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Impact of different drying methods and desiccants on storage quality of annual chrysanthemum and gerbera

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Abstract
The present experiment entitled, "Impact of different drying methods and desiccants on storage quality of annual chrysanthemum and gerbera" was carried out at the laboratory of Floriculture and Landscape Architecture, Department of Horticulture, College of Agriculture, JAU, Junagadh during the year 2019-2020 to know the impact of different drying methods and desiccants on storage quality of annual chrysanthemum and gerbera. The experiment was laid out in completely randomized design with factorial concept and two factors i.e. drying methods *viz.* sun drying and shade drying and desiccants *viz.* river sand (red), river sand (black), sea sand, silica gel, borax powder and replicated thrice. Flowers were dried properly as per treatments and observations were recorded. In case of storage parameters, shade dried flowers with sea sand resulted in acceptable flower colour with less mechanical damage. Along with that another treatment combination shade drying with borax powder resulted in less mechanical damage to flowers. However, acceptable shape with less attack of pest and disease noticed in sun drying with silica gel. It can be concluded from the present investigation that shade drying with sea sand produced quality dry flowers of annual chrysanthemum and gerbera during storage.

Keywords: storage quality, desiccants, drying methods, annual chrysanthemum, gerbera

Introduction
The dehydrated or dried ornamental plants are generally inexpensive and are sought for their everlasting and attractive appearances (Smith, 1993) [5]. By drying in absence of moisture, the microbial activity causing the ageing effect is drastically reduced. The main qualities of dried flowers include novelty, longevity, aesthetic, flexibility and year round availability (Joyce, 1998) [2]. The literature published on drying techniques is mostly related to the flora and fauna of temperate region. But, nearly 60 percent of raw material is obtained from natural geographical land that lies close to Western, Eastern and Northern Himalayan Ghats and plains, while remaining 40 percent of flowers are exclusively cultivated for dry flower industry (Raju, 2001) [4].

Today's approach of dry flower display is to emphasize on colour and texture which can be achieved by using mass increasing materials such as fillers so that it creates an impact. The dry flower industry is a creative approach and creating employment to lakhs of rural people, women and poor for their extra income. It can be taken up on small scale industries which will lead to the income generation and in turn increase the standard of living of small and marginal farmers.

Annual or garland chrysanthemum is one of the commercially important cultivated flower crops grown for its loose flowers in several parts of India. The crop has relatively short duration and further considered photo-insensitive. Under moderate climatic conditions flowering is observed almost throughout the year which can be used for production of dry flowers.

Gerbera is native to tropical regions of South America, Africa and Asia. Gerbera is very popular and widely used as a decorative garden plant or as cut flowers. They vary greatly in shape and size. Colors include white, yellow, orange, red, and pink. The centre of the flower is sometimes black. Often the same flower can have petals of several different colors which make it more suitable for dry flower production.

Apart from drying the flowers storage aspect also play a major role in dry flower production. It becomes important to know about the storage life, storage quality and pest and disease incidence. With this motif objective was set in order to know the impact of different drying

methods and desiccants on storage quality of annual chrysanthemum and gerbera.

Materials and Methods

The present investigation entitled "Impact of different drying methods and desiccants on storage quality of annual chrysanthemum and gerbera" was carried out in at the Floriculture and Landscape Architecture Laboratory, Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh (Gujarat), during 2020-21.

The experiment was conducted using Completely randomized design (Factorial) the experiment comprising of two crops annual chrysanthemum cv. Primrose gem and gerbera cv. Intense with twelve treatment combinations *viz.*, S_1M_1(Sun drying without desiccant), S_1M_2 (Sun drying + River sand (Red)), S_1M_3 (Sun drying + River sand (Black)), S_1M_4 (Sun drying+ Sea sand), S_1M_5 (Sun drying + Silica gel), S_1M_6 (Sun drying + Borax powder), S_2M_1(Shade drying without desiccant), S_2M_2 (Shade drying + River sand (Red)), S_2M_3 (Shade drying + River sand (Black)), S_2M_4 (Shade drying + Sea sand), S_2M_5 (Shade drying + Silica gel), S_2M_6 (Shade drying + Borax powder) replicated thrice and number of annual chrysanthemum used per treatment was six and number of gerberas used per treatment was four respectively.

The flowers were harvested and initial flower parameters were recorded and then were embedded with desiccants for 5 days in order for complete removal of moisture and wallet to dry. Gently and slowly the top layer of 2-3 cm above the flowers was removed from the container. Then very gently, the fingers were inserted into the desiccants at the edge of the embedding material and gently flowers were taken out. Then painting brush was used to remove the embedded desiccants which are adhered to the surface of the flower petals. Later, the flowers were kept to record storage parameters at 30 DAS, 45 DAS, 60 DAS and 90DAS. (DAS: Days after storage).

Statistical Analysis

For judging the impact of drying methods and desiccants on storage of annual chrysanthemum and gerbera, the data of different characters were recorded and statistically analyzed as per the factorial completely randomized design (FCRD). Then analyzed for treatment of comparison 'F" test was further employed to study the effect of different treatments on storage.

Results and Discussion

The findings of the present study as well as relevant discussion have been presented under the following heads:

Impact on flower colour

The results regarding flower colour of annual chrysanthemum and gerbera during storage as influenced by different drying methods and desiccants given in Table 1.

Highly acceptable colour of flowers was found in treatment combination (S_2M_4) *i.e.* shade drying with sea sand during 30 DAS and 45 DAS after which the colour gradually reduced. Whereas, not acceptable colour of flowers was found in treatment combinations (S_1M_1) *i.e.* sun drying without desiccant and (S_1M_5) *i.e.* sun drying with silica gel during 60 DAS and 90 DAS in both annual chrysanthemum and gerbera respectively. This because of fact that already shade dried flowers with sea sand showed acceptable bright colour during drying which continued during storage up to 45 DAS after which colour gradually started reducing. But, due to high temperature and more degradation of carotenoid pigments in treatment combinations sun drying without desiccant and sun drying with silica gel produced not acceptable flower colour. Rose and gerbera flowers which were red and dark pink became darker during 60 DAS and 90 DAS where as annual chrysanthemum flowers became dull coloured. Findings are in accordance with Khyati (2015) [3] in rose, gerbera and gomphrena.

Table 1: Impact of different drying methods and desiccants on flower colour in annual chrysanthemum and gerbera

	Annual chrysanthemum				Gerbera			
	Flower colour				Flower colour			
Treatments	**30 DAS**	**45 DAS**	**60 DAS**	**90 DAS**	**30 DAS**	**45 DAS**	**60 DAS**	**90 DAS**
S_1M_1	##	###	####	####	##	###	####	####
S_1M_2	#	##	###	####	#	##	###	####
S_1M_3	#	###	###	####	#	###	###	####
S_1M_4	#	###	###	####	#	###	###	####
S_1M_5	##	###	####	####	##	###	####	####
S_1M_6	##	##	###	####	##	##	###	####
S_2M_1	##	###	###	####	##	###	###	####
S_2M_2	#	##	###	####	#	##	###	####
S_2M_3	#	##	###	####	#	##	###	####
S_2M_4	#	#	##	##	#	#	##	###
S_2M_5	##	###	###	####	##	###	###	####
S_2M_6	#	##	###	####	#	##	###	####

Where, # = Highly acceptable, ## = acceptable, ### = fairly acceptable, #### = not acceptable

Impact on flower shape

The results regarding flower shape of annual chrysanthemum and gerbera during storage as influenced by different drying methods and desiccants given in Table 2.

Highly acceptable shape of flower was found in treatment combination (S_1M_5) *i.e.* sun drying with silica gel during 30 DAS and 45 DAS Whereas, not acceptable shape of flower was found in treatment combination (S_1M_1) *i.e.* sun drying without desiccant during 45 DAS, 60 DAS and 90 DAS in annual chrysanthemum and gerbera respectively. This is because of fact that the flowers which were dried under sun with silica gel resulted in maximum moisture loss and minimum moisture content during drying and there were less chances of loosening of petals during storage which helped them to maintain acceptable shape up to 45 DAS. But, flowers which were dried under sun and shade without desiccant produced distorted flower shape during storage because of direct exposure to high temperature without any embedding desiccant caused brittleness in petals and all petals started separating from flower after 45 DAS. The results were in

accordance with Chithira (2017) [1] in chrysanthemum var. Marigold.

Disease and pest attack

The results regarding disease and pest attack of annual chrysanthemum and gerbera during storage as influenced by different drying methods and desiccants given in Table 3.

Usually, in the dry flowers fungal diseases are more which is related with moisture content present in dried flowers. Not much infection was found during initial 30 DAS in all treatment combinations. But, as the storage period increased occurrence of pest and disease also increased gradually. The treatment combinations (S_1M_5) *i.e.* sun drying with silica gel and (S_1M_1) *i.e.* sun drying without desiccant showed no infection during 30 DAS and 45 DAS after which minor infection started. Whereas, high infection was found in treatment combination (S_2M_6) *i.e.* shade drying with borax powder during 60 DAS and 90 DAS in annual chrysanthemum and gerbera respectively. This is because of fact that due to maximum loss of moisture with minimum moisture content noticed in treatment combinations sun drying with silica gel and sun drying without desiccant so there was less chance for attack of fungal disease and pest up to 60 DAS after which mild infection started. But, because in treatment combination shade drying with borax there was less moisture loss and more moisture content present compared to all other treatment combinations which led to easy growth of fungus and more infection cause during 60 DAS and 90 DAS. The results were in accordance with Khyati (2015) [3] in rose, gerbera and gomphrena.

Table 2: Impact of different drying methods and desiccants on flower shape in annual chrysanthemum and gerbera

	Annual chrysanthemum				Gerbera			
	Flower shape				Flower shape			
Treatments	**30 DAS**	**45 DAS**	**60 DAS**	**90 DAS**	**30 DAS**	**45 DAS**	**60 DAS**	**90 DAS**
S_1M_1	@@@	@@@@	@@@@	@@@@	@@@	@@@	@@@@	@@@@
S_1M_2	@	@@	@@@	@@@@	@	@@	@@@	@@@@
S_1M_3	@	@@	@@@	@@@@	@	@@	@@@	@@@@
S_1M_4	@	@	@@@	@@@@	@	@	@@@	@@@
S_1M_5	@	@	@@	@@@@	@	@	@@	@@@
S_1M_6	@	@@	@@@	@@@@	@	@@	@@@	@@@@
S_2M_1	@@	@@@	@@@@	@@@@	@@	@@@	@@@	@@@@
S_2M_2	@	@@	@@@	@@@@	@	@@	@@@	@@@@
S_2M_3	@	@@	@@@	@@@@	@	@@	@@@	@@@@
S_2M_4	@	@@	@@@	@@@@	@	@@	@@@	@@@@
S_2M_5	@	@	@@@	@@@@	@	@	@@@	@@@@
S_2M_6	@	@@	@@@	@@@@	@	@@	@@@	@@@@

Where, @ = Highly acceptable, @@ = acceptable, @@@ = fairly acceptable, @@@@= not acceptable

Table 3: Impact of different drying methods and desiccants on disease and pest attack in annual chrysanthemum and gerbera

	Annual chrysanthemum				Gerbera			
	Disease and peat attack				Disease and pest attack			
Treatments	**30 DAS**	**45 DAS**	**60 DAS**	**90 DAS**	**30 DAS**	**45 DAS**	**60 DAS**	**90 DAS**
S_1M_1	*	*	**	***	*	*	**	***
S_1M_2	*	**	***	****	*	**	***	****
S_1M_3	*	**	***	****	*	**	***	****
S_1M_4	*	*	***	***	*	*	***	***
S_1M_5	*	*	**	***	*	*	**	***
S_1M_6	*	**	***	****	*	**	***	****
S_2M_1	*	*	***	***	*	*	***	***
S_2M_2	*	**	****	****	*	**	****	****
S_2M_3	*	**	****	****	*	**	****	****
S_2M_4	*	**	***	***	*	**	***	***
S_2M_5	*	*	***	***	*	*	**	***
S_2M_6	*	***	****	****	*	***	****	****

Where, *= Not infected, ** = Minor infection, ***= Infected, ****= Highly infected

Mechanical damage

The results regarding mechanical damage of annual chrysanthemum and gerbera during storage as influenced by different drying methods and desiccants given in Table 4.

The treatment combinations (S_2M_4) *i.e.* shade drying with sea sand and (S_2M_6) *i.e.* shade drying with borax powder showed less damage during 30 DAS and 45 DAS respectively after which damage was initiated. Whereas, maximum mechanical damage of flowers was found in (S_1M_1) *i.e.* sun drying without desiccant and (S_1M_5) *i.e.* sun drying with silica gel during 60 DAS and 90 DAS in annual chrysanthemum and gerbera respectively. After 90 DAS more damage and shedding of petals was found in all the treatment combinations. This is because in sun drying without desiccant and sun drying with silica gel due to maximum moisture loss petals became brittle this breakage of petals occurs leading to more mechanical damage after 60 DAS. Whereas, flowers dried under shade with sea sand and borax also showed mechanical damage but during initial days of storage up to 45 DAS there was less mechanical damage. These findings of more mechanical damage in sun drying with silica gel were noticed by Khyati (2015) [3] in rose, gerbera and gomphrena.

Conclusion

The present study entitled "Impact of different drying methods and desiccants on storage quality of annual

chrysanthemum and gerbera" was conducted in order to know the impact of desiccants and drying methods on storage quality of annual chrysanthemum and gerbera and flowers dried under shade with desiccant sea sand resulted in highly acceptable flower colour with less mechanical damage during storage. Whereas, highly acceptable flower shape with less attack of pest and disease resulted in sun drying with desiccant silica gel compared to all other treatment combinations during storage. From this study it can be concluded that shade drying with sea sand was found best for annual chrysanthemum and gerbera to maintain quality flowers during storage.

Author contributions

VR hypothesized the experiment; CS carried out the trial and recorded observations under the guidance of VR; CS performed the statistical analysis and wrote the manuscript.

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Table 4: Impact of different drying methods and desiccants on mechanical damage in annual chrysanthemum and gerbera

	Annual chrysanthemum				Gerbera			
	Mechanical damage				Mechanical damage			
Treatments	**30 DAS**	**45 DAS**	**60 DAS**	**90 DAS**	**30 DAS**	**45 DAS**	**60 DAS**	**90 DAS**
S_1M_1	+	++	++++	++++	+	++	++++	++++
S_1M_2	+	++	+++	++++	+	++	+++	+++
S_1M_3	+	++	+++	++++	+	++	+++	+++
S_1M_4	+	++	++	++++	+	++	++	+++
S_1M_5	+	++	++++	++++	+	++	++++	++++
S_1M_6	+	++	++	++++	+	++	++	+++
S_2M_1	+	++	+++	++++	+	++	+++	++++
S_2M_2	+	++	+++	++++	+	++	+++	+++
S_2M_3	+	++	+++	++++	+	++	+++	+++
S_2M_4	+	+	++	++++	+	+	++	+++
S_2M_5	+	++	+++	++++	+	++	+++	++++
S_2M_6	+	+	++	++++	+	+	++	+++

Where, + = no damage, ++ = 0-15% damage, +++ = 15-30% damage, ++++ = 30-50% damage

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