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RESEARCH PAPER

Storage losses in short day onions and factors affecting it

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Abstract: The research experiments were conducted to study the storage performance of onion from the year 2016 to 2021 over seasons (*kharif*, winter, summer). Different onion genotypes were grown to study the storage losses. Onions grown in winter seasons and stored through summer months were stored better (49.3 % loss) than summer (57.3 % loss) and *kharif* (73.8 % loss) grown crop. The mean performance of genotypes for storage loss varied from 32.28 % to 80.84 %, least in 2016 and highest in 2020 attributed basically for variation in weather conditions, selection pressure and their interaction. The storage loss fitted well to curvilinear model (Y= 500.851 + (-11.996) x_1 + (-2.910) x_2 + (0.653) x_3 + 16.437

Key words: *Allium cepa*, Genotypes, Onion, Seasons, Storage, Years

Introduction

Karnataka is second largest producer of onion in the country. Most of the onions in Karnataka come from northern districts (Chitradurga, Bellary, Bagalkot, Vijaypur and Gadag *etc*.) where it is cultivated in rainy (May - September) seasons under rainfed conditions. The change in climate pattern experience heavy to very heavy rains from last 3 - 4 years destroying the onion crop and farmers put to heavy loss and are in search of alternative crops like corn and cotton or shift onion to other seasons. Even *kharif* grown onions generally caught in rains while harvesting making vulnerable to many storage losses. As per the reports (Adamicki, 2005 and Tripathi and Lawande, 2006) hardly 50 % of the harvest reach consumers due to losses like physiological loss in weight (PLW), sprouting and rotting in storage. Cold storage can reduce the loss (Krishnakumar Patel *et al*., 2013) but lack of cold storages to handle huge produce calls for research to find out best season for cultivation and best storage type onion cultivars / hybrids. Madalageri *et al.* (2021b) in their breeding studies indicated that developing F_1's were better than poly crosses and open pollinated varieties in storage. Further Madalageri *et al.* (2021a) emphasised developing stable varieties / hybrids to mitigate changing climate conditions. In view of this, present investigations were undertaken at I & B Seeds Pvt. Ltd., Bangalore for last 5-6 years.

Material and methods

The onion genetic material at I & B Seeds Pvt. Ltd., Bangalore was raised from 2016-2021 and subjected to 4 months storage study following the chart given in table 1. The seedlings were raised in 96 hole pro-trays filled with coco peat media under green house nursery for 45 days and transplanted to main field at a distance of 15 cm x 10 cm on a raised bed both in red soil (I & B Farm, Bangalore) and black soil (Ranebennur and Bagalkot) in replicated trials. The crop was raised by following package of practices given by University of Agricultural Sciences, Bangalore (Anon., 1991). The bulbs were harvested when there was 50 % neck fall, cured and stored in net bags on bottom ventilated shelves under ambient conditions. Generally bulbs were cured in the field for 7-10 days after harvest when there were no rains. But during *kharif* crop, this was not possible because of frequent rains. Similarly the summer crop harvested in May often got affected due to torrential early monsoon showers. Observations on PLW, sprouting, rotting and total loss were recorded at 4 months after storage.

In the first year of study (2016), there was an unselected genetic pool of 66 entries for any of the characters and partly harvested bulbs from *kharif* crop were replanted to produce seed in October. In subsequent years, selection pressure was imposed for uniform big sized bulbs (> 6.00 cm diameter), single centred bulbs and high yield in red, white and yellow entries and stored as usual (2017). Further in 2018, 6 synthetics were developed by random mating using selected similar looking genotypes and they were evaluated for storage properties. During 2019, cytoplasm male sterile line (A), respective maintainer line (B) and restorer (R) lines of red, white and yellow were evaluated for storage. In 2020, 34 hybrids developed using male sterile line in red x red, white x white, yellow x yellow background and evaluated for their storage properties along with checks. New hybrids (17) developed in 2021 by using only red male sterile line crossed with red, white and yellow R lines were evaluated for storage. The mean data collected from all the years, seasons and genotypes were presented in the form of graphs while genotype interaction with environment was calculated using appropriate statistical method (Panse and Sukatme, 1954). The Bangalore weather data on temperature, relative humidity and rainfall over the past 10 years were obtained from Google to relate storage loss to weather parameters through correlation and regression analysis (Anon., 2022).

Results and discussion

The Fig.1 indicates the mean values over years and genotypes on storage losses due to seasons of cultivation. In general, the highest total loss of bulbs was in *kharif* (June) planted bulbs stored through winter months (73.8 %). Similar trend was noticed for PLW too.

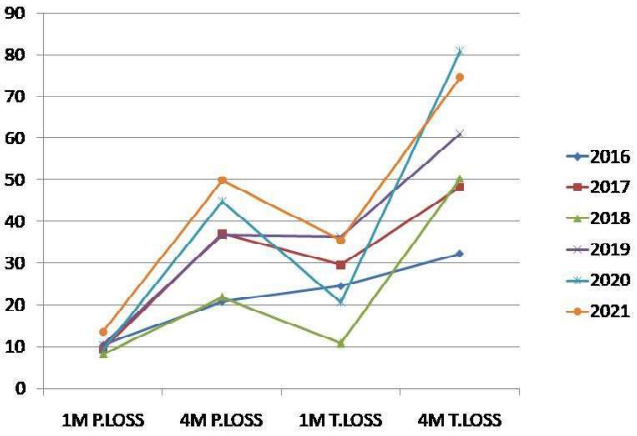

Fig. 1. Physiological (P) and Total (T) loss of onion grown in different seasons.

Table 1. The plan showing period of planting, harvesting and storing of onion bulbs

Season	Seed sowing	Planting date	Harvesting period	Storage period
Kharif	Apr. 2 nd week	June 1st week	Aug.-Sept.	Sept.-Dec.
Winter	Aug. 2nd week	October 1 st week	Jan.-Feb.	Feb.-May
Summer	Dec. 2 nd week	Feb. 1 st week	Apr.-May	May-Aug.

Table 2. Variance showing significant genotype x environment interaction for storage loss

Source	DF	SS	MS	CAL F	Table F
Variety/Hybrid	27	0.957795	0.035474	6.928239707**	1.58
Environment	2	0.272668	0.136334	26.62674126**	3.07
Var. x Env.	54	0.516376	0.009563	1.867610551*	1.45
Error	112	0.573461	0.00512		

Table 3. Prediction models for storage losses in onion in relation to weather parameters

Model 1 : Y=183.605 + (-5.109) x_1 + 20.053	Where, Y = Storage loss and x_1 = mean temperature
Model 2 : Y = 66.089 + (-0.087) x_2 +23.4	Where, Y = Storage loss and x_2 = mean relative humidity
Model 3 : Y = 62.114 + (-0.029) x_3 + 23.452	Where, Y = Storage loss and x_3= mean rainfall
Model 4 : Y = 500.851 + (-11.996) x1 + (-2.910) x2 + (0.653) x3 + 16.437	Where, Y = storage loss and x_1, x_2 and x_3 are temperature, relative humidity and rainfall, respectively.

Correlation coefficients (r)

Storage loss	*v/s*	Temperature	0.521 (NS)
Storage loss	*v/s*	RH	0.045 (NS)
Storage loss	*v/s*	Rainfall	0.062 (NS)

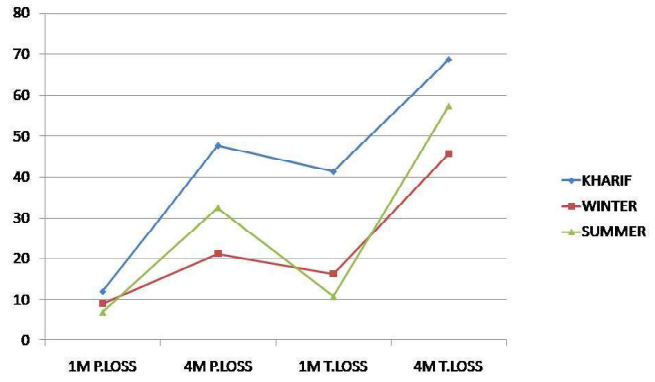

Fig. 2. Physiological (P) and Total (T) loss of onion genotypes grown in different years from 2016-2021 over seasons.

Winter (October) planted crop stored through summer months performed better with minimum storage loss of about 49.3%. Although summer planted crop with 57.3% loss was second best stored through rainy season months as these harvested bulbs often caught in the early monsoons. Wheeler *et al.* (1998) and Rutherford and Whittle (1982) who found that onions from coolest seasons had longest storage life. But Terhi Suojala (2001) from Finland opined that planting time had no effect on storage losses and there were no significant interactions between fixed factors.

There was year to year variation in physiological as well as total losses of onion in storage (Fig. 2). The least storage losses were observed in 2016 when unselected population was put to test. As the years progressed the storage losses have also increased because of changes in genetic structure of the population through selections, introduction of synthetics and hybrids. As the selection pressure was imposed for yield and quality (bigger diameter and single centre) there was increase in the storage loss. Gene pooling (development of synthetics - 2018) favoured good storage. However, the total effect of hybrids for better storage (2020, 2021) was found ineffective, although individually few hybrids were better storers. The masking effect may be because of using A and B lines selected through SSR (Simple sequence repeats) markers (2019). Genetic factors affecting storage losses have also been highlighted by Kalyani *et al.* (2018) who observed that Bhima Kiran and Bhima Shakti had good storage compared to other 5 varieties tested. Similarly Martinez *et al.* (2005) and Ko *et al.* (2002) indicated that local unselected populations of onions having higher dry matter content stored better.

It was interesting to note that there was genotype x environment interaction (Table 2) for storage losses. The correlation between storage loss and weather parameters were non significant and regression analysis using storage loss as dependent variable with temperature, relative humidity and rainfall as single independent variables did not show any relationship (Table 3). But multiple regression using all the independent variables had better fit (Y = 500.851 + (-11.996) x_1 + (-2.910) x_2 + (0.653) x_3 + 16.437, where Y is storage loss, x_1 is mean temperature, x_2 is % RH and x_3 is rainfall) to fairly predict the storage loss, although use of few more weather parameters might have given accuracy. Further, significant genotype x environment interaction suggests that there are possibilities to look forward to select / breed a genotype that can store well (Madalageri *et al*., 2021b). Mane *et al*. (2020) in the studies found out that a genotype AKON-3 consistently recorded minimum PLW, rotting and sprouting out of 20 genotypes even at 90 days of storage. Dubey *et al*. (2019) noticed genotypic differences in storage of 21 entries and found NRCWO-4 had minimum weight loss after 120 days after storage.

Conclusion

Under tropical conditions short day onions should be grown in winter season or late *kharif* under the circumstances of climate change to minimize storage loss with appropriate onion genotype (preferably synthetics or selected hybrid). A prediction model for onion loss is proposed using major climatic factors like mean temperature, relative humidity and rainfall.

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