained the higher protein content in the petal tissue. These findings are in close conformity with Sumathi and Alka Singh (2015) [21] in rose and Mangave *et al*. (2014) [15] in heliconia.

Maximum catalase (7.55 mM/min/g protein) and peroxidase activity (48.19 mM/min/g protein) was recorded with the treatment combination of bio fertilisers and spermine at 25 ppm (B_1C_1) which was followed by the treatment combination of biofertilisers and vermiwash at 4% (B_1C_7). Further, higher anthocyanin in the petal tissue was recorded by the treatment combination of bio fertilisers and vermiwash at 4% (B_1C_7) which was at par with the treatment combination B_1C_1. Higher water uptake and retained fresh weight of the flowers contributed in prevention of degradation of macromolecules *viz*., starch, protein and lipids (Graham *et al*., 1994) [7] and thus maintained the TSS petal tissue which further inhibited the protein degradation (Baraniak and Kostecka, 1999) [2]. Maintained protein levels improved the enzyme activity *viz*., catalase and peroxidase in the petal tissue of gerbera. Further, the stability of the anthocyanin pigment is strongly correlated with the value of vacuolar pH which increases during senescence, but spermine delays the oxidative stress and maintained anthocyanin pigment content in the petal tissue (Vaknin *et al*., 2005) [23].

Enhanced vase life of 9.29 days was recorded with the treatment combination of biofertilisers and spermine at 25 ppm (B_1C_1) which was followed by the treatment combination B_1C_7 (8.78 days). Increased vase life of gerbera was due to higher water uptake, minimum change in fresh weight, retained sugars and phenols, inhibited proteolysis there by increased the enzymatic activity in the flower treated with bio fertilizers and spermine at 25 ppm, which ultimately led to enhance the flower longevity there by recorded the maximum vase life of gerbera.

Table 1: Influence of bio fertilizers, chemicals and vermiwash on postharvest physiology of gerbera var. Alcatraz

	Change in fresh weight (%)			Water uptake (ml)			Total soluble sugars (mg/g)			Phenols (mg/g)			Protein (mg/g)		
	B_0	B_1	C Mean	B_0	B_1	C Mean	B_0	B_1	C Mean	B_0	B_1	C Mean	B_0	B_1	C Mean
C_1	25.68	21.02	23.35	25.04	28.96	27.00	33.60	39.90	36.75	0.96	1.33	1.15	25.95	30.73	28.34
C_2	27.11	23.99	25.55	22.29	27.01	24.65	30.98	36.17	33.57	0.84	1.03	0.93	24.00	28.65	26.32
C_3	27.00	25.06	26.03	20.87	26.26	23.57	29.72	35.63	32.67	0.85	1.10	0.97	22.75	29.85	26.30
C_4	27.84	25.03	26.43	20.22	27.03	23.62	31.08	35.79	33.43	0.87	1.15	1.01	23.07	29.39	26.23
C_5	27.20	23.59	25.39	21.01	26.61	23.81	32.02	34.92	33.47	0.87	1.01	0.94	23.37	28.03	25.70
C_6	26.67	23.06	24.86	20.64	27.05	23.84	32.47	35.24	33.85	0.83	0.96	0.89	23.76	27.66	25.71
C_7	25.87	21.21	23.54	24.47	28.66	26.56	32.84	38.73	35.78	0.97	1.26	1.11	24.80	30.28	27.54
B Mean	26.77	23.25	-	22.08	27.37	-	31.81	36.62	-	0.88	1.12	-	23.96	29.22	-
	B	C	BC	B	C	BC	B	C	BC	B	C	BC	B	C	BC
C. D. 5%	0.05	0.11	0.16	0.28	0.53	0.75	0.28	0.52	0.73	0.02	0.05	0.07	0.64	1.20	1.63

Table 2: Influence of bio fertilizers, chemicals and vermiwash on postharvest physiology of gerbera var. Alcatraz

	Catalase activity (mM/min/g protein)			Peroxidase activity (mM/min/g protein)			Anthocyanin (mg/g)			Vase life (days)		
	B_0	B_1	C Mean	B_0	B_1	C Mean	B_0	B_1	C Mean	B_0	B_1	C Mean
C_1	6.97	7.55	7.26	46.40	48.19	47.30	16.72	17.79	17.26	7.69	9.29	8.49
C_2	6.60	7.32	6.96	45.63	46.45	46.04	16.40	17.35	16.87	6.99	8.56	7.77
C_3	6.70	7.34	7.02	45.35	47.22	46.29	16.30	17.02	16.66	7.00	8.10	7.55
C_4	6.84	7.37	7.10	45.76	46.81	46.28	16.12	17.38	16.75	7.05	8.17	7.61
C_5	6.66	7.15	6.90	45.24	46.24	45.74	16.15	17.57	16.86	6.55	7.66	7.11
C_6	6.78	7.25	7.01	45.80	46.39	46.10	16.25	17.59	16.92	6.78	7.93	7.35
C_7	6.99	7.48	7.23	46.10	47.43	46.76	16.88	17.88	17.38	7.36	8.78	8.07
B Mean	6.79	7.35	-	45.76	46.96	-	16.40	17.51	-	7.06	8.35	-
	B	C	BC	B	C	BC	B	C	BC	B	C	BC
C. D. 5%	0.08	0.12	0.19	0.17	0.32	0.46	0.11	0.21	0.30	0.06	0.12	0.17

Acknowledgement
The first author is highly thankful to the Department of Science & Technology, New Delhi for the provision of fellow ship for her Ph. D. studies. This research article is a part of her Ph. D. research work.

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