Content list available at http://epubs.icar.org.in, www.kiran.nic.in; ISSN: 0970-6429

Indian Journal of Hill Farming

Special Issue 2020, Page 97-103

Characterization of newly evolved hybrids of gerbera (*Gerbera Jamesonii* Bolus) under different growing conditions

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ARTICLE INFO

Article history:
Received December 5 April 2017
Revision Received 25 September 2018
Accepted 12 November 2018

Key words:
Gerbera, hybrids, fan and pad polyhouse, open field conditions

ABSTRACT

This study was carried out to characterize the newly evolved hybrids of gerbera under AICRP floriculture at ICAR Research Complex for NEH Region, Umiam during 2013-16. It was observed that fan and pad polyhouse recorded higher performance for vegetative and floral characters of gerbera hybrids over open field conditions. Hybrids RCGH-117, 22 and RCGH-113 had maximum vegetative characters. However, maximum number of suckers was produced in hybrid RCGH-117 and RCGH-19. Hybrid RCGH-117, 114 and RCGH-22 showed maximum flower stalk length, flower stalk diameter, flower diameter and number of flowers. The longest field life was noted in hybrids RCGH-12 and RCGH-113; however, RCGH-114 exhibited maximum vase life (6.88 days). Present results suggested that characterization of traits would be of great help to identify promising gerbera hybrids for domestic as well as export market and also assist in selection of potential parents for their further utilization in gerbera improvement programmes.

1. Introduction

Gerbera (*Gerbera jamesoni* Bolus) is an attractive cut-flowers crop belonging to the Asteraceae family, the largest family of flowering plants. It consists of 30 species, which are of Asiatic and South African origin. Among the different species, *Gerbera jamesoni* Bolus is the only species under commercial cultivation. Modern cultivated gerbera arose from the hybridization between *G. jamesonii* and *G. viridifolia* and possibly other species. The genus *Gerbera* was named in honour of the German naturalist Traugott Gerber, while the species *jamesonii* was named in honour of Captain Jameson. Gerbera one of the most important cut and pot flowers worldwide occupies 5th position in the international flower trade after rose, carnation, chrysanthemum and tulip in the global cut flower trade owing to its wide range of bewitching colours, forms and attractive geometrical shape (Hedau *et al.*, 2012). The market preferences for cut flowers changes with time. Hence, to meet these preferences, crop improvement is the need of the time to sustain the availability of desirable cultivars. Improvement through selection depends upon the variability existing in the available genotypes, which may be either due to different genetic constitution of cultivars or variations in the growing environments. Gerbera breeding work was started by Robert Jameson in South Africa and subsequently it is carried out in different part of the world. The availability of wide range of exotic varieties and their adaptability to grow on wide range of climate makes it a profitable cut flower crop for the growers. To obtain good quality flowers of international grade in open field conditions year round is almost impossible. This is due to the erratic environmental conditions where optimal climatic conditions required for proper crop growth is not available. To meet the climatic requirements of gerbera so that it performs to its optimum genetic potential, fan and pad polyhouse offers a suitable option to overcome these problems. Polyhouse offers potential solution in flower cultivation as it improves growth conditions leading to high yield, quality flowers and year round production. In addition, it is easy to protect the crop against extreme climatic conditions and incidence of pests and disease, thus the genetic potentiality of the hybrids can be

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exploited to the fullest (Rymbai *et al.*, 2015). Keeping this in view, an experiment was conducted to characterize the performance of different hybrids of gerbera under different growing conditions.

2. Materials and Methods

The experiment was carried out in the Division of Horticulture, ICAR Research Complex for NEH Region, Umiam, Meghalaya during the year 2012-2014 under the All India Coordinated Research Project on Floriculture. The study consists of 18 newly developed hybrids by the institute. These hybrids were planted under two different growing conditions, *viz.* open field conditions (ambient temperature 20-28 °C during April-September and 5.3-20 °C during October-March) and fan and pad polyhouse following standard cultivation and recommended practices for raising the plants. The hybrids were planted in three rows of one meter width raised bed at 30 cm between rows. The temperature (23 °C to 25 °C) and relative humidity (80 – 85%) were maintained under fan and pad cooled polyhouse throughout the experimental period. The observations for vegetative parameters such as the number of leaves were counted at flowering stage. Leaf length and leaf breadth were recorded using ruler in cm. Plant spread (cm^2) were measured in west-east and north-south direction using ruler in cm. Number of suckers were counted at the time of flowering. The floral parameters including numbers of flowers were determined by counting the number of the first appearing flowers till the last flowers to open by removing the flowers as and when it opened. Flower stalk length was recorded from the upper end to the lower end of stalk using ruler in cm. Flower stalk diameter were recorded in the middle of the stalk using vernier caliper in mm. Flower diameter were noted in the middle cross section of the flower using ruler in cm. Field life was recorded in a tagged flowers from the day it opened to the day it end its life. Flowers were harvested early in the morning when two rows of disc florets were fully opened and perpendicular to the stalk. It was harvested with sideward push of the flower stem at the base. The harvested flowers were immediately placed in clean water to remove field heat. The damaged, blemished flowers were discarded. Stalks were cut again prior to placing them in holding solution to study the vase life (days) using amber bottle flask containing 2% sucrose under room temperature away from direct sunlight. The experiment was laid out in factorial randomized block design (FRBD) with 5 replications. Each replication consists of twenty five plants selected randomly and were tagged for recording the observations during the three years studies. Vase life study was carried based on factorial complete block design (FCRD). The mean value was worked out and results of pooled analysis were used to study various vegetative, floral characters and vase life of gerbera hybrids. The analysis was carried using software Statical Package for Agricultural Workers developed by O.P. Sheoram. Valid conclusion was drawn only on significant differences at 0.05 level of probability.

3. Results and Discussion

3.1 Vegetative characteristics

Result showed significant differences for vegetative growth characteristics due to genotypes, growing conditions and their interaction ($p \leq 0.05$, Table 1). Regarding number of leaves per plant, maximum number of leaves was recorded in RCGH-23 (52.28) while minimum was observed in RCGH-51(14.98). Among growing conditions, fan and pad polyhouse produced highest number of leaves (35.25) per plant as compared to open-field conditions (31.29). In the interaction effect, it was observed that RCGH-23 produced maximum number of leaves (59.27) under fan and pad polyhouse, while RCGH-51 under open conditions recorded minimum number of leaves (11.70). The difference recorded among gerbera hybrids for number of leaves might be due to genetic makeup of each hybrid (Singh and Mandhar, 2004). Das *et al.* (2012) also reported the variation among gerbera varieties in term of leave number. Furthermore, result also indicated that fan and pad polyhouse conditions favour leaf number production as reported by Singh and Ramachandran (2002) that polyhouse conditions favours better vegetative growth characters. With respect to leaf length and breadth, it was observed that among hybrids, RCGH-7 had longest leaf length (27.43 cm), however the least leaf length was recorded in RCGH-89 (16.59 cm). Among growing conditions, hybrids growing under fan and pad polyhouse gave significantly higher leaf length (24.58 cm) as compared to hybrids under open field conditions (21.93 cm). In the genotypic-environment interactions, maximum leaf length was observed in RCGH-22 (28.39 cm) growing under fan and pad polyhouse. While, minimum leaf length was recorded in RCGH-89 (15.96 cm) under open field conditions. A variation observed in leaf length among hybrids because each hybrid is unique in genetic constitution. Similarly, vegetative growth characters were enhanced under polyhouse conditions (Singh and Ramachandran, 2002). Regarding hybrids, maximum leaf breadth was observed in the hybrid RCGH-7 (8.52 cm) while minimum was noted in hybrid RCGH-89 (4.37 cm). Regarding growing conditions, hybrids under fan and pad polyhouse gave maximum leaf breadth (6.75 cm) as compared to hybrids growing under open field conditions (5.50 cm). The genotypic-environment interaction showed that maximum leaf breadth was observed in RCGH-51 under fan and pad polyhouse (8.41 cm) and minimum in RCGH-76 (4.08 cm) under open conditions.

Table 1. Vegetative characteristics of gerbera hybrids under different growing conditions

Hybrids/ Variety (s)	Number of leaves per plant			Leaf length (cm)			Leaf breadth (cm)			Plant spread (cm)			Number of suckers per plant		
	FPP	OFC	Mean	FPP	OFC	Mean	FPP	OFC	Mean	FPP	OFC	Mean	FPP	OFC	Mean
RCGH-7	39.14	38.05	38.60	27.17	27.68	27.43	8.07	7.97	8.52	42.11	41.62	41.86	8.68	12.52	10.60
RCGH-9	41.60	14.40	28.00	25.28	21.98	23.63	5.80	4.66	5.23	38.15	27.09	32.62	11.32	12.16	11.74
RCGH-12	33.02	34.50	33.76	30.44	24.39	27.42	6.31	5.44	5.88	37.28	33.59	35.43	10.52	13.32	11.92
RCGH-19	37.13	36.80	36.96	24.93	21.44	23.19	7.28	5.23	6.25	40.25	30.85	35.55	13.32	15.32	14.32
RCGH-22	35.72	33.80	34.76	28.39	24.39	26.39	7.50	5.44	6.47	55.38	29.94	42.66	10.88	15.52	13.20
RCGH-23	59.27	45.30	52.28	27.17	20.29	23.73	7.24	5.23	6.24	41.91	34.68	38.29	12.68	15.60	14.14
RCGH-33	52.00	32.48	42.24	24.65	26.58	25.61	5.95	5.54	5.75	50.10	31.91	41.01	12.68	13.32	13.00
RCGH-42	42.75	30.00	36.38	24.97	22.66	23.82	5.97	4.54	5.26	38.50	27.60	33.05	9.32	8.68	9.00
RCGH-51	18.25	11.70	14.98	24.18	23.38	23.78	8.41	6.16	7.29	43.32	25.70	34.51	6.68	10.52	8.60
RCGH-76	24.30	27.50	25.90	20.46	18.48	19.47	5.47	4.08	4.62	38.17	24.83	31.50	7.32	9.32	8.32
RCGH-89	17.92	21.25	19.59	15.96	17.06	16.51	4.43	4.45	4.37	31.50	28.69	30.09	8.68	14.00	11.34
RCGH-95	39.58	45.40	42.49	19.08	22.33	20.70	4.79	4.75	4.77	32.86	36.05	34.45	10.00	13.32	11.66
RCGH-100	18.80	24.93	21.87	24.78	22.42	23.60	7.78	7.16	7.47	35.90	27.14	31.52	10.68	12.68	11.68
RCGH-113	40.94	28.00	34.47	27.87	20.52	25.19	6.77	6.55	6.66	51.58	33.37	42.48	9.32	11.88	10.60
RCGH-114	40.90	37.80	39.35	25.78	19.63	22.70	6.23	4.48	5.35	48.37	33.58	40.97	12.12	15.04	13.58
RCGH-117	41.32	30.65	35.99	27.91	23.78	25.85	7.56	5.60	6.58	47.18	31.48	39.33	12.63	15.84	14.24
RCGH-128	32.93	38.50	35.72	25.22	20.11	22.67	7.84	4.44	6.14	27.29	27.69	27.49	8.00	11.48	9.74
RCGH-226	19.00	32.13	25.56	24.30	21.72	23.01	8.10	7.28	7.69	31.74	32.89	32.31	10.52	14.00	12.26
Alesmera	27.8	25.8	26.8	29.15	24.41	26.78	10.75	9.24	10.00	45.20	38.89	42.05	10.64	13.60	12.12
Mean	35.25	31.29		24.47	21.93		6.75	5.50		40.64	31.04		10.31	13.05	
Factors	H	G	HxG	H	G	HxG	H	G	HxG	H	G	HxG	H	G	HxG
CD (p=0.05)	1.62	1.05	2.57	1.05	0.95	2.07	0.79	0.52	1.13	2.12	2.35	3.52	0.58	0.03	NS

H, hybrids; G, growing conditions; FPP, fan and pad polyhouse; OFC, open field conditions; NS, non-significant

The unique trait of individual hybrids might be responsible for variation in leaf breadth among hybrids. Furthermore, fan and pad polyhouse produced maximum leaf breadth might be due to favourable conditions (Singh and Ramachandran, 2002). Maximum plant spread was recorded in the hybrid RCGH-22 (42.66 cm) which was *at par* with RCGH-113 (42.48 cm). While, minimum plant spread was observed in hybrid RCGH-128 (27.49 cm). Fan and pad polyhouse growing conditions produced maximum plant spread (40.64 cm) while open field conditions showed minimum plant spread (31.04 cm). The interaction effect of hybrids and growing conditions showed that maximum plant spread was observed in RCGH-113 (51.58 cm) under fan and pad polyhouse conditions. However, minimum plant spread was observed in RCGH-76 (24.83 cm) under open field conditions. The differences in various vegetative growth parameters might be attributed to inherent genetic characters of the varieties evaluated under different growing conditions, which was further enhanced by favourable conditions of polyhouse (Singh and Ramachandran, 2002). Maximum number of suckers was produced in hybrid RCGH-19 (14.32) which was *at par* with RCGH-117 (14.24), while minimum was produced in hybrid RCGH-76 (8.32). Regarding growing conditions, gerbera hybrids produced maximum number of suckers (13.05 /plant/ year) in open field conditions as compared to hybrids under fan and pad polyhouse (10.31 /plant/ year). However, interaction effect showed no significant difference. The variation in number of suckers produced might be due to genetic inherent of hybrids (Sarmah *et al.*, 2014). Fan and pad polyhouse produced more number of suckers might be due to congenial environmental conditions.

Flowering characteristics

Similarly, a significance variation in flowering characteristics was also observed among hybrids, growing conditions and their interaction (Table 2). Hybrid RCGH-117 showed maximum flower stalk length (47.10 cm) while, hybrid RCGH-76 had least flower stalk length (35.53 cm). Regarding growing conditions, hybrids growing under fan and pad polyhouse showed maximum flower stalk length (46.11 cm) as compared to hybrids in open field conditions (36.40 cm). In the interaction effect, hybrid RCGH-22 had maximum flower stalk length under fan and pad polyhouse (55.47 cm). While hybrid RCGH-76 had minimum flower stalk length (25.62 cm) in open field conditions. The variation in stalk length was owing to their genetic character (Halevy and Mayak, 1981). The higher flower stalk length might be due to fan and pad polyhouse provide congenial environmental conditions for gerbera growth. This was also corroborated by Guttal and Takte (1993) who obtained maximum floral attributes in chrysanthemum under fan and pad polyhouse as compared to open field conditions. Among the hybrids, it was noted that hybrid RCGH-117 gave maximum flower stalk diameter (5.27 mm) which was *at par* with RCGH-23, while hybrid RCGH-226 gave minimum flower diameter (3.96 mm). Hybrids growing under Fan and Pad Polyhouse produced maximum flower stalk diameter (5.05 mm) as compared to open field conditions (4.78 mm). In the interaction effect, hybrid RCGH-117 showed maximum flower stalk diameter growing under fan and pad polyhouse (5.44 mm), while minimum flower stalk diameter was noted in hybrid RCGH-226 (3.85 mm) under open field conditions. Similar variation in flower stalk length and diameter was also reported by Barua and Bordoloi (2012) in gerbera. The better conditions under fan and pad polyhouse over open field conditions was reported by Guttal and Takte (1993). Regarding flower diameter, hybrid RCGH-117 produced maximum flower diameter (10.60 cm), while hybrid RCGH-128 (7.13 cm) had minimum flower diameter. Hybrids growing under fan and pad polyhouse showed significantly higher flower diameter (10.54cm) over gerbera growing in open field conditions (10.04 cm). In the interaction effect, hybrids RCGH-117 showed maximum flower diameter under fan and pad polyhouse (10.73cm) under fan and pad polyhouse conditions. However, minimum flower diameter was observed in hybrid RCGH-128 in open conditions (6.79 cm). Variation in flower diameter among hybrids might be attributed to genetic features of hybrids. Maximum flower diameter has also been reported in chrysanthemum under polyhouse conditions as compared to open field conditions (Guttal and Takte, 1993). Among the hybrids, RCGH-114 produced maximum number of flowers per month (4.42) which was *at par* with RCGH-117 (4.32) while, minimum number of flowers was noted in hybrid RCGH-19 (2. 56). Regarding growing conditions, fan and pad polyhouse showed maximum number of flowers (3.69) while minimum was observed in open field conditions (2.97). In the interaction effect, hybrid RCGH-114 produces maximum number of flower under fan and pad polyhouse (4.89) while hybrid RCGH-9 in field conditions recorded minimum number of flowers (2.21). The ability to produce flowers varied with hybrids might be due to their difference in their genetic makeup as well as the availability of a suitable environment to each hybrid, that they could reach their maximum genetic potential. Result was also in accordance with Singh and Mandhar (2004) who reported that flower

Table 2. Flowering characteristics of gerbera hybrids under different growing conditions

Hybrids/ variety(s)	Flower stalk length (cm)			Flower stalk diameter (mm)			Flower diameter (cm)			Number of flower/plant/month		
	FPP	OFC	Mean	FPP	OFC	Mean	FPP	OFC	Mean	FPP	OFC	Mean
RCGH-7	44.04	37.09	40.57	4.84	4.64	4.74	9.33	8.87	9.10	3.64	3.33	3.48
RCGH-9	43.08	28.11	35.60	5.01	4.21	4.61	9.57	9.46	9.52	3.31	2.21	2.76
RCGH-12	42.3	39.01	40.65	5.14	4.88	5.01	9.88	9.57	9.73	4.57	2.58	3.57
RCGH-19	39.43	35.55	37.49	4.35	4.78	4.57	9.56	8.6	9.08	2.83	2.29	2.56
RCGH-22	45.32	44.29	44.81	5.22	4.97	5.10	10.03	9.31	9.67	4.34	3.83	4.08
RCGH-23	48.08	32.5	40.29	5.4	5.14	5.27	8.92	8.77	8.85	3.36	2.66	3.01
RCGH-33	51.3	37.15	44.23	5.04	4.92	4.98	9.1	8.44	8.77	3.92	2.82	3.37
RCGH-42	44.31	31.25	37.78	5.08	4.28	4.68	8	7.78	7.89	2.92	2.36	2.64
RCGH-51	48.14	35.93	42.04	5.05	4.94	5.00	9.25	9.04	9.15	4.33	3.39	3.86
RCGH-76	45.43	25.62	35.53	5.03	4.54	4.79	8.85	8.69	8.77	4.34	2.43	3.385
RCGH-89	45.49	29.48	37.49	5.27	4.22	4.75	8.7	8.16	8.43	2.8	2.42	2.61
RCGH-95	41.73	38.75	40.24	4.89	4.64	4.77	8.42	8.94	8.68	2.83	2.98	2.91
RCGH-100	41.6	41.27	41.44	4.87	4.89	4.88	10.43	9.64	10.04	3.99	3.22	3.61
RCGH-113	52.81	42.82	47.82	5.11	4.3	4.71	7.89	7.62	7.76	4.08	4	4.04
RCGH-114	48.84	41.38	45.11	5.24	5.15	5.20	10.34	10.14	10.24	4.89	3.95	4.42
RCGH-117	48.47	45.73	47.10	5. 44	5.27	5.35	10.73	10.46	10.60	4.56	4.08	4.32
RCGH-128	37.71	33.34	35.53	4.86	5.13	5.00	6.79	7.46	7.13	3.06	2.61	2.83
RCGH-226	51	34.35	42.68	4.12	3.85	4.49	9.77	8.96	9.37	2.85	2.38	2.62
Alesmera	50.15	46.5	48.33	6.46	6.12	6.29	10.54	10.04	10.29	3.42	2.94	3.18
Mean	46.11	36.40		5.05	4.78		9.26	8.99		3.68	2.97	
Factors	H	G	HxG	H	G	HxG	H	G	HxG	H	G	HxG
CD (p =0.05)	0.62	0.60	1.06	0.04	0.02	0.07	0.63	0.75	1.23	0.28	0.33	0.72

H, hybrids; G, growing conditions; FPP, fan and pad polyhouse; OFC, open field condition

production is directly related to the cultivar. Gaikwad and Dumbrepatil (2001) observed 35 – 40% more flowers in chrysanthemum under polyhouse conditions over open condition.

Field and vase life of gerbera flowers

Field and vase life is an important factor when it comes to cut flower as it has maximum influence on local market and international trades. A significant variation among hybrids, growing conditions and their interaction was observed for field- and vase- life of flowers (Table 3). Among hybrids, RCGH-12 exhibited longest field life (20.65 days) which was *at par* with hybrid RCGH-113 (20.64 days). However, hybrid RCGH-23 recorded minimum field life (14.58 days). Fan and pad polyhouse produced longer field life (19.20 days) as compared to hybrids in open field conditions (16.48 days). The interaction effect between hybrids and growing conditions showed that hybrid RCGH-117 under fan and pad polyhouse had maximum field life (24.06 days), while minimum field life was observed in RCGH-42 in open conditions (14.33 days).

The variation in field life among hybrids might be due to unique trait of hybrids. The variation in vase life among different hybrids might be due to inherent traits (Gondhali *et al.*, 1997). Result was also in accordance with the finding of Kumar *et al.* (2013) in different varieties of gerbera belonging to the same species. The result was in accordance with Guttal and Takte (1993) who reported that flowers of chrysanthemum produced under polyhouse gave maximum vase life over open field grown flowers. Similar variation in different floral traits was also observed by Singh and Srivastava (2008); Barooah and Talukdar (2009) in gerbera cultivars evaluation. Generally flower with longest vase life are preferred. Result indicated that among hybrids, RCGH-114 had longest vase life (6.88 days) while hybrid RCGH-7 had shortest vase life (5.21 days). Regarding growing conditions, fan and pad polyhouse produced flowers with maximum vase life (6.27 days), while minimum was observed in hybrids growing under open field conditions (5.63 days). The interaction effect of hybrids and growing conditions exhibited variation in vase life of hybrids. Hybrid Alesmera possessed maximum vase life under fan and pad polyhouse (7.33 days), while minimum vase life was noted in hybrid RCGH-7 in open field conditions (5.02 days).

Table 3. Field and vase life of gerbera hybrids under different growing conditions

Hybrids/ variety(s)	Field life (days)			Vase life (days)		
	FPP	OFC	Mean	FPP	OFC	Mean
RCGH-7	22.25	16.87	19.56	5.398	5.019	5.21
RCGH-9	19.59	16.06	17.82	6.208	5.329	5.77
RCGH-12	20.64	20.67	20.65	6.738	5.549	6.14
RCGH-19	19.42	17.03	18.22	6.468	6.279	6.37
RCGH-22	17.52	14.74	16.13	5.558	5.869	5.71
RCGH-23	15.76	16.40	16.08	6.458	5.329	5.89
RCGH-33	16.71	14.82	15.76	6.018	5.149	5.58
RCGH-42	14.84	14.33	14.58	6.128	5.39	5.76
RCGH-51	16.45	16.34	16.39	6.558	6.029	6.29
RCGH-76	17.62	15.14	16.38	5.908	5.39	5.65
RCGH-89	19.86	15.37	17.62	6.038	5.239	5.64
RCGH-95	21.40	16.91	19.15	6.128	5.519	5.82
RCGH-100	19.50	16.49	18.00	6.468	5.759	6.11
RCGH-113	22.28	19.01	20.64	6.148	5.519	5.83
RCGH-114	18.55	16.43	17.49	6.968	6.789	6.88
RCGH-117	24.06	17.22	20.64	6.588	5.189	5.89
RCGH-128	16.60	16.09	16.35	6.178	6.099	6.14
RCGH-226	21.76	15.90	18.83	5.959	5.203	5.58
Alesmera	19.93	17.26	18.59	7.33	6.36	6.85
Mean	19.20	16.48		6.27	5.63	
Factors	H	G	HxG	H	G	HxG
CD (p=0.05)	1.16	1.24	2.26	0.32	0.52	1.03

H, hybrids; G, growing conditions; FPP, fan and pad polyhouse; OFC, open field conditions

4. Conclusion

Based on the results, it can be concluded that hybrids RCGH-12, RCGH-22, RCGH-114 and RCGH-117 had better performance over other hybrids with respect to vegetative and flower characters. These promising hybrids need further evaluation and trials before recommending them for commercial cultivation. Similarly, fan and pad polyhouse conditions was found to produce higher yield and quality gerbera with respect to all the vegetative and flowering characteristics, with the exception of suckers production where open field conditions was found to be more suitable. Therefore, selection of growing conditions is determined by the purpose of production, either for suckers or cut flower. Depending upon the availability of resource and climatic conditions, selection of hybrid/variety which will interact well with the environment must be considered.

5. Acknowledgements

Authors are duly acknowledge the Director, ICAR Research Complex for NEH Region, Umiam – 793 103, Meghalaya, India and Project Coordinator of AICRP-floriculture for providing financial and technical support

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