

**STUDIES ON PERFORMANCE OF VARIETIES, F<sub>1</sub>  
HYBRIDS AND SYNTHETICS OF ONION  
(*Allium cepa*L.) IN EASTERN DRY ZONE OF  
KARNATAKA**

**SUHAS, Y.H.**

**UHS14PGM544**

**DEPARTMENT OF VEGETABLE SCIENCE  
COLLEGE OF HORTICULTURE, KOLAR- 563 103  
UNIVERSITY OF HORTICULTURAL SCIENCES  
BAGALKOT**

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*Thesis submitted to the*

**COLLEGE OF HORTICULTURE, KOLAR- 563 102  
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**By**

**SUHAS, Y.H.**

**UHS14PGM544**

**DEPARTMENT OF VEGETABLE SCIENCE  
COLLEGE OF HORTICULTURE, KOLAR- 563 103  
UNIVERSITY OF HORTICULTURAL SCIENCES  
BAGALKOT**

**SEPTEMBER, 2016**

*Affectionately*  
*Dedicated to My*  
*Father Hanumegowda*  
*Mother Shylaja*  
*Brother Santhosh*  
*& to My Friends*



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Kolar  
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(**SUHAS, Y. H.**)

**STUDIES ON PERFORMANCE OF VARIETIES, F<sub>1</sub> HYBRIDS AND  
SYNTHETICS OF ONION (*Allium cepa*L.) IN  
EASTERN DRY ZONE OF KARNATAKA**

**ABSTRACT**

A field experiment was conducted to know the performance of varieties, F<sub>1</sub> hybrids and synthetics of onion (*Allium cepa*L.) in Eastern Dry Zone of Karnataka during *Kharif* and *Rabi* seasons 2015-16 at College of Horticulture, Kolar, Karnataka. Twenty five genotypes(13 varieties, 10 hybrids and 2 synthetics) were collected and evaluated in both *Kharif* and *Rabi* seasons. The research work was carried out to identify the elite genotypes suitable for *Kharif*, *Rabi* and for both the seasons for higher bulb yield with good quality, long storability, disease and insect pest resistance. The performance of the different genotypes with respect to growth, bulb yield, quality and storage behaviour, *Rabi* season was found better compared to *Kharif*season. However, with respect to performance of genotypes between two seasons, Super Flare (38.16 t/ha), S-780 (36.50 t/ha) and ArkaBheem (36.33 t/ha) performed better in *Kharif*season. While, in *Rabi* season Flare (38.50 t/ha), Super Flare (37.00 t/ha) and S-780 (36.40 t/ha) were found best for obtaining quality bulb yield. Studies on incidence of disease and insect pest resistance indicated that, ArkaBindu (10.00%) and Poona Firusungi (8.75%) were resistance to purple blotch. Whereas, Rampur Local (8.00%) and ArkaLalima (8.00%) were showed equally resistance to thrips infestation. ArkaBheem and ArkaPragathi were best suited for long term storage with good shelf-life. In the studies, onion F<sub>1</sub> hybrids were found to be superior than the synthetics and open pollinated varieties for higher bulb yield Super Flare (37.58 t/ha) and Flare (37.08 t/ha) under both the seasons after combined analysis. Therefore, it is concluded that onion F<sub>1</sub> hybrids need to be popularise for commercial cultivation for increasing productivity in the country.

Signature of the Student  
(Sahas, Y. H.)

Signature of the Major Advisor  
(H. Amarananjundeswara)

ಕರ್ನಾಟಕ ಪೂರ್ವ ಒಣ ವಲಯದಲ್ಲಿ ಈರುಳ್ಳಿಯ (ಆಲಿಯಮ್ ಸಿಪಾ ಎಲ್.) ತಳಿಗಳು,  
ಸಂಕರಣ ತಳಿಗಳು ಮತ್ತು ಸಂಶ್ಲೇಷಿತ ತಳಿಗಳ ಪ್ರದರ್ಶನದ ಅಧ್ಯಯನ  
ಪ್ರಬಂಧದ ಸಾರಾಂಶ

ಈ ಕ್ಷೇತ್ರ ಸಂಶೋಧನೆಯನ್ನು ತೋಟಗಾರಿಕೆ ಮಹಾವಿದ್ಯಾಲಯ, ಕೋಲಾರದಲ್ಲಿ ಕರ್ನಾಟಕ ಪೂರ್ವ ಒಣ ವಲಯದಲ್ಲಿ ಈರುಳ್ಳಿಯ (ಆಲಿಯಮ್ ಸಿಪಾ ಎಲ್.) ತಳಿಗಳು, ಸಂಕರಣ ತಳಿಗಳು ಮತ್ತು ಸಂಶ್ಲೇಷಿತ ತಳಿಗಳ ಪ್ರದರ್ಶನದ ಅಧ್ಯಯನ ಎಂಬ ಶೀರ್ಷಿಕೆಯಡಿಯಲ್ಲಿ 2015-16ರ ಸಾಲಿನ ಮುಂಗಾರು ಮತ್ತು ಹಿಂಗಾರು ಋತುಗಳಲ್ಲಿ ಹಮ್ಮಿಕೊಳ್ಳಲಾಯಿತು. ಈ ಪ್ರಸ್ತುತ ಸಂಶೋಧನೆಗಾಗಿ ಒಟ್ಟು 25 ತಳಿಗಳನ್ನು (13 ತಳಿಗಳು, 10 ಸಂಕರಣ ತಳಿಗಳು ಮತ್ತು 02 ಸಂಶ್ಲೇಷಿತ ತಳಿಗಳು) ಸಂಗ್ರಹಿಸಿ ಮುಂಗಾರು ಮತ್ತು ಹಿಂಗಾರಿನಲ್ಲಿ ಮೌಲ್ಯವಾಪನ ಮಾಡಲಾಯಿತು. ಈರುಳ್ಳಿ ತಳಿಗಳು ಮುಂಗಾರಿಗೆ, ಹಿಂಗಾರಿಗೆ ಮತ್ತು ಎರಡು ಋತುಗಳಿಗೆ ಬೇಸಾಯಕ್ಕೆ ಸೂಕ್ತವಾಗಿರುವುದು ಪರೀಕ್ಷಿಸುವುದರ ಜೊತೆಗೆ ಉತ್ತಮ ಇಳುವರಿ, ಒಳ್ಳೆಯ ಗುಣಮಟ್ಟ, ದೀರ್ಘ ಶೇಖರಣಾ ಸಾಮರ್ಥ್ಯ ಶಕ್ತಿ, ಕೀಟ ಮತ್ತು ರೋಗ ನಿರೋಧಕ ಶಕ್ತಿಯನ್ನು ಹೊಂದಿರುವಂತಹ ತಳಿಗಳನ್ನು ಗುರುತಿಸುವುದು ಈ ಸಂಶೋಧನೆಯ ಮುಖ್ಯ ಉದ್ದೇಶವಾಗಿರುತ್ತದೆ. ಈ ಬೆಳೆಯ ಉತ್ತಮ ಬೆಳವಣಿಗೆ, ಇಳುವರಿ, ಒಳ್ಳೆಯ ಗುಣಮಟ್ಟ, ದೀರ್ಘ ಶೇಖರಣಾ ಸಾಮರ್ಥ್ಯ ಶಕ್ತಿ, ಕೀಟ ಮತ್ತು ರೋಗ ನಿರೋಧಕ ಶಕ್ತಿಯಿರುವುದನ್ನು ಕಂಡುಹಿಡಿಯಲು ಸಂಶೋಧನೆಗೆ ಒಳಪಡಿಸಿದಾಗ, ಹಿಂಗಾರು ಋತುವು ಮುಂಗಾರಿಗಿಂತ ಉತ್ತಮವಾಗಿರುವುದು ತೋರಿರುತ್ತದೆ. ಹಾಗೆಯೇ ಎರಡು ಋತುಗಳಲ್ಲಿ ಈರುಳ್ಳಿ ಬೆಳೆಯುವುದಕ್ಕೆ ಸಂಬಂಧಿಸಿದಂತೆ ಮುಂಗಾರು ಋತುವಿನಲ್ಲಿ ತಳಿಗಳಾದ ಸೂಪರ್ ಫ್ಲೇರ್ (38.16ಟನ್/ಹೆಕ್ಟೇರ್), ಎಸ್-780 (36.50ಟನ್/ಹೆಕ್ಟೇರ್) ಮತ್ತು ಅರ್ಕಾಭೀಮ್ (36.33ಟನ್/ಹೆಕ್ಟೇರ್) ಉತ್ತಮ ಪ್ರದರ್ಶನ ತೋರಿದರೆ, ಹಿಂಗಾರು ಋತುವಿನಲ್ಲಿ ಫ್ಲೇರ್ (38.50ಟನ್/ಹೆಕ್ಟೇರ್), ಸೂಪರ್ ಫ್ಲೇರ್ (37.00ಟನ್/ಹೆಕ್ಟೇರ್) ಮತ್ತು ಎಸ್-780 (36.40ಟನ್/ಹೆಕ್ಟೇರ್) ತಳಿಗಳು ಹೆಚ್ಚು ಇಳುವರಿ ಕೊಟ್ಟು ಉತ್ತಮ ಪ್ರದರ್ಶನ ತೋರಿರುತ್ತವೆ. ಇನ್ನು ಕೀಟ ಮತ್ತು ರೋಗ ನಿರೋಧಕ ಶಕ್ತಿಗೆ ಸಂಬಂಧಿಸಿದಂತೆ ಅರ್ಕಾ ಬಿಂದು (ಶೇ. 10.00) ಮತ್ತು ಪೂನಾ ಪೂರುಸಂಗಿ (ಶೇ. 8.75) ತಳಿಗಳು ನೇರಳೆ ಮಚ್ಚೆ ರೋಗಕ್ಕೆ ನಿರೋಧಕತೆ ತೋರಿಸಿರುತ್ತವೆ. ಹಾಗೆಯೇ ರಾಂಪುರ ಸ್ಥಳಿಯ (ಶೇ. 8.00) ಮತ್ತು ಅರ್ಕಾ ಲಾಲೀಮಾ (ಶೇ. 8.00) ತಳಿಗಳು ನುಸಿ ಹಾವಳಿಗೆ ನಿರೋಧಕ ಶಕ್ತಿ ಹೊಂದಿರುವುದು ಕಂಡುಬಂದಿರುತ್ತದೆ. ತಳಿಗಳಾದ ಅರ್ಕಾ ಭೀಮ್ ಮತ್ತು ಅರ್ಕಾ ಪ್ರಗತಿಯು ದೀರ್ಘ ಶೇಖರಣಾ ಸಾಮರ್ಥ್ಯವಿರುವುದು ದೃಢಪಟ್ಟಿರುತ್ತದೆ. ಆದರೆ ಈ ಸಂಶೋಧನೆಯಿಂದ ಹೊರಪಟ್ಟಿರುವುದೇನೆಂದರೆ ಈರುಳ್ಳಿಯ ಎಲ್ಲಾ ತಳಿಗಳಿಗೆ ಹೋಲಿಸಿದಾಗ ಸಂಕರಣ ತಳಿಗಳು ಅಧಿಕ ಇಳುವರಿ ನೀಡಿರುವುದು ವೈಜ್ಞಾನಿಕವಾಗಿ ಖಾತರಿಯಾಗಿರುತ್ತದೆ. ಆದುದರಿಂದ ಈರುಳ್ಳಿ ಉತ್ಪಾದಕತೆಯ ವರ್ಧನೆಗೆ ಸೂಪರ್ ಫ್ಲೇರ್ (37.58ಟನ್/ಹೆಕ್ಟೇರ್) ಮತ್ತು ಫ್ಲೇರ್ (37.08ಟನ್/ಹೆಕ್ಟೇರ್) ತಳಿಗಳು ಕರ್ನಾಟಕ ಪೂರ್ವ ಒಣ ವಲಯದ ಎರಡು ಋತುಗಳಲ್ಲಿ ವಾಣಿಜ್ಯ ಬೇಸಾಯಕ್ಕೆ ಜನಪ್ರಿಯಗೊಳಿಸುವ ಅಗತ್ಯವಿದೆಯೆಂದು ಈ ಸಂಶೋಧನೆಯಿಂದ ದೃಢಪಟ್ಟಿರುತ್ತದೆ.

ವಿಧ್ಯಾರ್ಥಿ  
(ಸುಹಾಸ್, ವೈ.ಹೆಚ್.)

ಪ್ರಧಾನ ಸಲಹೆಗಾರರು  
(ಹೆಚ್. ಅಮರನಂಜುಂಡೇಶ್ವರ)

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# *Introduction*

## I. INTRODUCTION

Onion (*Allium cepa* L.), is an important species belonging to family Alliaceae and its chromosome number  $2n=16$ . It is most widely grown and popular vegetable crop among the Alliums. Onion is considered to be the second most important vegetable crop grown in the world after tomato. It is an indispensable item in every kitchen as vegetable and condiment used to flavour many of the food stuffs. Therefore, onion is popularly referred as 'Queen of the kitchen'. In addition, onion is used as salad and pickle. Recently onion is being employed by processing industry to a greater extent for preparation of dehydrated onion products like powder and flakes.

Onion is also known to possess several medicinal and therapeutic properties; its effectiveness range against common cold to diabetes, heart disease, osteoporosis and other diseases. Onion is known for anti-platelet aggregation, anti-rheumatic, diuretic and fibrinolytic effects as well as it reduces the blood sugar. Onion contains a chemical compound called quercetin, which is believed to have anti-inflammatory, anti-cholesterol, anti-cancer, and antioxidant properties. Bulb juice is used as smelling agent against hysterical convulsions and faintness. The key constituent of onion bulb is Allyl propyl disulphide, which is a sulphur based compound responsible for the characteristic alliaceous odour and is also known to possess antibacterial properties. The nutritive value of the onion vary with varieties and generally 100 g of edible bulb portion contain moisture (86.8 g), carbohydrates (11.0 g), proteins (1.2 g), fibre (0.6 g) and minerals like calcium (180 mg), phosphorous (50 mg), iron (0.7 mg), nicotinic acid (0.4 mg) and traces of thiamine, altogether accounting for an average nutritive value of 2.06 (Anon., 2008). Although the nutritive value of onion is low, but it is greatly valued for its inevitable and extensive usage as a vegetable to a medicine.

According to De Candolle (1885), onion originated in the area spreading from Palestine to India. Whereas, Vavilov (1926) reported Central Asia as the primary centre of origin and the area near East and Mediterranean regions as the secondary centres of origin. Onion is one of the ancient vegetable crops in continuous cultivation. The ancient Egyptians cultivate onions along the Nile River. Egyptian pharaohs regarded the onion as a symbol of eternity. The humble onion was sacred enough to be carved into King Tut's tomb and valuable enough to be gifted on weddings in medieval Europe. In India onions have been in cultivation since 600 BC. Many virtues have been attributed in Charaka-Samhita and the references of onion

India ranks first in area, second in production and third in export of onion in the world. In India, onion is predominantly cultivated during *Rabi* (60%) followed

by 20 per cent each in *Kharif* and late *Kharif* season. In India, onion cultivate in an area of 12.03 lakh hectares with a total production of 194.01 lakh tons (Anon., 2015). In India Maharashtra, Karnataka, Madhya Pradesh, Gujarat, Rajasthan, Bihar, Andhra Pradesh and Tamil Nadu are the main onion growing states. In the country 38.93 per cent area and 30.22 per cent production of onion alone comes from Maharashtra. In Karnataka, onion is produced throughout the year and cultivated in an area of 1.37 lakh hectares with the production of 20.65 lakh tons (Anon., 2015).

Even though India stands in second place with respect to the production of onion in the world next to china, the productivity is very low as compared to other advanced countries. The higher productivity could be achieved by selection of proper varieties specific to areas, appropriate agronomical practices such as balanced nutrition, optimum water management as well as need based plant protection measures, harvesting and post-harvest handling of the produce etc.

Onion cultivars show wide variation in their yielding ability when grown over varied agro-climatic conditions. Besides the yield and quality of onion depends upon soil, climatic conditions and variety or hybrid used. Different cultivars have different soil and climatic requirements for their optimum performance. India being a vast country with varied agro-climatic regions, a single variety or hybrid may not be suitable for all the agro-climatic conditions. Hence, new varieties and hybrids need to be introduced or evolved for specific regions.

Many varieties and pre-breeding lines are developed by different breeding centres in India and local cultivars grown by farmers in different agro-climatic zones are need to be evaluated at different locations as the response is location specific. Onion being highly cross pollinated crop, high variation in genetic components can be seen. This genetic variability can be exploited in development of varieties or lines for different breeding objectives. To improve the bulb yield of varieties through selection the information on the nature and magnitude of variability for yield, insect pests, disease resistance, other quantitative and qualitative characters present in the population owing to its genetic causes play an important role and as such it is a basic pre-requisite for any systematic breeding programme.

Onion being a semi-perishable crop gets deteriorated during storage, transportation and marketing. Due to the storage losses, it cannot be guaranteed that whole amount of the total production is consumed by the people. In this regard it becomes essential to study the performances of onion cultivars for storage characteristics during *Kharif* and *Rabi* seasons.

Keeping these points in view the present study was undertaken with following objectives;

1. Evaluation of varieties,  $F_1$  hybrids and synthetics of onion for growth, bulb yield and quality traits
2. Studies on variability of varieties,  $F_1$  hybrids and synthetics of onion for growth, bulb yield and quality traits
3. Studies on storage behaviour of varieties,  $F_1$  hybrids and synthetics of onion.

# *Review of Literature*

## II. REVIEW OF LITERATURE

Though India is a major producer of onion and large number of cultivars are being grown in different parts of the country, but productivity of onion is very low in India, as compared to major onion growing countries in the world. Similarly, although Karnataka is the second largest producer of onion in India, the productivity of onion is also however low. In this regard, several factors have been identified which limit onion production and productivity in India and also in Karnataka in particular. Some of them are lack of high yielding cultivars suitable for different agro-climatic conditions with good quality of bulbs and longer storage life. Hence, an attempt has been made to review the available scientific information on onion which is presented under following sub-headings.

### 2.1 Evaluation of onion for growth traits

Patil *et al.* (1990) observed significant differences in plant height among the onion varieties. The variety UD-102 recorded highest plant height (62.58 cm) followed by N-53 (58.66 cm). Whereas lowest plant height (48.89 cm) was recorded in Local White and also observed significant differences in production of leaves per plant. Maximum number of leaves per plant was recorded in Pusa Red (9.54) followed by UD-101 (9.37), Line-102 (9.29) and the least in N-53 (7.87).

Somkumar *et al.* (1994) studied fourteen varieties and hybrids for growth and yield characters of onion at Indian Institute of Horticulture Research (IIHR), Bengaluru and reported that the varieties did not show any significant differences for number of leaves. However, Arka Kalyan had more number of leaves (9.33). Whereas, Hybrid-5 had registered less number of leaves (9.20).

Sharma and Choudhary (1995) recorded significant differences in plant height among different onion varieties in both *Kharif* and *Rabi* seasons. In *Kharif* season, the maximum plant height was documented in Agrifound Dark Red (49.73 cm) followed by N-53 (46.50) and Agrifound Light Red (45.16 cm) which were statistically on par with each other for most of the characters studied. In *Rabi* season, the maximum plant height was recorded in Nasik Red (52.10) followed by Patna Red (50.93) and Agrifound Light Red (50.33) which were on par with each other.

Khan (1997) evaluated ten varieties of onion in mid hills of Uttar Pradesh and reported that there was no significant difference in plant height. However, the variety 'Pithoragarh Local' recorded the highest plant height (56.7 cm) and 'Agrifound Dark Red' recorded the lowest height (38.7 cm). Besides, reported that the significant differences in production of leaves per plant. Pithoragarh

Local recorded the highest number of leaves per plant (13.80) which is followed by Agrifound Light Red (12.05). Minimum number of leaves per plant was noticed in Nasik Red (7.95).

Gowda *et al.* (1998a) recorded the highest plant height in variety Arka Niketan (50 cm) and lowest in Arka Bindu (30 cm). Similarly, Gowda *et al.* (1998b) recorded highest plant height in variety Arka Lalima (56 cm) and lowest in Arka Kirthiman (50 cm)

Mohanty and Prusti (2001a) evaluated twelve varieties of onion in Bhawanipatna, Orissa. Reported that variety Nasik Red registered maximum plant height (40.40 cm) and Arka Niketan recorded the lowest the plant height (25.0 cm) However, variety Pusa Red documented maximum number of leaves per plant (16.50) followed by Arka Kalyan (15.30), Pusa Madhavi (14.20), N-53 (13.60). Whereas, lowest number of leaves was observed in Arka Niketan (12.40).

Mohanty and Prusti (2001b) tested twelve onion varieties in black soils of Orissa. Among the different varieties, Nasik Red was the tallest with a plant height of 49.72 cm. While, Arka Pitamber was shortest with lowest plant height of 39.33 cm. Among them the highest number of leaves per plant was recorded in Nasik Red (15.65), while Agrifound Dark Red displayed lowest number of leaves per plant (7.22).

Mohanty and Prusti (2002) recorded the highest plant height was in onion variety N-53 (46.0 cm) closely followed by Nasik Red (43.90 cm), whereas N-2-4-1 registered lower plant height (33.14 cm). The onion variety N-53 produced maximum number of leaves per plant (15.50) which was on par with Arka Kalyan (14.40) and Pusa Madhavi (13.60). On the contrary, Arka Pitamber recorded the minimum number of leaves per plant (7.20).

Mahantesh *et al.* (2005) documented that plant height was significantly higher in Baswant-780 (53.23 and 46.09 cm in *Rabi* and *Kharif* respectively) over the other varieties evaluated and observed significant differences in the production of leaves per plant in both *Rabi* and *Kharif* seasons. In *Kharif* season, they noticed that onion variety Baswant-780 recorded maximum number of leaves per plant (11.65) followed by Arka Kalyan (8.30) and minimum in Bellary Red (6.10). In *Rabi* season, the maximum number of leaves per plant was recorded in Baswant-780 (9.19) followed by Arka Kalyan (8.01) and minimum in Bellary Red (4.69).

Sharma (2009) evaluated five onion varieties during *Kharif* under sub-montane low hill conditions of Himachal Pradesh. The variety Baswant-780

recorded the highest plant height (65.46 cm), whereas variety Arka Kalyan had the lowest plant height (55.80 cm). Similarly, variety Baswant-780 registered the maximum number leaves per plant (10.59) followed by N-53 (10.06), whereas lowest number of leaves per plant registered in Arka Kalyan (9.81).

Hosmani *et al.* (2010) revealed that onion genotype 'PRO-6' documented maximum plant height (32.00 cm), whereas Agrifound White recorded the lowest plant height (23.33 cm). Onion genotype 'RO-597' recorded highest number of leaves per plant (8.33) and lowest number of leaves per plant in 'L-28' (5.00) and Agrifound White (5.00).

Trivedi and Dhumal (2010) reported that among the eighteen onion genotypes and four varieties evaluated during *Kharif* season at NRCOG, Pune, the genotype NRCOG-581 had highest plant height (60.20 cm) and NRCOG-542 had lowest plant height (46.30 cm). Onion genotype NRCOG-596 had the highest number of leaves per plant (10.87) followed by NRCOG-567 (10.05). Whereas, lowest number of leaves per plant was recorded in NRCOG-542 (6.70).

Ram *et al.* (2011a) evaluated sixteen genotypes under Lucknow conditions, where Pusa Madhavi recorded the highest plant height (60.20 cm) and AOSDRB-0906 recorded the lowest plant height (41.43 cm). The maximum number of leaves per plant was noticed in variety Pusa Madhavi (9.77) followed by genotype 'CORB-9070' (9.44). Whereas, minimum number of leaves per plant was observed in genotype AOSDRB-0919 (8.00).

## **2.2 Evaluation of onion for bulb yield and quality**

Muthukrishnan *et al.* (1978) observed that there was not much variation in total soluble solids (TSS) content of different varieties of onion which ranged from 9.4 (Hissar-2) to 12.20 per cent (Bellary Red).

Nagarjuna (1988) evaluated fourteen genotypes and reported that the genotype NER had maximum polar diameter of bulb (5.28 cm), while the genotype Sel-1 had minimum (4.06 cm) polar diameter of bulb. The genotype N-53 had maximum (4.05 cm) equatorial diameter of bulb, whereas the genotype Sel-1 had minimum (3.11 cm) equatorial diameter of bulb.

Bajaj *et al.* (1990) studied the varietal variations by analyzing five white and six red varieties of onion for dry matter content of the bulb and reported that the mean value of the dry matter content ranged from 9.28 per cent (VL-67) to 12.9 per cent (Punjab-48) and considered that Punjab-48 (white in colour) as the best variety for dehydration purpose.

Singh *et al.* (1992) reported that after four months of storage, the cultivar Hisar-2 exhibited minimum sprouting (23.20 %) and the maximum sprouting was observed in VL-3 (51.20%) followed by VL-1 (46.59%).

Satodiya and Singh (1993) observed that after four months of storage, the percentage of sprouted bulbs was significantly lowest in 'Hisar-2' (3.45%), whereas it was highest in 'Lalpur-2' (24.93%). The extent of sprouting was influenced markedly by climatic conditions and duration of storage.

Jadhav *et al.* (1990) recorded the maximum polar diameter of bulb in Parbhani Local (5.98 cm) followed by Agrifound Dark Red (89.75 g), N-2-4-1 (5.22 cm) and minimum in case of Baswant-780 (4.62 cm). The maximum equatorial diameter of bulb in Agrifound Light Red (6.07 cm) followed by Pusa White Flat (6.04 cm) and Baswant-780 (5.90 cm) and lowest in case of Arka Kalyan (4.72 cm). Also recorded the maximum bulb weight in Agrifound Light Red (122.06 g) followed by Pusa White Flat (114.80 g), Agrifound Dark Red (110.80 g) and minimum in case of Arka Kalyan (84.66 g).

Patil *et al.* (1991) registered the highest bulb weight in N-53 (76.00 g) followed by FB-780 (58.50 g), N-2-4-1 (53.20 g) and it was least in Nagpur Local White (37.70 g).

Katwale and Saraf (1991) studied eight onion cultivars under Satpura zone of Madhya Pradesh conditions during rainy season and reported that cultivar N-53 gave highest bulb yield (13.39 t/ha).

Pathak and Gowda (1994) reported that maximum polar diameter of bulb was noticed in Arka Kirthiman (6.20 cm) followed by Arka Lalima (5.50 cm) and Arka Kalyan recorded the lowest polar diameter of bulb (4.70 cm). However, maximum equatorial diameter of bulb was observed in Arka Kirthiman (6.50 cm) followed by Arka Lalima (5.90 cm) and Arka Kalyan revealed the lowest equatorial diameter of bulb (5.10 cm).

Somkumar *et al.* (1994) obtained maximum polar diameter of bulb in Arka Niketan (6.42 cm) followed by Hybrid-3 (5.96 cm) and lowest in Arka Bindu (3.61 cm). Whereas, the maximum equatorial diameter of bulb was noticed in Pusa Madhavi (6.71 cm) followed by Arka Pragati (6.66 cm), Arka Kalyan (6.30 cm) and lowest in local onion (4.62 cm).

Khan (1997) recorded maximum polar diameter of bulb in Pithoragarh Local (6.75 cm) followed by Poona Red (5.55 cm), Agrifound Light Red (5.40 cm) and least in Agrifound Dark Red (3.20 cm). Maximum equatorial diameter of bulb

in Pithoragarh Local (6.60 cm) followed by Poona Red (6.05 cm), Agrifound Light Red (5.75 cm) and lowest in Agrifound Dark Red (3.40 cm).

Mastanareddy and Sulikeri (1998) evaluated onion cultivars under Tungabhadra project area at Gangavati recorded the highest TSS in Arka Niketan (14.23%) and the lowest TSS was recorded in lowest in N-53 (11.14%).

Shanmugasundaram (1999a) studied on storability of onion genotypes for fifteen weeks under ambient conditions and observed that the minimum rotten bulbs was recorded in TA-1026 (21.75%), followed by TA-337 (24.41%) and maximum in AC-572 (95.0%).

Shanmugasundaram (2000a) reported that the maximum dry matter content of bulb was recorded in Red Creole (14.3%) followed by TA-1025 (13.75%) and the minimum dry matter was observed in California-606 (5.8%).

Mohanty and Prusti (2001a) noticed that the maximum bulb weight of 74.60 g was marked in cultivar Arka Kalyan followed by Arka Niketan (65.20 g). Whereas, minimum bulb weight was recorded in N-2-4-1(50.80 g).

Mohanty and Prusti (2001b) evaluated twelve onion varieties in black soils of Orissa. Among them Arka Niketan was the highest with a bulb weight of 75.11 g followed by Agrifound Light Red (73.55 g). While, Arka Pitamber had a lowest bulb weight of 44.44 g.

Mahantesh (2002) reported that the number of rings per bulb differed significantly among different varieties or hybrids in both irrigated and rainfed conditions evaluated in *Kharif* and *Rabi* seasons. Under irrigated conditions in the *Kharif* season, the variety Baswant-780 produced significantly the highest number of rings per bulb (10.50) and differed significantly with Arka Kalyan (9.35), Agrifound Light Red (9.16) and H-4 (9.08). The least number of rings per bulb was registered by Bellary Red (7.93). In case of *Rabi* season, Baswant-780 produced significantly the highest number of rings per bulb (11.18) and differed significantly with Arka Kalyan (10.13), Agrifound Light Red (10.11) and Arka Niketan (9.93), whereas the least number of rings per bulb was recorded in N-2-4-1 (8.95). However in rainfed conditions Baswant-780 (9.39), Arka Kalyan (9.08) and Agrifound Light Red were on par and recorded significantly the highest number of rings per bulb and Bellary Red produced the least number of rings per bulb (7.43).

Mohanty and Prusti (2002) noticed that bulb weight was higher in onion variety Arka Kalyan (76.94 g) closely followed by N-53 (73.55 g). Whereas, Pusa Red recorded the lower bulb weight (49.08 g).

Mahantesh *et al.* (2005) revealed that bulb weight was significantly higher in Baswant-780 (79.66 g and 73.33 g in *Kharif* and *Rabi* seasons, respectively), followed by Arka Kalyan (66.00 g in both *Kharif* and *Rabi* seasons, respectively). Whereas, lowest bulb weight was recorded in Bellary red (32.33 and 32.34 g in *Kharif* and *Rabi*, respectively).

Ananthan and Balakrishnamoorthy (2007) evaluated 12 genotypes of Bellary onion for both *Rabi* and *Kharif* season at TNAU, Coimbatore, the pooled mean analysis revealed that the maximum bulb shape index was recorded in genotype ACC.7 (1.293) which was on par with ACC.17 (1.280) followed by ACC.29 (1.057) and minimum bulb shape index was observed in ACC.12 (0.823).

Khar *et al.* (2007) reported that among the ten onion lines along with five checks. Accession no. 597 had recorded the highest polar diameter of bulb (4.83 cm) followed by accession No. 546 (4.70 cm) and lowest polar diameter of bulb registered in accession No. 654 (4.44 cm). Whereas, Accession No. 597 had recorded the highest equatorial diameter of bulb (5.66 cm) followed by Arka Niketan (5.52 cm) and lowest equatorial diameter of bulb registered in accession No. 651 (5.12 cm).

Dhotre (2009) evaluated *Kharif* onion and reported that the genotypes exhibited wider variability with a range from 0.86 to 1.19. The maximum bulb shape index was recorded in genotype Bidar Local (1.19), whereas minimum bulb shape index was observed in Kohinoor-9 (0.86)

Mahantesh *et al.* (2009) reported that maximum pooled mean bulb weight was recorded in onion variety Baswant-780 (68.33 g) followed by Arka Kalyan (60.66 g), whereas minimum mean bulb weight was recorded in Bellary Red (26.16 g).

Sharma (2009) evaluated five onion varieties and noticed the highest polar diameter of bulb in Baswant-780 (5.72 cm) and lowest polar diameter of bulb was observed in Arka Kalyan (4.88 cm). Similarly, maximum equatorial diameter of bulb in Baswant-780 (6.93 cm) followed by Agrifound Dark Red (6.71 cm) and lowest equatorial diameter of bulb recorded in Arka Niketan (6.00 cm).

Yadav *et al.* (2009) evaluated eight varieties of onion under Konkan agro-climatic conditions of Maharashtra and reported that maximum polar diameter of bulb was observed in Sindhurg Local (6.42 cm), followed by Phule Samarth (5.86 cm) and least in the variety Phule Swarna (5.10 cm). Whereas, the maximum equatorial diameter of bulb was registered in Sindhurg Local (6.23

cm), followed by N-2-4-1 (5.81 cm) and least marked in the variety Phule Swarna (4.72 cm).

Hosmani *et al.* (2010) observed maximum polar diameter of bulb in Arka Niketan (6.20 cm), which was found to be at par with PRO-6 (6.17) and RHR-O-SI (6.10 cm), whereas least polar diameter of bulb was observed in SEL-402 (3.23 cm). However, maximum equatorial diameter of bulb was noticed in SEL-283 (6.20 cm), which was followed by NRCWO-2 (5.57 cm) and Arka Niketan (5.03 cm), whereas lowest equatorial diameter of bulb observed in L-28 (3.27 cm).

Trivedi and Dhumal (2010) reported that among eighteen genotypes and four check cultivars evaluated during *Kharif* at NRC for Onion and Garlic, Pune. The genotype DPS-1029 produced the longest bulb length (6.74 cm) followed by Hy-3667 (6.35 cm), whereas NRCOG-567 produced shortest bulb length (4.15 cm). The cultivar Baswant-780 produced the highest equatorial diameter of bulb (6.26 cm) followed by NRCOG-588 (6.07 cm), whereas NRCOG-581 produced least equatorial diameter of bulb (4.60 cm).

Mallor *et al.* (2011) documented that accession BGHZ-0323 known as 'Liria' showed the lowest firmness value (3.0 Kg cm<sup>-2</sup>). Where, BGHZ-1132 known as 'Lagrimade Oro' was the firmest accession (9.0 Kg cm<sup>-2</sup>).

Gallina *et al.* (2012) observed the lowest pyruvate content in white onions with 6.5  $\mu$  moles per gram of fresh weight. Whereas, higher values (8.4-8.6  $\mu$  moles per gram of fresh weight) were observed in yellow and red onions.

### **2.3 Variability in onion for growth traits**

Mohanty (2001) observed the significant variation in plant height among 12 varieties of onion. The range was varied between 30.25 cm to 42.62 cm, recorded moderate GCV (14.96%) and low PCV (9.01%) with moderate genetic advance over percentage of mean (11.27%) and moderate heritability (36.20%) for the trait. The significant variation in onion for number of leaves per plant ranged between 7.30-16.90, PCV was high (24.06%), moderate GCV (19.00%) and moderate values of heritability (41.00%) associated with high genetic advance over percentage of mean (44.27%).

Prasad *et al.* (2005) recorded significant variation in plant height among 209 onion lines which were having high heritability (65.20%) associated with low genetic advance over percentage of mean (6.23%).

Golani *et al.* (2006) documented that, the significant difference in onion for plant height indicating existence of genetic difference among the 32 genotypes. It was ranged from 49.91 cm to 59.49 cm and recorded low GCV (3.96%) and PCV (7.90%), low heritability (25.50%) coupled with low genetic advance over percentage of mean (4.08%). Also observed significant differences for number of leaves per plant and noticed low heritability (8.00%) coupled with low genetic advance over percentage of mean (1.35%) for this trait.

Ananthan and Moorthy (2007) registered a wide range of variation in onion bulbs for neck thickness. However, moderate estimates of genotypic coefficient of variation (16.28%) and phenotypic coefficient of variation (16.40%) with high heritability (98.52%) coupled with low genetic advance over percentage of mean (0.27%) for this trait.

Haydar *et al.* (2007) observed that, plant height with the mean of 44.05 cm in onion and also recorded the high GCV (47.24%) and PCV (61.28%), high heritability (78.06%) with moderate genetic advance over percentage of mean (18.96%). A Significant differences among the 10 onion varieties for number of leaves per plant also noticed moderate GCV (10.63%) and PCV (15.63%), high heritability (66.78%) coupled with high genetic advance over percentage of mean (24.09%) for this trait.

Sendek *et al.* (2008) noticed wide variability in shallot for plant height with a range of 18.60 to 31.05 cm, moderate PCV (12.69%) and low GCV (8.05%), moderate heritability (40%), genetic advance (3.12%) with moderate genetic advance over percentage of mean (18.96%). A wide variability for number of leaves per plant ranged from 14.35 to 48.90, they also reported high PCV (27.33%) and moderate GCV (13.08%), high heritability (65.10%) coupled with high genetic advance over percentage of mean (21.09%) for this trait.

Dhotre (2009) reported lesser variation in plant height among 14 onion genotypes which ranged between (40.39 to 52.17 cm), low GCV (6.46%) and PCV (8.33%), high heritability (61.34%) coupled with low genetic advance over percentage of mean (6.25%). A wider variability in number of leaves ranged from 5.93 to 12.73, moderate GCV (11.46%) and PCV (15.28%) and moderate heritability (55.82%) coupled with moderate genetic advance over percentage of mean (17.64%).

Hosamani *et al.* (2010) recorded the significant difference for Plant height indicating existence of genetic difference among 21 onion genotypes, which ranged from 23.33 cm (Agrifound White) to 32.00 cm (PRO-6) with a mean of 27.70 cm. Low GCV (7.34%) and moderate PCV (10.69%), moderate heritability (49.09%) associated with moderate genetic advance over percentage of mean

(10.36%). Also observed the wide variability in onion for number of leaves per plant which was ranged from 5.00 to 8.33 with moderate GCV (13.37%) and high PCV (21.91%), moderate heritability (37.33%) and moderate genetic advance over percentage of mean (16.84%).

Singh *et al.* (2010) reported lesser variability in onion for number of leaves which ranged from 8.40 to 9.70, low PCV (5.73%) and GCV (3.41%), moderate heritability (35.53%) coupled with low genetic advance over percentage of mean (4.18%).

Ram *et al.* (2011a) observed that, all the varieties of onion showed significant differences for plant height, moderate GCV (11.57%) and PCV (12.00%) with high heritability (93.00%), genetic advance (11.38%) associated with high genetic advance over percentage of mean (22.99%). Besides they reported significant variation for the number of leaves per plant which ranged between 8.00 to 9.77, low GCV (4.70%) and PCV (6.50%) and high heritability (63.80%) associated with genetic advance (0.16%) coupled with moderate genetic advance over percentage of mean (11.85%).

Singh and Dubey (2011) registered lesser variability for plant height which ranged from 56.58 to 65.96 cm in onion. They also reported low GCV (3.24%) and PCV (3.87%), high heritability (70.00%) with low genetic advance over percentage of mean (5.58%). In addition lesser variability was observed for number of leaves which ranged from 2.26 to 8.50. Low genotypic (5.34%) and phenotypic (5.61%) coefficient of variations and high value of heritability (90.30%).

Abubakar and Ado (2013) noticed that in onion number of leaves per plant recorded higher genotypic variance (2.47%) than the environmental variance (2.37%).

Ashok and Netrapal (2013) documented that all the varieties of onion showed significant differences for the characters studied. The highest plant height was observed in Pusa Madhavi (54.8 cm), highly significant differences in values indicated great amount of variation among the treatments. A large amount of variation existed in the varieties/ lines revealed considerable improvement can be made in this crop.

Shree *et al.* (2014) indicated that in garlic germplasms differed significantly for the different morphological attributes. Collar thickness ranged from 12.21 cm (COLL 652) to 18.31 cm (Sel-397) among the tested lines. However, parity was recorded among NRCRO-4, VG-18, Syn-06, Soyol-2009 and RO-252.

## 2.4 Variability in onion for bulb yield and quality traits

Patil (1997) revealed that in onion polar and equatorial diameter ranged between 3.99 to 6.46 cm with a mean of 6.08 cm, while GCV (6.32%) and PCV (12.34%) was low to moderate and high heritability (65.2%) associated with moderate genetic advance over percentage of mean (13.56%) for this trait and also reported that, the TSS range varies between 9.50 to 17.6 ° brix in onion. Genotypic (12.04%) and phenotypic (13.89%) coefficients of variation were observed to be moderate for TSS with higher heritability (75.10%) and genetic advance (2.68%).

Mohanty (2001) concluded that, in onion variability for polar diameter ranged between 4.55-6.47 cm, with Low GCV (7.91%) and moderate PCV (10.66%), moderate heritability (55.1%) coupled with moderate genetic advance over percentage of mean (12.05%).

Golani *et al.* (2006) reported the range of TSS in onion from 12.60 to 16.02 °brix, genotypic (4.62%) and phenotypic (9.92%) coefficient of variation were low with high heritability (74.2%) associated with low genetic advance over percentage of mean (4.43%).

Ananthan and Moorthy (2007) recorded moderate genotypic coefficient of variation (11.92%) and phenotypic coefficient of variation (12.02%) with high heritability (98.40%) coupled with high genetic advance over percentage of mean (24.37%) for total soluble solids in onion.

Haydar *et al.* (2007) reported significant variation among 10 onion varieties and they observed high genotypic (142.41%) and phenotypic coefficient of variation (291.32%) associated with moderate heritability (48.88%) for average bulb weight.

Dhotre (2009) reported significant variation for polar and equatorial diameter in onion and it ranged between 38.20 to 47.80 mm. While, low GCV (8.49%) and PCV (9.38%), high heritability (80.88%) associated with moderate genetic advance over percentage of mean (15.74%) for diameter of bulb. Besides, they observed a wide range of TSS in onion which varied from 10.40°brix to 18.7 °brix and moderate genotypic coefficient of variation (14.87%) and phenotypic coefficient of variation (16.45%), high heritability (82.28%) coupled with high genetic advance over percentage of mean (23.68%).

Sendek *et al.* (2008) reported wide variability in shallot for total soluble solids which ranged from 9.90 to 16.30 ° brix, with moderate PCV (10.94%), low GCV (6.70%) and moderate heritability (37.5%).

Hosamani *et al.* (2010) noticed significant variation among 21 onion genotypes for polar diameter and it ranged from 3.33 to 6.20 cm with a mean of 4.53 cm. The estimate of GCV (14.38%) and PCV (19.07%) were moderate. Heritability was moderate (57.33%) coupled with high genetic advance over percentage of mean (22.30%).

Singh *et al.* (2010) reported the wide range of variability in onion for marketable yield which ranged from 239.33 to 338.49 q/ha, moderate magnitude of genotypic coefficient of variation (10.18%) coupled with high heritability (80.49%) and high genetic advance over percentage of mean (23.88 %).

Bharti *et al.* (2011) observed average bulb weight of onion ranged from 81.33 to 128.44 g with a mean of 97.31 g, moderate GCV (11.57%) and PCV (14.27%) have high heritability (65.7%) coupled with moderate genetic advance over percentage of mean (19.32%).

Ram *et al.* (2011b) recorded that, in onion, bulb diameter was ranged from 4.84 to 6.12 cm. An estimate of GCV (5.65%) and PCV (8.32%) were low. However, heritability was moderate (46.2%) with low genetic advance over percentage of mean (7.85%).

Singh and Dubey (2011) observed less variability in onion for diameter of bulb which ranged from 5.14 to 5.62 cm with the mean of 5.37 cm. An estimate of GCV (1.56%) and PCV (2.94%) were low. However, heritability was low (28.20%) with low genetic advance over percentage of mean (1.67%).

Chattopadhyay *et al.* (2013) reported the low GCV (8.38%) and moderate PCV (16.91%) values for polar and equatorial bulb diameter in onion. Low heritability (24.58%) associated with high genetic advance over percentage of mean for all the traits except polar diameter (8.56%) of bulb was indicative of additive gene action and also reported that, wide range of variability in onion for marketable yield ranged from 6.77 to 11.85 q ha<sup>-1</sup>. Moderate GCV (16.78%) and PCV (17.18%), high heritability (95.39%) with high genetic advance over percentage of mean (33.76%) were observed.

## **2.5 Storage behavior and keeping quality of bulbs.**

Singh *et al.* (1992) reported that after four months of storage, the cultivar Hisar-2 exhibited minimum sprouting (23.20%). However, it did not differ significantly from Arka Nikethan, Pusa White Round and Pusa Red. The maximum sprouting was observed in VL-3 (51.20%) followed by VL-1 (46.59%). It might be due to low TSS content in these cultivars.

Satodiya and Singh (1993) recorded that after four months of storage, the percentage of sprouted bulbs was significantly lowest in Hisar-2 (3.45%). Whereas, it was highest in Lalpur-2 (24.93%). The extent of sprouting was influenced markedly by climatic conditions and duration of storage.

Somkumar *et al.* (1997) studied on storability of onion cultivars under ambient temperature and reported that after six months of storage the lowest rotten bulbs (8.0%) was recorded in Arka Bindu followed by H-4 (14.67%). Whereas, highest rotten bulbs was noticed in N-53 (38.30%).

Shanmugasundaram (1999a) investigated the storability of onion genotypes for fifteen weeks under ambient conditions and reported that the minimum rotten bulbs was observed in TA-1026 (21.75%) followed by TA-337 (24.41%) and maximum in AC-572 (95.0%).

Shanmugasundaram (2000a) studied on storability of onion genotypes for fifteen weeks under ambient conditions and reported that the minimum storage loss was recorded in Red Creole (22.50%) followed by H-675 (27.50%). Whereas, storage loss in weight was maximum in California-606 (95.80%).

Shanmugasundaram (2003a) conducted studies on storability of onion lines for fifteen weeks under ambient conditions and reported that the minimum storage loss was recorded in ST(R)-D-A-C (8.10%) followed by ST (E)-B-Y (20.50%). Whereas, storage loss in weight was maximum in California-606 (68.10%).

Trivedi and Dhumal (2010) reported that among the eighteen onion genotypes and four varieties evaluated for storage at NRCOG, Pune. The variety N-2-4-1 had showed the lowest storage loss (21.96%) followed by NRCOG 574 (23.09%). While, DPS-1029 had registered the highest storage loss in weight (39.25%).

Jamali *et al.* (2012) studied the storability of onion bulbs. The experimental results revealed that the physiological weight loss after 60 days of storage was 7.74%, 8.86% and 10.89% in Nusarpuri, Phulkara and Indian white bulb, respectively.

## **2.6 Screening for Purple blotch disease and Thrips**

### **2.6.1 Screening for purple blotch disease incidence (*Alternaria porri*)**

Sandhu *et al.* (1981) tested 49 lines over two years by inoculation with *Alternaria porri* in the field. The varieties Red Creole, 33-2, New-selection and VL 167 proved to be moderately resistant.

Bhangale and Joi (1985) screened 74 cultivars of onion against purple blotch disease under field conditions but no cultivar was found resistant.

Gupta and Pathak (1988) screened twenty one indigenous and exotic cultivars at two locations in India under artificial inoculations. All the exotic lines except two from Sudan were highly resistant to *Alternaria porri*. While, all the indigenous lines were found susceptible.

Dhiman *et al.* (1986) evaluated eighteen genotypes of onion against infestation of purple blotch disease under natural conditions, but no genotypes were found resistant. Whereas, two genotypes VL-1 and Sel-2-4-1 were found moderately resistant (5-15 % disease intensity) and three genotypes were found highly susceptible.

Pathak *et al.* (1986) evaluated thirty six lines of onion against purple blotch, in order to locate the source of resistance to disease. Only one line IHR-56 was found resistant. While, five lines were moderately resistant.

Sharma (1997) tested 94 genotypes of onion for their performance against the purple blotch. The lines IC39178 and IC49371 were resistant and Agrifound Dark Red, Red Globe, IC33671, IC43130, IC48001 and IC48045 were found to be moderately resistant.

Sindhu *et al.* (1994) reported that Punjab Naroya a new red skinned onion variety was less susceptible to purple blotch than Punjab Red Round and Punjab Selection.

Sharma and Sain (2003) observed that a newly developed Ro-1 onion cultivar copper red in colour for cultivation under the agro climatic zone of Rajasthan, India. Exhibited high bulb yield and resistance to purple blotch (*Alternaria porri*).

Mathur *et al.* (2006) conducted three *Rabi* season trails and showed that out of thirty land races, half of them *viz.*, Ro-15, Ro-17, Ro-18, Ro-22, Ro-26, Ro-27, Ro-28, Ro-30, Ro-32, Ro-33, Ro-34, Ro-35, Ro-37, Ro-38 and Ro-39 were found resistant (PDI < 10 %) to *Alternaria porri*. Land races Ro-18, Ro-22, Ro-26, Ro-30, Ro-32 and Ro-34 were resistant to *Alternaria porri* with significant increase in bulb yields over the check while Ro-19 and Ro-25 were moderately resistant to *Alternaria porri*.

Upmanyu and Sharma (2007) evaluated eight genotypes of red onion against purple blotch disease to locate the source of resistance to the disease. All the eight genotypes of onion were susceptible with disease severity ranging between 18.4 and 52.5 per cent. Among those genotype-409 exhibited minimum (18.4%) disease severity and genotype-432 exhibited maximum (52.5%) and remaining genotypes exhibited intermediate values of apparent infection rate.

Kumari *et al.* (2011) screened three hundred and ten onion genotypes against purple blotch during *Kharif* season and reported that none of them were found resistant or immune. While, four genotypes *viz.*, Arka Kalyan (AK)-171, AK-172, AK-173 and MSPBR-120 were found to be moderately resistant with grade scale of 2. The per cent leaf area infected ranged from 11 to 20 Per cent. Out of total genotypes, 132 genotypes were grouped in moderately susceptible group and the grade scale was 3 with 21-40 per cent leaf area infection and 120 genotypes were found susceptible and remaining 54 genotypes were highly susceptible whereas check cultivar Arka Niketan (A.N-177) also fall under this group.

The distribution analysis for qualitative characters showed maximum number of classes for bulb skin colour and shape of mature dry bulbs. In bulb colour, dark brown was predominant with 29.00 per cent share and 37.00 per cent of total accessions fall in broad elliptic bulb shape. The green foliage colour was observed in 42.00 per cent, medium density of leaves 63.00 per cent, erect leaf habit in 71.00 per cent, flat cross-section in 46.00 per cent, medium degree of leaf waxiness in 71.00 per cent, bulb (single) as a storage organ in 54.00 per cent and black seed coat colour in 80.00 per cent of total accessions (Khosla *et al.*, 2013).

### **2.6.2 Screening for onion thrips damage (*Thrips tabaci*)**

Bhangale and Joi (1985) screened seventy four cultivars of onion against thrips, under field conditions and no cultivar was found to be resistant.

Alimousavi *et al.* (2007) evaluated fifteen Iranian onion genotypes for onion thrips "Meshkan", "Sefid- e- Kurdistan", "Sefid- e-Qom" and "Eghlid" had the lowest thrips infestation and percentage of leaf infestation and ascertained the genotypes with glossy foliage were resistant and genotypes with non-glossy foliage were found susceptible to thrips.

John Diaz-Montano *et al.* (2010) reported that among twenty two cultivars, fourteen cultivars had damage ratings between 3.4 and 4.4 with 30 and 43 per cent of their leaf tissue damaged by *T. tabaci*. The cultivar OOLYS05N5O had the lowest damage (less than 10% leaf damage) and was significantly less

damaged than many of the popular commercial cultivars (e.g., Infinity, Red Wing, Nebula, Red Bull and Red Beauty).

Anon. (2011a) reported that based on the damage occurred due to thrips feeding, injury rating and curling was given on 0 to 5 scale. Out of twenty one lines, only EL-650 was found resistant to thrips. Whereas, seventeen lines *viz.*, 1172, EL-1044, EL-546, N-2-4-1, 720, EL-595, 780-5-3-LR, EL- 654, NRCOG-1133, Pillipatti Junagadh, NRCOG-1168, Red Elite Composite, EL-670, Bhima Shakti, 1218, Bhima Kiran and EL-651 were found moderately resistant and 3 lines *viz.*, EL-592, MS 65 B and RGO-53 fall under susceptible category.

Anon. (2011b) revealed that, ten yellow lines were screened against thrips under field conditions and plant thrips index was worked out. In two lines *viz.*, Y-067 and Y-017 PTI value was recorded less than 25 per cent. While in four lines it was more than 40 per cent. PTI values among yellow lines varied from 20 to 58 per cent. Whereas, in check Arka Pitamber it was 52 per cent.

Anon. (2011c) observed that, white onion germplasm along with checks were screened against thrips in two replication during *Rabi* season on the basis of foliar damage symptoms scored on 0 to 5 scale. Plant Thrips Index (PTI) was calculated and out of eighty six lines screened, six lines *viz.*, W-103/M-3, W-294/M-2, W-316/M-2, W-417/EI-3, W-220 and W-361/M-1 noted less than 25% PTI whereas, among these lines PTI ranged from 18 to 52 per cent. However, seventeen lines had PTI values more than 40 per cent. In white checks PTI ranged from 30 to 46.70 per cent.

# *Material and Methods*

### **III. MATERIAL AND METHODS**

The experiment entitled “Studies on performance of varieties, F<sub>1</sub> hybrids and synthetics of onion (*Allium cepa* L.) in Eastern Dry Zone of Karnataka” was carried out during *Kharif* and *Rabi* seasons of 2015-16 at College of Horticulture, Kolar, Karnataka. The details of material and methods adopted during the course of study have been described here under.

#### **3.1 Geographical location and weather condition**

The site of experimental plot lies at 78° 10' 32.59" East longitude and 13° 08' 00.52" North latitude with an altitude of 752.15 m above mean sea level. The weather parameters prevailed during cropping period were recorded and presented in Appendix-I. During *Kharif* season, the mean maximum and minimum temperatures were 30.68 °C and 17.56 °C, respectively. The mean relative humidity in the morning and evening were 85.96 and 65.25 per cent, respectively. A total rainfall of 100.83 mm was received in 8.6 rainy days. In *Rabi* season, the mean maximum and minimum temperatures were 31.20 °C and 13.76 °C, the mean relative humidity in the morning and evening were 84.94 and 55.81 per cent with the total rainfall of 90.46 mm with total number of 6.67 rainy days.

#### **3.2 Soil of the experimental site**

Levelled land having red loam sandy soil with uniform fertility was selected for the experiment.

#### **3.3 Details of the experiment**

The experiment entitled “Studies on performance of varieties, F<sub>1</sub> hybrids and synthetics of onion (*Allium cepa* L.) in Eastern Dry Zone of Karnataka” was carried out during 2015-16 under irrigated condition.

##### **3.3.1 Design and layout**

The experiment was laid out in Randomized Complete Block Design (RCBD) with two replications. The plan and layout of the experimental plot has been furnished in

Fig. 1. General view of experimental plot in *Kharif* and *Rabi* season is shown in plate 1a and plate 1b, respectively.

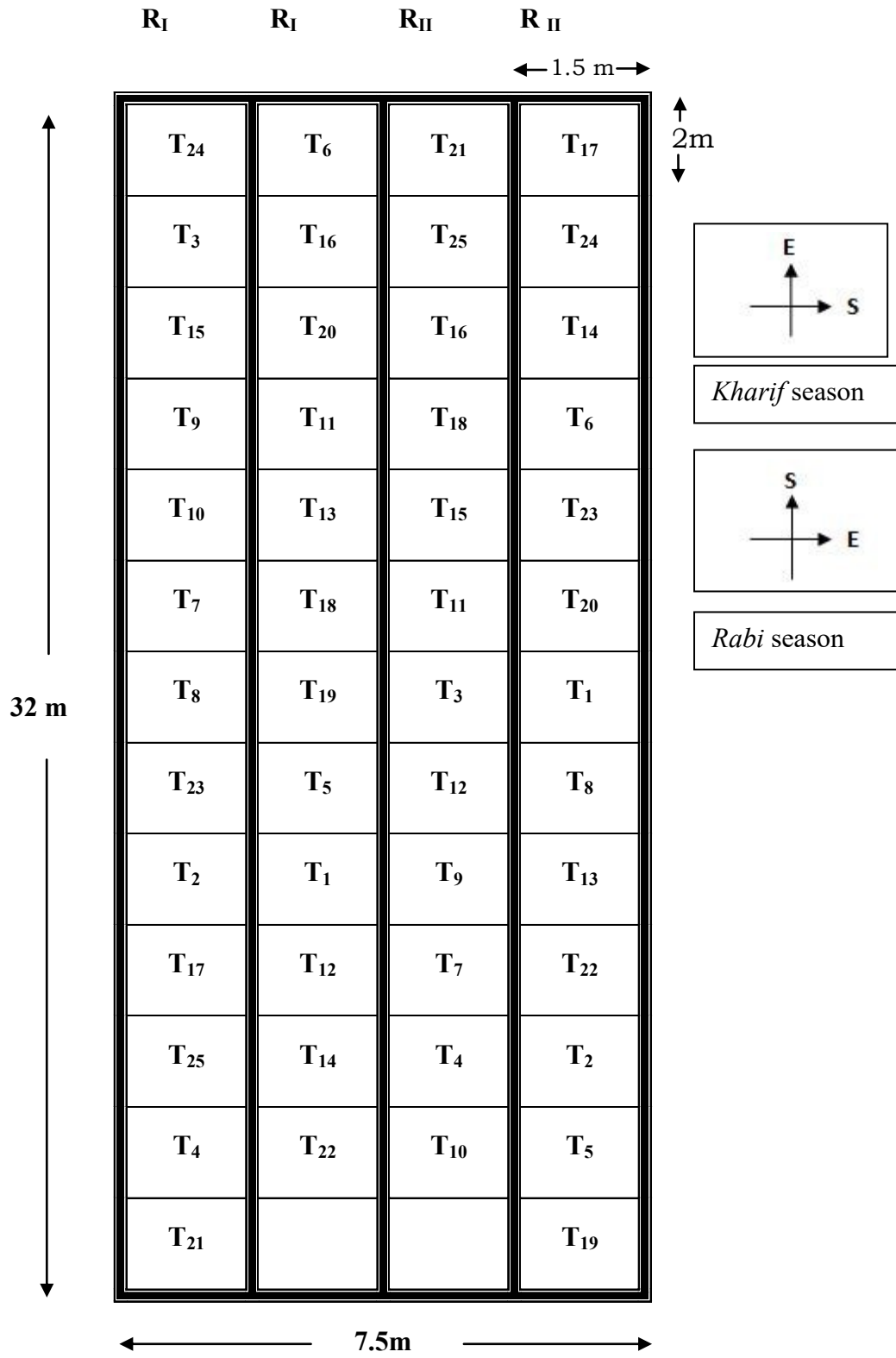
Design : RCBD (Randomized Complete Block Design)  
Treatments (genotypes) : 25  
No. of Replications : 2  
Plot size : 2.0 m x 1.5 m  
Spacing : 15 cm x 10 cm  
Season : *Kharif*-2015 and *Rabi*-2016

### **3.3.2 Treatment details**

The experiment was conducted using twenty five genotypes (13 varieties, 10 hybrids and 2 synthetics) as treatments collected from various sources. The genotypes and their source of collections are furnished in Table 1. Onion genotypes evaluated during *kharif* and *rabi* season were shown in plate 2a, plate 2b and plate 2c.

### **3.4 Raising of nursery**

Onion seedlings were raised under poly house by using pro-trays. The seeds were sown in protrays filled with coir pith in the third week of June 2015 for *Kharif* crop and first week of November 2015 for *Rabi* crop. After sowing Pro-trays were staked one over the other and drenched with carbendazim at 2 gram per litre at every ten days interval and the seedlings watered regularly in the morning and weeding was done in protrays as and when required. The seedlings were managed scientifically up to six weeks till they were ready for transplanting.



**Fig. 1: Plan and layout of experimental site**



**Plate 1a. General view of experimental plot in *Kharif* season**



**Plate 1b. General view of experimental plot in *Rabi* season**

**Table 1: Different onion genotypes used in the experiment and their sources of collection**

| Sl. No.                      | Genotypes            | Source                                    |
|------------------------------|----------------------|---|
| <b>Varieties</b>             |                      |   |
| 1                            | Arka Pragathi        | IIHR, Hesaraghatta Bengaluru              |
| 2                            | Arka Kalyan          | IIHR, Hesaraghatta Bengaluru              |
| 3                            | Arka Bindu           | IIHR, Hesaraghatta Bengaluru              |
| 4                            | Arka Niketan         | IIHR, Hesaraghatta Bengaluru              |
| 5                            | Nasik Red            | Solar seeds                               |
| 6                            | Rampur Local         | Challakere (Chitradurga District)         |
| 7                            | Bellary Red          | Bellary District                          |
| 8                            | Sataragarvha (check) | Local farmer (Chitradurga District)       |
| 9                            | Poona Furusungi      | Solar seeds                               |
| 10                           | Agrifound Light Red  | NHRDF, Nasik, Maharashtra                 |
| 11                           | S-780                | Solar seeds                               |
| 12                           | Light Red            | Solar seeds                               |
| 13                           | Prema-178            | East –West seeds, Bengaluru               |
| <b>F<sub>1</sub> Hybrids</b> |                      |   |
| 14                           | Arka Kirthiman       | IIHR, Hesaraghatta Bengaluru              |
| 15                           | Arka Lalima          | IIHR, Hesaraghatta Bengaluru              |
| 16                           | Super Flare          | Bheejo Sheethal seeds, Aurangabad         |
| 17                           | Lucifer              | Bheejo Sheethal seeds, Aurangabad         |
| 18                           | BSS-827              | Bheejo Sheethal seeds, Aurangabad         |
| 19                           | Suvarna              | Khalash Bheejo sheethal seeds, Aurangabad |
| 20                           | Samruddhi            | Khalash Bheejo sheethal seeds, Aurangabad |
| 21                           | Sudharshan           | Khalash Bheejo sheethal seeds, Aurangabad |
| 22                           | Super Red            | East –West seeds, Bengaluru               |
| 23                           | Flare                | Khalash Bheejo Sheethal seeds, Aurangabad |
| <b>Synthetics</b>            |                      |   |
| 24                           | Arka Bheem           | IIHR, Hesaraghatta Bengaluru              |
| 25                           | Marshall             | INDAM, Bengaluru                          |



Plate 2a. Onion genotypes evaluated during *Kharif* and *Rabi* season



**Plate 2b. Onion genotypes evaluated during *Kharif* and *Rabi* season**



**Plate 2c. Onion genotypes evaluated during *Kharif* and *Rabi* season**

## **3.5 Cultural practices**

### **3.5.1 Land preparation**

The main field was thoroughly ploughed and leaving the land fallow during summer season. The stubbles were removed and the clods were crushed.

The soil was harrowed twice to bring it into fine tilth. Recommended quantity of Farm Yard Manure was applied to the experimental site at the rate of 25 tonnes per hectare and thoroughly mixed with soil. Then the land was laid out into subplots of size 2.0 m x 1.5 m with total 50 plots were prepared as shown in Fig. 1.

A recommended dose of fertilisers 125:75:125 kg ha<sup>-1</sup> NPK was applied. Half dose of nitrogen and full dose of phosphorous and potassium were applied at the time of transplanting as basal dose and remaining 50 per cent of nitrogen was applied at 30 days after transplanting as top-dressing.

### **3.5.2 Transplanting**

The seedlings of all the cultivars were transplanted on 3<sup>rd</sup> September 2015 for *Kharif* crop and 31<sup>st</sup> December 2015 for *Rabi* crop. For transplanting, seedlings were uprooted genotype-wise separately and immediately transplanted in the main field in plots at row of spacing of 15 cm with plant spacing of 10 cm within each row in irrigated plots.

### **3.5.3 Irrigation and weeding**

The plots were irrigated at 10 days interval depending upon soil and climatic conditions. The experimental plots were kept free from weeds by hand weeding once in 15 days interval during cropping period.

### **3.5.4 Plant protection measures**

The crop was sprayed with mixture of spray solution containing Phosphomidon (0.25%) and Mancozeb (0.25%) first week after transplanting. The second spray was given using Dimethoate (0.18%) and Mancozeb (0.25%) twelve weeks after transplanting. The third spray was given using Imidacloprid (0.30%) and Mancozeb (0.25%) at ten days after the second spray as a prophylactic measures to manage thrips and purple blotch disease.

### **3.6 Harvesting**

The bulbs were harvested at proper maturity stage separately for each treatment. The plants were uprooted from the individual plot and then dried under shade for curing of the bulbs.

### **3.7 Biometric observations**

The following biometrical observations were recorded during the course of investigation.

#### **3.7.1 Morphological characters**

For recording growth parameters five randomly selected plants from each treatment were identified.

##### **3.7.1.1 Plant height (cm)**

The maximum plant height was measured from the ground to the tip of longest leaf at 30, 60 and 90 days after transplanting. The mean of the five plants in a treatment was worked out.

##### **3.7.1.2 Number of leaves per plant**

The number of fully grown, green and functional leaves were recorded from five randomly selected plants at 30, 60 and 90 days after transplanting and average number of leaves per plant was calculated.

##### **3.7.1.3 Leaf length (cm)**

The maximum leaf length was measured from the attachment of leaf base to stem to the tip of longest leaf at 30, 60 and 90 days after transplanting. The mean of the ten plants in a treatment was worked out.

##### **3.7.1.4 Leaf width (cm)**

The leaf width was measured in middle of leaf where leaf shown maximum width, the point at which measured with vernier calipers.

##### **3.7.1.5 Collar thickness at harvest (cm)**

The collar thickness at harvest was measured using vernier calipers and the measurement was made in centimetre below the joint of leaf lamina. The observations recorded on five plants and were averaged to get mean value.

### **3.7.1.6 Neck thickness after curing (cm)**

The neck thickness after curing was measured from vernier calipers and the measurement was made in centimetre below the joint of leaf lamina. The observations recorded on five plants and were averaged to get mean value.

### **3.7.1.7 Plant establishment (%)**

The population of plants at 30 days of transplanting in each plot was taken into count and observations were recorded.

$$\text{Plant establishment} = \frac{\text{Total number of plants survived}}{\text{Total number of seedlings transplanted}} \times 100$$

### **3.7.1.8 Bolting (%)**

Before harvesting the crop, the number of plants which were bolted in each plot was counted and bolting percentage was worked out.

$$\text{Bolting per cent} = \frac{\text{Number of bolting plants}}{\text{Total number of plants}} \times 100$$

### **3.7.1.8 Duration of crop (days)**

The days taken by individual genotypes from the date of transplanting to attain harvest maturity was recorded.

## **3.7.2 Quality traits**

### **3.7.2.1 Number of centres per bulb**

Bulb hearting or centres recorded by visual observation of cross sectioned onion after harvesting the individual genotypes.

### **3.7.2.2 Number of rings per bulb**

The number of complete fleshy rings encircling the growing centre(s) was recorded in five bulbs. For this purpose, all the five bulbs were cut completely across the bulb length at the equatorial region with the help of sharp knife. The mean number of rings per bulb was counted.

### 3.7.2.3 Total soluble solids (TSS %)

The juice of fresh onion bulb was obtained by a cork borer by introducing up to the middle of the bulb at its horizontal position (Mc Collum, 1963 and Nieuwhof *et al.*, 1973) and the total soluble solids in percentage value were observed with the help of digital refractometer (0-30). The average was calculated from five bulbs studied.

### 3.7.2.4 Pungency (Pyruvic acid content $\mu$ moles/gram FW)

Pungency develops when allinase enzyme which interacts with precursors collectively known as S-alkyl cystine sulfoxide, after cutting or crushing of onion tissue. The pungency was estimated in terms of enzymatically formed pyruvic acid (which appears when tissue is disrupted) following the method developed by Ketter and Randle (1998). This is simplified method over the original method of Schwimmer and Wetson (1961).

### 3.7.2.5 Dry matter content (%)

A hundred grams of fresh slices of bulb (excluding outer skin) was weighed and dried in hot air oven at 65<sup>0</sup>C for 72 hours to get consistent dry weight. The per cent dry matter was calculated by using the following formula.

$$\text{Dry matter content} = \frac{\text{Oven dry weight}}{\text{Fresh weight}} \times 100$$

### 3.7.2.6 Firmness of bulb (kg/cm<sup>2</sup>)

The firmness of the bulb was determined by using a pocket penetrometer.

### 3.7.2.7 Split bulbs (%)

Among the harvested bulbs from each genotype, the bulbs having splits or doubles were counted and percentage of split bulbs was calculated.

$$\text{Split bulbs (\%)} = \frac{\text{Number of split bulbs}}{\text{Total number of bulbs}} \times 100$$

### **3.7.3 Yield traits**

#### **3.7.3.1 Polar diameter of bulb (cm)**

The length between two polar ends was measured with the help of Vernier callipers. The mean length of bulb was calculated in centimetre.

#### **3.7.3.2 Equatorial diameter of bulb (cm)**

The equatorial diameter of bulb at the middle of polar length was documented with the help of Vernier callipers and the mean was calculated centimetre.

#### **3.7.3.3 Average bulb weight (g)**

Ten competitive bulbs were weighed individually using an electronic balance and then mean values were calculated.

#### **3.7.3.4 Average ten bulb weight (g)**

Ten randomly selected bulbs were weighed on an electronic balance.

#### **3.7.3.5 Bulb yield per plot (kg)**

Total bulb yield obtained from the plot was used to calculate the yield of the bulbs in kilograms per plot.

#### **3.7.3.6 Total bulb yield (t/ha)**

Total bulb yield obtained from each plot was used to calculate the yield in tonnes per hectare using formula.

$$\text{Total bulb yield (t/ha)} = \frac{\text{Area of 1 ha X Bulb yield (kg/plot)}}{\text{Plot size X 1000}} \times 100$$

### 3.7.3.7 Marketable bulb yield (t/ha)

Out of total yield good bulbs with uniform size were separated and considered as 'marketable bulbs'. The marketable bulb yield obtained from plot was used to calculate marketable bulb yield in tonnes per hectare.

$$\text{Marketable bulb yield (t/ha)} = \frac{\text{Area of 1 ha X Marketable bulb yield (kg/ plot)}}{\text{Plot size X 1000}} \times 100$$

### 3.7.3.8 Unmarketable bulb Yield (t/ha)

Of total yield good bulbs with smaller size of less than 3 cm were separated and considered as 'unmarketable bulbs'. The unmarketable bulb yield obtained from each plot was used to calculate unmarketable bulb yield in tonnes per hectare.

$$\text{Unmarketable bulb yield (t/ha)} = \frac{\text{Area of 1 ha X Unmarketable bulb yield (kg/plot)}}{\text{Plot size X 1000}} \times 100$$

## 3.7.4 Storage behaviour and keeping quality of bulbs

### 3.7.4.1 Sprouted bulbs (%)

The percentage of sprouted bulbs was calculated by counting the number of sprouted bulbs in three months storage period in different treatments and expressed in terms of percentage by using following formulae.

$$\text{Per cent of sprouted bulbs} = \frac{\text{Number of sprouted bulbs}}{\text{Total number of bulbs}} \times 100$$

### **3.7.4.2 Rotten bulbs (%)**

The percentage of rotten bulbs was calculated by counting the number of rotten bulbs in three months storage period in different treatments and expressed in terms of percentage by using following formulae.

$$\text{Per cent of rotten bulbs} = \frac{\text{Number of rotten bulbs}}{\text{Total number of bulbs}} \times 100$$

### **3.7.4.3 Physiological loss in weight [PLW (%)]**

The physiological loss in weight was obtained by taking difference between the weight of bulbs prior to storage and weight after storage taken every 30 days intervals for three months. The per cent reduction in the initial weight was computed by using following formulae.

$$\text{PLW (\%)} = \frac{\text{Initial weight of bulbs} - \text{Final weight of bulbs}}{\text{Initial weight of bulbs}} \times 100$$

### **3.7.4.4. Black molds infected bulbs (%)**

The percentage of black molds affected bulbs were calculated by counting the number of black molds affected bulbs in three months storage period in different treatments and expressed in terms of percentage by using following formulae.

$$\text{Black molds affected bulbs} = \frac{\text{Number of black molds affected bulbs}}{\text{Total number of bulbs}} \times 100$$

### **3.7.5 Field screening of different genotypes of onion for Purple blotch disease and Thrips**

Individual genotypes was raised in separate plots. The infestation of thrips and purple blotch were recorded under natural epiphytic condition. The minimum plant protection measures were taken during cropping period.

### 3.7.5.1 Screening of different genotypes of onion against purple blotch disease (*Alternaria porri*)

For recording the Per cent Disease Index (PDI) a “0-5” scale rating technique was adopted, where 0= No disease and 5= More than 60 per cent leaf area covered by the disease symptoms. The PDI was calculated as given by Dhiman *et al.* (1986).

$$\text{Plant Disease Index (\%)} = \frac{\text{Sum of all class ratings}}{n \times 5} \times 100$$

Where, n = Number of leaves examined and 5 = Maximum class ratings in the scale.

Leaves of different genotypes were placed in different categories of resistance and susceptibility as follows on the basis of score method.

|               |          |                                     |
|---------------|----------|-------------------------------------|
| <b>Scale:</b> | 0 = (I)  | Immune                              |
|               | 1 = (R)  | Resistant (1-10%)                   |
|               | 2 = (MR) | Moderately Resistant (11-20%)       |
|               | 3 = (MS) | Moderately Susceptible (21-40%)     |
|               | 4 = (S)  | Susceptible (41-60%)                |
|               | 5 = (HS) | Highly Susceptible (61% and above). |

### 3.7.5.1 Screening of different genotypes of onion against thrips (*Thrips tabaci*)

For recording the Plant Thrips Index (PTI) a 0-5 scale rating technique was used based on the damage occurred due to thrips feeding, injury rating and curling. The PTI was given by Bhangale and Joi (1985).

The cultivars were placed in different categories of resistance and susceptibility as follows on the basis of score method.

$$\text{Plant Thrips Index (\%)} = \frac{\text{Sum of grade numbers}}{\text{No. of plants examined} \times \text{No. of grades}} \times 100$$

|               |          |                                     |
|---------------|----------|-------------------------------------|
| <b>Scale:</b> | 0 = (I)  | Immune                              |
|               | 1 = (R)  | Resistant (1-10%)                   |
|               | 2 = (MR) | Moderately Resistant (11-20%)       |
|               | 3 = (MS) | Moderately Susceptible (21-40%)     |
|               | 4 = (S)  | Susceptible (41-60%)                |
|               | 5 = (HS) | Highly Susceptible (61% and above). |

## 3.8 Statistical analysis of data

### 3.8.1 Mean, range and variance

The mean, range and variance values of each character were calculated for each genotype.

$$\text{Mean} = \frac{\text{Sum of observations of all plants}}{\text{No. of plants}} \times 100$$

Range = The minimum and maximum values for each trait

$$\text{Variance} = \frac{1}{(n-1)} [\sum (X_i - \bar{X})^2]$$

Where,

$X_i$  = Individual value

$\bar{X}$  = Population mean

n = Number of observations

### 3.8.2 Estimation of genetic parameters

In order to identify and ascertain the genetic variability among genotypes and to assess the extent of environmental effect on various characters, different genetic parameters were estimated by using formulae as given below.

#### 3.8.2.1 Genotypic and phenotypic variance

These were calculated according to the formula given by Chaudhary and Prasad (1968).

$$\text{Genotypic variance } (\sigma_g^2) = \frac{\text{MSS (treatment)} - \text{MSS (error)}}{\text{No. of replications}} \times 100$$

$$\text{Phenotypic variance } (\sigma_p^2) = \sigma_g^2 + \text{MSS (error)}$$

### 3.8.2.2 Phenotypic and genotypic coefficient of variation

The coefficient of variation both at phenotypic and genotypic levels for all the characters were computed by applying the formula as suggested by Burton and Devane (1953).

$$\text{Genotypic coefficient of variation (GCV)} = \frac{\sigma_g}{\bar{X}} \times 100$$

$$\text{Phenotypic coefficient of variation (PCV)} = \frac{\sigma_p}{\bar{X}} \times 100$$

Where,

$\bar{X}$  = Grand mean of the character

$\sigma_p$  = Phenotypic standard deviation

$\sigma_g$  = Genotypic standard deviation

PCV and GCV were classified into low, moderate and high as suggested by Shivasubramanian and Menon (1973)

#### Scale:

|                         |   |          |
|-------------------------|---|----------|
| 0 – 10 per cent         | : | Low      |
| 10.1 – 20 per cent      | : | Moderate |
| 20.1 per cent and above | : | High     |

### 3.8.2.3 Heritability ( $h^2$ ) in broad sense

Heritability in broad sense for all the characters was computed by the formula suggested by Hanson *et al.* (1956).

$$\text{Heritability in broad sense} = \frac{\sigma_g^2}{\sigma_p^2} \times 100$$

Where,

$h^2_{bs}$  = heritability (broad sense)

$\sigma_g^2$  = genotypic variance

$\sigma_p^2$  = phenotypic variance

Heritability was classified into low, moderate and high as suggested by Robinson *et al.* (1949).

#### Scale:

|                         |   |          |
|-------------------------|---|----------|
| 0 - 30 per cent         | : | Low      |
| 30.1 - 60 per cent      | : | Moderate |
| 60.1 per cent and above | : | High     |

### 3.8.2.4 Genetic Advance (GA)

The predicted genetic advance was estimated according to the formula given by Johnson and Robinson (1955).

$$GA = h_{bs}^2 \times K \times \sigma p$$

Where,

$h_{bs}^2$  = Heritability in broad sense

K = Selection differential at given intensity

$\sigma p$  = Phenotypic standard deviation

### 3.8.2.5 Genetic advance as per cent mean (GAM)

This was calculated using the formula given below.

$$GAM = \frac{GA}{\bar{X}} \times 100$$

Where,

GA = Genetic advance,

$\bar{X}$  = General mean

The genetic advance as per cent of mean was categorized into low, moderate and high as suggested by Johnson and Robinson (1955).

#### Scale:

|                           |   |          |
|---------------------------|---|----------|
| 0 – 10 per cent           | : | Low      |
| 10.1 – 20 per cent        | : | Moderate |
| > 20.1 per cent and above | : | High     |

# *Experimental Results*

## IV. EXPERIMENTAL RESULTS

The results of the experiment, entitled “Studies on performance of varieties, F<sub>1</sub> hybrids and synthetics of onion (*Allium cepa* .L) in Eastern Dry Zone of Karnataka” during *Kharif and Rabi* seasons of 2015-16 under irrigated conditions are presented under the following sub-headings in this chapter.

In view to understand the extent of variation observed due to genetic factors, the mean, range, genotypic variance (GV), phenotypic variance (PV), genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h<sup>2</sup>) and genetic advance as per cent over mean (GAM) were worked out for growth, yield and quality parameters for pooled analysis are presented in Table 6.

### **4.1 Evaluation and variability of onion genotypes for the growth, yield and quality attributes in Eastern Dry Zone of Karnataka**

#### **4.1.1 Growth parameters**

##### **4.1.1.1 Plant height (cm) at different stages of crop growth**

The data pertaining to plant height recorded by different onion genotypes at 30, 60 and 90 DAT (Days after transplanting) differed significantly during *Kharif* and *Rabi* season (Table 2).

At 30 DAT, Super Flare recorded highest plant height (52.45 cm) followed by Super Red (49.35cm). While, Arka Bindu registered the lowest plant height (36.85 cm) in *Kharif* season. Whereas, in *Rabi* season Flare noticed highest plant height (52.55 cm) followed by Super Flare (52.15 cm) and Arka Bindu recorded the lowest plant height (37.30 cm).

In pooled analysis, the maximum plant height at 30 DAT was registered in Super Flare (52.30 cm) followed by Arka Bheem (49.15 cm). Whereas, Arka Bindu recorded lowest plant height (37.08 cm). A total of twelve genotypes were found to have maximum plant height at 30 DAT than the grand mean of 44.79 cm.

At 60 DAT, out of twenty five genotypes evaluated Super Flare recorded highest plant height (62.10 cm) followed by Super Red (60.80 cm) and Arka Bindu recorded the lowest plant height (47.20 cm) in *Kharif* .While, Flare registered highest plant height (63.25 cm), which was on par

with Super Flare (62.90 cm) followed by Arka Bheem (61.15 cm) and Arka Bindu recorded the lowest plant height (47.60 cm) in *Rabi* season.

In pooled analysis, the maximum plant height at 60 DAT was registered in Super Flare (62.50 cm) followed by Flare (60.48 cm). Whereas, Arka Bindu recorded lowest plant height (47.40 cm). Total twelve genotypes were found to have maximum plant height at 60 DAT than the grand mean (55.78 cm).

At 90 DAT, Super Flare noticed the highest plant height (68.45 cm) followed by Super Red (64.45 cm) and Arka Bindu recorded the lowest plant height (48.90 cm) in *Kharif*. The hybrid Flare recorded the highest plant height (68.75 cm) followed by Super Flare (67.50 cm). Whereas, Arka Bindu recorded the lowest plant height (51.30 cm) in *Rabi* season.

In pooled analysis, the maximum plant height at 90 DAT was registered in Super Flare (67.98 cm) followed by Super Red (63.93 cm). Whereas, Arka Bindu documented lowest plant height (50.10 cm). Total eleven genotypes were found to have maximum plant height at 90 DAT than the grand mean (55.78 cm).

In pooled analysis, variability for plant height at 90 DAT, ranged from 50.10 cm (Arka Bindu) to 67.98 cm (Super Flare) with an average mean of 58.99 cm. The GV and PV were 10.80 and 17.19, respectively. Low estimate of GCV (5.57%) and PCV (7.03%) were observed. High heritability (62.80%) was observed along with low genetic advance as per cent of mean (9.09%) and genetic advance (5.36) for this trait (Table 6).

#### **4.1.1.2 Number of leaves at different stages of crop growth**

The data owing to number of leaves recorded by different onion genotypes at 30, 60 and 90 DAT differed significantly during *Kharif* and *Rabi* seasons (Table 3).

Table 2. Plant height of different onion genotypes as influenced by *Kharif* and *Rabi* seasons

| Sl. No.                      | Genotypes            | Plant height(cm) |              |              |               |              |              |               |              |              |
|------------------------------|----------------------|------------------|--------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|
|                              |                      | 30 DAT           |              |              | 60 DAT        |              |              | 90 DAT        |              |              |
|                              |                      | <i>Kharif</i>    | <i>Rabi</i>  | Pooled       | <i>Kharif</i> | <i>Rabi</i>  | Pooled       | <i>Kharif</i> | <i>Rabi</i>  | Pooled       |
| <b>Varieties</b>             |                      |                  |              |              |               |              |              |               |              |              |
| 1                            | Arka Pragathi        | 44.65            | 43.85        | <b>44.25</b> | 55.00         | 56.00        | <b>55.50</b> | 56.60         | 59.65        | <b>58.13</b> |
| 2                            | Arka Kalyan          | 42.85            | 41.90        | <b>42.38</b> | 54.70         | 53.05        | <b>53.88</b> | 55.25         | 57.35        | <b>56.30</b> |
| 3                            | Arka Bindu           | 36.85            | 37.30        | <b>37.08</b> | 47.20         | 47.60        | <b>47.40</b> | 48.90         | 51.30        | <b>50.10</b> |
| 4                            | Arka Niketan         | 43.15            | 44.95        | <b>44.05</b> | 54.50         | 54.95        | <b>54.73</b> | 57.25         | 59.10        | <b>58.18</b> |
| 5                            | Nasik Red            | 41.50            | 45.05        | <b>43.28</b> | 51.10         | 55.95        | <b>53.78</b> | 54.65         | 60.85        | <b>57.75</b> |
| 6                            | Rampur Local         | 42.55            | 44.75        | <b>43.65</b> | 53.40         | 55.25        | <b>54.58</b> | 56.75         | 58.70        | <b>57.73</b> |
| 7                            | Bellary Red          | 40.65            | 43.55        | <b>42.10</b> | 51.40         | 52.95        | <b>52.40</b> | 53.05         | 57.35        | <b>55.20</b> |
| 8                            | Sataragarvha (check) | 44.10            | 47.60        | <b>45.85</b> | 55.30         | 58.55        | <b>56.65</b> | 58.15         | 62.95        | <b>60.55</b> |
| 9                            | Poona Furusungi      | 45.65            | 48.10        | <b>46.88</b> | 56.60         | 57.65        | <b>57.10</b> | 57.45         | 61.60        | <b>59.53</b> |
| 10                           | Agrifound Light Red  | 39.85            | 42.95        | <b>41.40</b> | 50.10         | 53.15        | <b>51.63</b> | 52.55         | 56.45        | <b>54.50</b> |
| 11                           | S-780                | 43.35            | 47.95        | <b>45.65</b> | 56.30         | 58.25        | <b>57.28</b> | 57.65         | 62.35        | <b>60.00</b> |
| 12                           | Light Red            | 38.46            | 43.20        | <b>40.83</b> | 49.00         | 55.05        | <b>52.00</b> | 52.52         | 58.70        | <b>55.61</b> |
| 13                           | Prema-178            | 40.95            | 43.45        | <b>42.20</b> | 52.10         | 54.80        | <b>53.43</b> | 54.95         | 58.85        | <b>56.90</b> |
| <b>F<sub>1</sub> Hybrids</b> |                      |                  |              |              |               |              |              |               |              |              |
| 14                           | Arka Kirthiman       | 44.65            | 47.30        | <b>45.98</b> | 55.40         | 58.00        | <b>56.70</b> | 58.15         | 62.00        | <b>60.08</b> |
| 15                           | Arka Lalima          | 45.35            | 47.80        | <b>46.58</b> | 57.20         | 58.80        | <b>58.00</b> | 59.35         | 63.85        | <b>61.60</b> |
| 16                           | Super Flare          | 52.45            | 52.15        | <b>52.30</b> | 62.10         | 62.90        | <b>62.50</b> | 68.45         | 67.50        | <b>67.98</b> |
| 17                           | Lucifer              | 42.35            | 46.40        | <b>44.38</b> | 53.60         | 57.30        | <b>55.43</b> | 55.40         | 61.35        | <b>58.38</b> |
| 18                           | BSS-827              | 44.25            | 48.75        | <b>46.50</b> | 55.70         | 59.85        | <b>57.75</b> | 56.90         | 64.15        | <b>60.53</b> |
| 19                           | Suvarna              | 41.10            | 43.75        | <b>42.43</b> | 51.90         | 55.75        | <b>53.83</b> | 54.75         | 59.30        | <b>57.03</b> |
| 20                           | Samruddhi            | 43.65            | 46.95        | <b>45.30</b> | 56.60         | 57.65        | <b>57.10</b> | 57.50         | 61.75        | <b>59.63</b> |
| 21                           | Sudharshan           | 40.40            | 43.00        | <b>41.70</b> | 49.60         | 54.25        | <b>51.90</b> | 51.90         | 58.50        | <b>55.20</b> |
| 22                           | Super Red            | 49.35            | 48.55        | <b>48.95</b> | 60.80         | 59.40        | <b>60.10</b> | 64.45         | 63.40        | <b>63.93</b> |
| 23                           | Flare                | 44.65            | 52.55        | <b>48.60</b> | 57.70         | 63.25        | <b>60.48</b> | 58.85         | 68.75        | <b>63.80</b> |
| <b>Synthetics</b>            |                      |                  |              |              |               |              |              |               |              |              |
| 24                           | Arka Bheem           | 48.15            | 50.15        | <b>49.15</b> | 59.60         | 61.15        | <b>60.35</b> | 62.25         | 65.10        | <b>63.68</b> |
| 25                           | Marshall             | 46.75            | 50.05        | <b>48.40</b> | 59.20         | 60.75        | <b>59.98</b> | 60.15         | 64.60        | <b>62.38</b> |
|                              | Mean                 | <b>43.51</b>     | <b>46.08</b> | <b>44.79</b> | <b>54.66</b>  | <b>56.89</b> | <b>55.78</b> | <b>56.95</b>  | <b>61.02</b> | <b>58.99</b> |
|                              | SEm±                 | <b>2.32</b>      | <b>1.98</b>  | <b>1.77</b>  | <b>2.36</b>   | <b>2.12</b>  | <b>1.52</b>  | <b>2.12</b>   | <b>2.17</b>  | <b>1.79</b>  |
|                              | CD at 5%             | <b>6.76</b>      | <b>5.79</b>  | <b>5.15</b>  | <b>6.88</b>   | <b>6.20</b>  | <b>4.43</b>  | <b>6.20</b>   | <b>6.34</b>  | <b>5.22</b>  |
|                              | CV (%)               | <b>7.53</b>      | <b>6.09</b>  | <b>5.57</b>  | <b>6.10</b>   | <b>5.28</b>  | <b>3.85</b>  | <b>5.28</b>   | <b>5.03</b>  | <b>4.29</b>  |

DAT: Days after transplanting

At 30 DAT, Super Flare recorded maximum number of leaves (7.10) followed by Arka Bheem (6.80) and Arka Bindu registered the lowest number of leaves (4.80) in *Kharif*. Whereas, in *Rabi* season Flare recorded highest number of leaves (7.25) followed by Super Flare (7.10) and Arka Bindu documented the lowest number of leaves (4.10).

In pooled analysis, Super Flare noticed maximum number of leaves (7.10), followed by Flare (6.88). While, lowest number of leaves observed in Arka Bindu (4.45). However twelve genotypes exceeded the grand mean of 5.81 at 30 DAT.

In *Kharif* season, Super Flare recorded highest number of leaves (12.10) followed by Arka Bheem (11.40) and Arka Bindu recorded the lowest number of leaves (7.10) at 60 DAT. Flare registered highest number of leaves (12.35) which was on par with Super Flare (12.10) followed by Arka Lalima (11.35) while, Arka Bindu documented the lowest number of leaves (6.30) in *Rabi* season.

In pooled analysis, Super Flare showed maximum number of leaves (12.10), followed by Flare (11.58). While, lowest number of leaves were observed in Arka Bindu (6.70). However fourteen genotypes exceeded the grand mean of 9.69 at 60 DAT.

Among different genotypes, Super Flare documented highest number of leaves (13.60) followed by Arka Bheem (12.60) and Arka Bindu recorded the lowest number of leaves (8.50) in *Kharif*. In *Rabi* season, the hybrid Flare recorded highest number of leaves (13.80) followed by Super Flare (13.20) and Arka Bindu recorded the lowest number of leaves (8.20) at 90 DAT.

In pooled analysis, Super Flare recorded maximum number of leaves (13.40), followed by Flare (12.80). While lowest number of leaves was observed in Arka Bindu (8.35). Whereas, fourteen genotypes exceeded the grand mean of 10.93 at 90 DAT.

The number of leaves per plant at 90 DAT ranged from 8.35 (Arka Bindu) to 13.40 (Super Flare) with a grand mean of 10.93. The phenotypic (1.69) and genotypic variance (1.10) were noticed. There was a low GCV (9.62%) and moderate PCV (11.88%) observed for this trait. The heritability was high (65.53%) with a moderate (16.03%) genetic advance as per cent over mean and genetic advance (1.75) for this trait (Table 6).

**Table 3. Number of leaves per plant of different onion genotypes as influenced by *Kharif* and *Rabi* seasons**

| Sl. No.                      | Genotypes            | Number of leaves per plant |             |             |               |             |              |               |              |              |
|------------------------------|----------------------|----------------------------|-------------|-------------|---------------|-------------|--------------|---------------|--------------|--------------|
|                              |                      | 30 DAT                     |             |             | 60 DAT        |             |              | 90 DAT        |              |              |
|                              |                      | <i>Kharif</i>              | <i>Rabi</i> | Pooled      | <i>Kharif</i> | <i>Rabi</i> | Pooled       | <i>Kharif</i> | <i>Rabi</i>  | Pooled       |
| <b>Varieties</b>             |                      |                            |             |             |               |             |              |               |              |              |
| 1                            | Arka Pragathi        | 5.50                       | 6.20        | <b>5.85</b> | 8.40          | 9.10        | <b>8.75</b>  | 9.90          | 10.85        | <b>10.38</b> |
| 2                            | Arka Kalyan          | 6.10                       | 4.90        | <b>5.50</b> | 9.60          | 7.20        | <b>8.40</b>  | 10.80         | 9.10         | <b>9.95</b>  |
| 3                            | Arka Bindu           | 4.80                       | 4.10        | <b>4.45</b> | 7.10          | 6.30        | <b>6.70</b>  | 8.50          | 8.20         | <b>8.35</b>  |
| 4                            | Arka Niketan         | 6.20                       | 5.50        | <b>5.85</b> | 10.60         | 9.45        | <b>10.03</b> | 11.70         | 10.35        | <b>11.03</b> |
| 5                            | Nasik Red            | 5.90                       | 5.60        | <b>5.75</b> | 10.10         | 9.25        | <b>9.68</b>  | 11.10         | 10.10        | <b>10.60</b> |
| 6                            | Rampur Local         | 5.50                       | 6.35        | <b>5.93</b> | 9.60          | 10.20       | <b>9.90</b>  | 10.80         | 11.80        | <b>11.30</b> |
| 7                            | Bellary Red          | 5.20                       | 6.45        | <b>5.83</b> | 9.10          | 10.10       | <b>9.60</b>  | 10.10         | 11.25        | <b>10.68</b> |
| 8                            | Sataragarvha (check) | 5.40                       | 4.35        | <b>4.88</b> | 9.40          | 7.15        | <b>8.28</b>  | 10.50         | 8.85         | <b>9.68</b>  |
| 9                            | Poona Furusungi      | 4.90                       | 6.80        | <b>5.85</b> | 9.80          | 10.20       | <b>10.00</b> | 11.30         | 12.40        | <b>11.85</b> |
| 10                           | Agrifound Light Red  | 5.10                       | 4.45        | <b>4.78</b> | 9.30          | 7.25        | <b>8.28</b>  | 10.20         | 8.75         | <b>9.48</b>  |
| 11                           | S-780                | 6.70                       | 6.90        | <b>6.80</b> | 11.10         | 11.30       | <b>11.20</b> | 12.30         | 12.85        | <b>12.58</b> |
| 12                           | Light Red            | 6.20                       | 5.35        | <b>5.78</b> | 10.40         | 9.25        | <b>9.83</b>  | 11.70         | 10.35        | <b>11.03</b> |
| 13                           | Prema-178            | 6.10                       | 4.45        | <b>5.28</b> | 10.20         | 7.35        | <b>8.78</b>  | 11.30         | 8.55         | <b>9.93</b>  |
| <b>F<sub>1</sub> Hybrids</b> |                      |                            |             |             |               |             |              |               |              |              |
| 14                           | Arka Kirthiman       | 6.30                       | 5.65        | <b>5.98</b> | 10.50         | 9.85        | <b>10.18</b> | 11.80         | 10.70        | <b>11.25</b> |
| 15                           | Arka Lalima          | 6.70                       | 6.85        | <b>6.78</b> | 10.40         | 11.35       | <b>10.88</b> | 12.10         | 12.15        | <b>12.13</b> |
| 16                           | Super Flare          | 7.10                       | 7.10        | <b>7.10</b> | 12.10         | 12.10       | <b>12.10</b> | 13.60         | 13.20        | <b>13.40</b> |
| 17                           | Lucifer              | 6.10                       | 5.36        | <b>5.73</b> | 10.60         | 9.75        | <b>10.18</b> | 11.90         | 10.40        | <b>11.15</b> |
| 18                           | BSS-827              | 6.30                       | 5.10        | <b>5.70</b> | 10.80         | 9.25        | <b>10.03</b> | 12.10         | 10.30        | <b>11.20</b> |
| 19                           | Suvarna              | 5.90                       | 4.76        | <b>5.33</b> | 9.20          | 7.15        | <b>8.18</b>  | 10.10         | 8.45         | <b>9.28</b>  |
| 20                           | Samruddhi            | 6.10                       | 5.27        | <b>5.69</b> | 10.40         | 9.35        | <b>9.88</b>  | 11.90         | 10.25        | <b>11.08</b> |
| 21                           | Sudharshan           | 5.80                       | 4.45        | <b>5.13</b> | 9.80          | 8.35        | <b>9.08</b>  | 10.70         | 9.40         | <b>10.05</b> |
| 22                           | Super Red            | 6.30                       | 4.35        | <b>5.33</b> | 10.60         | 8.10        | <b>9.35</b>  | 11.50         | 9.25         | <b>10.38</b> |
| 23                           | Flare                | 6.50                       | 7.25        | <b>6.88</b> | 10.80         | 12.35       | <b>11.58</b> | 11.80         | 13.80        | <b>12.80</b> |
| <b>Synthetics</b>            |                      |                            |             |             |               |             |              |               |              |              |
| 24                           | Arka Bheem           | 6.80                       | 6.45        | <b>6.63</b> | 11.40         | 10.35       | <b>10.88</b> | 12.60         | 11.50        | <b>12.05</b> |
| 25                           | Marshall             | 6.70                       | 6.10        | <b>6.40</b> | 11.10         | 10.25       | <b>10.68</b> | 12.30         | 11.15        | <b>11.73</b> |
| <b>Mean</b>                  |                      | <b>6.01</b>                | <b>5.60</b> | <b>5.81</b> | <b>10.10</b>  | <b>9.29</b> | <b>9.69</b>  | <b>11.30</b>  | <b>10.56</b> | <b>10.93</b> |
| <b>SEm±</b>                  |                      | <b>0.24</b>                | <b>0.38</b> | <b>0.22</b> | <b>0.52</b>   | <b>0.59</b> | <b>0.45</b>  | <b>0.65</b>   | <b>0.78</b>  | <b>0.54</b>  |
| <b>CD at 5%</b>              |                      | <b>0.70</b>                | <b>1.12</b> | <b>0.63</b> | <b>1.52</b>   | <b>1.73</b> | <b>1.32</b>  | <b>1.90</b>   | <b>2.27</b>  | <b>1.57</b>  |
| <b>CV (%)</b>                |                      | <b>5.69</b>                | <b>9.70</b> | <b>5.24</b> | <b>7.28</b>   | <b>9.02</b> | <b>6.60</b>  | <b>8.12</b>   | <b>10.40</b> | <b>6.97</b>  |

DAT: Days after transplanting

#### 4.1.1.3 Leaf length (cm) at different stages of crop growth

The data related to leaf length recorded for different onion genotypes at 60 and 90 DAT differed significantly during *Kharif* and *Rabi* seasons. Whereas at 30 DAT, there were no significant differences observed among 25 genotypes for leaf length in *Kharif* and *Rabi* seasons (Table 4).

In pooled analysis, the maximum leaf length at 30 DAT was registered in Super Flare (45.60 cm) followed by Flare (45.15 cm). While, Arka Bindu recorded lowest leaf length (34.30 cm). However, twelve genotypes were found to have maximum leaf length at 30 DAT than the grand mean of 41.04 cm.

At 60 DAT, in *Kharif* season Super Flare recorded highest leaf length (56.15 cm) followed by Super Red (54.85 cm) and Arka Bindu noticed the lowest leaf length (42.52 cm). In *Rabi* season Flare registered highest leaf length (59.15 cm) followed by Super Flare (58.75 cm) and Arka Bindu recorded the lowest leaf length (42.75 cm).

In pooled analysis, the maximum leaf length at 60 DAT was observed in Super Flare (57.45 cm) followed by Flare (56.05 cm). While, Arka Bindu registered lowest leaf length (42.64 cm). Eleven genotypes were found to have maximum leaf length at 60 DAT than the grand mean (51.06 cm).

At 90 DAT, Super Flare recorded highest leaf length (59.15 cm) followed by Super Red (58.45 cm). While Arka Bindu recorded the lowest leaf length (43.75 cm) in *Kharif* season. Flare recorded highest leaf length (62.85 cm) followed by Super Flare (62.25 cm) and Arka Bindu recorded the lowest leaf length (45.45 cm) in *Rabi* season.

In pooled data analysis, the maximum leaf length at 90 DAT was recorded in Super Flare (60.70 cm) followed by Flare (59.70 cm). While, Arka Bindu registered lowest leaf length (44.60 cm). However twelve genotypes were found to have maximum leaf length at 90 DAT than the grand mean (54.15 cm).

The variability for leaf length at 90 DAT was ranged from 44.60 cm (Arka Bindu) to 60.70 cm (Super Flare) with an average mean of 54.15 cm. The GV and PV were 10.74 and 16.65, respectively. Low estimate of GCV (6.05%) and PCV (7.53%) were observed. High heritability (64.50%) was observed along with low genetic advance as per cent of mean (10.01%) and genetic advance (5.42) for this trait (Table 6).

**Table 4. Leaf length of different onion genotypes as influenced by *Kharif* and *Rabi* seasons**

| Sl. No.                      | Genotypes            | Leaf length (cm) |              |              |               |              |              |               |              |              |
|------------------------------|----------------------|------------------|--------------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|
|                              |                      | 30 DAT           |              |              | 60 DAT        |              |              | 90 DAT        |              |              |
|                              |                      | <i>Kharif</i>    | <i>Rabi</i>  | Pooled       | <i>Kharif</i> | <i>Rabi</i>  | Pooled       | <i>Kharif</i> | <i>Rabi</i>  | Pooled       |
| <b>Varieties</b>             |                      |                  |              |              |               |              |              |               |              |              |
| 1                            | Arka Pragathi        | 40.50            | 39.95        | <b>40.23</b> | 50.42         | 51.22        | <b>50.82</b> | 53.32         | 54.45        | <b>53.89</b> |
| 2                            | Arka Kalyan          | 39.85            | 38.25        | <b>39.05</b> | 50.13         | 48.45        | <b>49.29</b> | 52.75         | 51.75        | <b>52.25</b> |
| 3                            | Arka Bindu           | 34.95            | 33.65        | <b>34.30</b> | 42.52         | 42.75        | <b>42.64</b> | 43.75         | 45.45        | <b>44.60</b> |
| 4                            | Arka Niketan         | 40.22            | 40.95        | <b>40.59</b> | 49.65         | 50.45        | <b>50.05</b> | 53.66         | 53.45        | <b>53.56</b> |
| 5                            | Nasik Red            | 37.35            | 41.12        | <b>39.24</b> | 46.35         | 51.75        | <b>49.05</b> | 50.25         | 55.05        | <b>52.65</b> |
| 6                            | Rampur Local         | 39.75            | 40.65        | <b>40.20</b> | 48.65         | 51.05        | <b>49.85</b> | 51.45         | 53.12        | <b>52.29</b> |
| 7                            | Bellary Red          | 37.65            | 39.75        | <b>38.70</b> | 46.75         | 48.85        | <b>47.80</b> | 48.45         | 51.75        | <b>50.10</b> |
| 8                            | Sataragarvha (check) | 40.82            | 43.55        | <b>42.19</b> | 50.15         | 53.65        | <b>51.90</b> | 53.75         | 57.15        | <b>55.45</b> |
| 9                            | Poona Furusungi      | 42.45            | 43.92        | <b>43.19</b> | 51.55         | 53.05        | <b>52.30</b> | 54.55         | 55.95        | <b>55.25</b> |
| 10                           | Agrifound Light Red  | 37.55            | 38.95        | <b>38.25</b> | 45.25         | 48.85        | <b>47.05</b> | 48.15         | 50.75        | <b>49.45</b> |
| 11                           | S-780                | 40.75            | 43.75        | <b>42.25</b> | 51.55         | 53.35        | <b>52.45</b> | 54.35         | 56.55        | <b>55.45</b> |
| 12                           | Light Red            | 35.94            | 39.15        | <b>37.55</b> | 43.95         | 50.45        | <b>47.20</b> | 47.22         | 53.15        | <b>50.19</b> |
| 13                           | Prema-178            | 37.80            | 39.45        | <b>38.63</b> | 47.15         | 50.63        | <b>48.89</b> | 49.35         | 53.25        | <b>51.30</b> |
| <b>F<sub>1</sub> Hybrids</b> |                      |                  |              |              |               |              |              |               |              |              |
| 14                           | Arka Kirthiman       | 40.10            | 43.15        | <b>41.63</b> | 50.24         | 53.85        | <b>52.05</b> | 55.22         | 56.25        | <b>55.74</b> |
| 15                           | Arka Lalima          | 42.23            | 43.75        | <b>42.99</b> | 52.22         | 54.54        | <b>53.38</b> | 55.55         | 58.65        | <b>57.10</b> |
| 16                           | Super Flare          | 43.15            | 48.05        | <b>45.60</b> | 56.15         | 58.75        | <b>57.45</b> | 59.15         | 62.25        | <b>60.70</b> |
| 17                           | Lucifer              | 39.45            | 42.55        | <b>41.00</b> | 48.75         | 53.24        | <b>51.00</b> | 51.42         | 55.95        | <b>53.69</b> |
| 18                           | BSS-827              | 42.24            | 44.45        | <b>43.35</b> | 50.95         | 55.35        | <b>53.15</b> | 53.65         | 58.45        | <b>56.05</b> |
| 19                           | Suvarna              | 38.60            | 39.65        | <b>39.13</b> | 46.95         | 51.55        | <b>49.25</b> | 51.55         | 54.15        | <b>52.85</b> |
| 20                           | Samruddhi            | 41.12            | 42.85        | <b>41.99</b> | 51.55         | 53.05        | <b>52.30</b> | 53.95         | 56.15        | <b>55.05</b> |
| 21                           | Sudharshan           | 36.80            | 39.12        | <b>37.96</b> | 44.75         | 49.95        | <b>47.35</b> | 48.54         | 53.14        | <b>50.84</b> |
| 22                           | Super Red            | 43.65            | 44.45        | <b>44.05</b> | 54.85         | 54.85        | <b>54.85</b> | 58.45         | 57.74        | <b>58.10</b> |
| 23                           | Flare                | 41.85            | 48.45        | <b>45.15</b> | 52.95         | 59.15        | <b>56.05</b> | 56.55         | 62.85        | <b>59.70</b> |
| <b>Synthetics</b>            |                      |                  |              |              |               |              |              |               |              |              |
| 24                           | Arka Bheem           | 42.85            | 46.35        | <b>44.60</b> | 54.35         | 56.95        | <b>55.65</b> | 58.35         | 59.95        | <b>59.15</b> |
| 25                           | Marshall             | 42.45            | 46.05        | <b>44.25</b> | 53.45         | 56.25        | <b>54.85</b> | 57.65         | 59.12        | <b>58.39</b> |
| <b>Mean</b>                  |                      | <b>40.00</b>     | <b>42.08</b> | <b>41.04</b> | <b>49.65</b>  | <b>52.48</b> | <b>51.06</b> | <b>52.84</b>  | <b>55.46</b> | <b>54.15</b> |
| <b>SEm±</b>                  |                      | <b>2.63</b>      | <b>2.42</b>  | <b>2.06</b>  | <b>1.94</b>   | <b>1.97</b>  | <b>1.45</b>  | <b>2.15</b>   | <b>2.54</b>  | <b>1.72</b>  |
| <b>CD at 5%</b>              |                      | <b>NS</b>        | <b>NS</b>    | <b>NS</b>    | <b>5.67</b>   | <b>5.75</b>  | <b>4.24</b>  | <b>6.27</b>   | <b>7.42</b>  | <b>5.02</b>  |
| <b>CV (%)</b>                |                      | <b>NS</b>        | <b>NS</b>    | <b>NS</b>    | <b>5.54</b>   | <b>5.30</b>  | <b>4.02</b>  | <b>5.75</b>   | <b>6.48</b>  | <b>4.49</b>  |

DAT: Days after transplanting

NS: Non significant

#### 4.1.1.4 Leaf width at different stages of crop growth (cm)

The data related to leaf width documented by different onion genotypes was differed significantly at 30 DAT during *Kharif* and *Rabi* seasons (Table 5).

At 30 DAT, the variety S-780 and Super Flare recorded highest leaf width (0.97 cm) followed by Rampur Local (0.96 cm) and lowest leaf width (0.73cm) was noticed in Arka Bindu during *Kharif*. Whereas, in *Rabi* season Rampur Local, S-780 and Super Flare registered highest leaf width (0.98 cm) followed by Marshall (0.96 cm) and lowest leaf width (0.73cm) was recorded in Arka Bindu.

In pooled data analysis, the maximum leaf width at 30 DAT was registered in Super Flare (0.98 cm), followed by Rampur Local (0.97 cm). While, Arka Bindu registered lowest leaf width (0.73 cm). Of total genotypes twelve were exceeded the grand mean of 0.88 cm.

At 60 and 90 DAT, there were no significant differences observed among different genotypes for leaf width in both *Kharif* and *Rabi* season.

In pooled analysis, the maximum leaf width at 60 DAT was registered in Super Flare (1.36 cm), followed by S-780 (1.33 cm). Whereas, Suvarna registered lowest leaf width (1.14 cm). Fourteen genotypes were exceeded the grand mean of 1.27 cm.

In pooled analysis, the maximum leaf width at 90 DAT was documented in Super Flare (1.40 cm), followed by Rampur Local (1.39 cm). Whereas, Suvarna registered lowest leaf width of 1.18 cm. However, twelve genotypes were exceeded the grand mean of 1.27 cm.

**Table 5. Leaf width of different onion genotypes as influenced by *Kharif* and *Rabi* seasons**

| Sl. No.                      | Genotypes            | Leaf width (cm) |             |             |               |             |             |               |             |             |
|------------------------------|----------------------|-----------------|-------------|-------------|---------------|-------------|-------------|---------------|-------------|-------------|
|                              |                      | 30 DAT          |             |             | 60 DAT        |             |             | 90 DAT        |             |             |
|                              |                      | <i>Kharif</i>   | <i>Rabi</i> | Pooled      | <i>Kharif</i> | <i>Rabi</i> | Pooled      | <i>Kharif</i> | <i>Rabi</i> | Pooled      |
| <b>Varieties</b>             |                      |                 |             |             |               |             |             |               |             |             |
| 1                            | Arka Pragathi        | 0.80            | 0.79        | <b>0.80</b> | 1.17          | 1.16        | <b>1.17</b> | 1.23          | 1.22        | <b>1.23</b> |
| 2                            | Arka Kalyan          | 0.81            | 0.82        | <b>0.82</b> | 1.19          | 1.21        | <b>1.20</b> | 1.25          | 1.27        | <b>1.26</b> |
| 3                            | Arka Bindu           | 0.73            | 0.73        | <b>0.73</b> | 1.10          | 1.30        | <b>1.20</b> | 1.15          | 1.33        | <b>1.24</b> |
| 4                            | Arka Niketan         | 0.83            | 0.84        | <b>0.84</b> | 1.18          | 1.19        | <b>1.19</b> | 1.22          | 1.24        | <b>1.23</b> |
| 5                            | Nasik Red            | 0.87            | 0.89        | <b>0.88</b> | 1.21          | 1.22        | <b>1.22</b> | 1.27          | 1.28        | <b>1.28</b> |
| 6                            | Rampur Local         | 0.96            | 0.98        | <b>0.97</b> | 1.26          | 1.31        | <b>1.29</b> | 1.45          | 1.32        | <b>1.39</b> |
| 7                            | Bellary Red          | 0.86            | 0.87        | <b>0.87</b> | 1.12          | 1.10        | <b>1.11</b> | 1.30          | 1.22        | <b>1.26</b> |
| 8                            | Sataragarvha (check) | 0.87            | 0.88        | <b>0.88</b> | 1.16          | 1.18        | <b>1.17</b> | 1.22          | 1.25        | <b>1.24</b> |
| 9                            | Poona Furusungi      | 0.91            | 0.92        | <b>0.92</b> | 1.27          | 1.28        | <b>1.28</b> | 1.29          | 1.31        | <b>1.30</b> |
| 10                           | Agrifound Light Red  | 0.82            | 0.83        | <b>0.83</b> | 1.16          | 1.18        | <b>1.17</b> | 1.23          | 1.26        | <b>1.25</b> |
| 11                           | S-780                | 0.97            | 0.98        | <b>0.98</b> | 1.32          | 1.33        | <b>1.33</b> | 1.36          | 1.37        | <b>1.37</b> |
| 12                           | Light Red            | 0.85            | 0.86        | <b>0.86</b> | 1.15          | 1.16        | <b>1.16</b> | 1.21          | 1.22        | <b>1.22</b> |
| 13                           | Prema-178            | 0.83            | 0.84        | <b>0.84</b> | 1.14          | 1.15        | <b>1.15</b> | 1.19          | 1.20        | <b>1.20</b> |
| <b>F<sub>1</sub> Hybrids</b> |                      |                 |             |             |               |             |             |               |             |             |
| 14                           | Arka Kirthiman       | 0.89            | 0.90        | <b>0.90</b> | 1.19          | 1.21        | <b>1.20</b> | 1.23          | 1.27        | <b>1.25</b> |
| 15                           | Arka Lalima          | 0.91            | 0.92        | <b>0.92</b> | 1.21          | 1.23        | <b>1.22</b> | 1.25          | 1.29        | <b>1.27</b> |
| 16                           | Super Flare          | 0.97            | 0.98        | <b>0.98</b> | 1.34          | 1.37        | <b>1.36</b> | 1.39          | 1.4         | <b>1.40</b> |
| 17                           | Lucifer              | 0.88            | 0.89        | <b>0.89</b> | 1.22          | 1.24        | <b>1.23</b> | 1.26          | 1.28        | <b>1.27</b> |
| 18                           | BSS-827              | 0.92            | 0.93        | <b>0.93</b> | 1.27          | 1.28        | <b>1.28</b> | 1.29          | 1.31        | <b>1.30</b> |
| 19                           | Suvarna              | 0.81            | 0.82        | <b>0.82</b> | 1.13          | 1.14        | <b>1.14</b> | 1.17          | 1.18        | <b>1.18</b> |
| 20                           | Samruddhi            | 0.93            | 0.94        | <b>0.94</b> | 1.25          | 1.24        | <b>1.25</b> | 1.28          | 1.27        | <b>1.28</b> |
| 21                           | Sudharshan           | 0.84            | 0.83        | <b>0.84</b> | 1.23          | 1.22        | <b>1.23</b> | 1.25          | 1.24        | <b>1.25</b> |
| 22                           | Super Red            | 0.88            | 0.9         | <b>0.89</b> | 1.21          | 1.22        | <b>1.22</b> | 1.23          | 1.25        | <b>1.24</b> |
| 23                           | Flare                | 0.87            | 0.89        | <b>0.88</b> | 1.23          | 1.25        | <b>1.24</b> | 1.27          | 1.29        | <b>1.28</b> |
| <b>Synthetics</b>            |                      |                 |             |             |               |             |             |               |             |             |
| 24                           | Arka Bheem           | 0.85            | 0.86        | <b>0.86</b> | 1.21          | 1.23        | <b>1.22</b> | 1.23          | 1.24        | <b>1.24</b> |
| 25                           | Marshall             | 0.94            | 0.96        | <b>0.95</b> | 1.28          | 1.29        | <b>1.29</b> | 1.32          | 1.33        | <b>1.33</b> |
| <b>Mean</b>                  |                      | <b>0.87</b>     | <b>0.88</b> | <b>0.88</b> | <b>1.21</b>   | <b>1.23</b> | <b>1.22</b> | <b>1.26</b>   | <b>1.27</b> | <b>1.27</b> |
| <b>SEm±</b>                  |                      | <b>0.04</b>     | <b>0.04</b> | <b>0.03</b> | <b>0.07</b>   | <b>0.05</b> | <b>0.04</b> | <b>0.06</b>   | <b>0.06</b> | <b>0.05</b> |
| <b>CD at 5%</b>              |                      | <b>0.10</b>     | <b>0.11</b> | <b>0.08</b> | NS            | NS          | NS          | NS            | NS          | NS          |
| <b>CV (%)</b>                |                      | <b>5.78</b>     | <b>6.21</b> | <b>4.68</b> | NS            | NS          | NS          | NS            | NS          | NS          |

DAT: Days after transplanting

NS: Non significant

**Table 6. Estimates of genetic parameters for growth, yield and quality in onion genotypes**

| Sl. No.                   | Character                         | Mean±S.Em    | Range (Min-Max) | GV       | PV       | GCV (%) | PCV (%) | h <sup>2</sup> | GA     | GAM (%) |
|---------------------------|-----------------------------------|--------------|-----------------|----------|----------|---------|---------|----------------|--------|---------|
| <b>Growth Parameters</b>  |                                   |              |                 |          |          |         |         |                |        |         |
| 1                         | Plant height at 90 DAT(cm)        | 58.99±1.79   | 50.10-67.98     | 10.80    | 17.19    | 5.57    | 7.03    | 62.80          | 5.36   | 9.09    |
| 2                         | Number of leaves at 90 DAT        | 10.93±0.54   | 8.35-13.40      | 1.10     | 1.69     | 9.62    | 11.88   | 65.53          | 1.75   | 16.03   |
| 3                         | Leaf length at 90 DAT(cm)         | 54.15±1.72   | 44.60-60.70     | 10.70    | 16.65    | 6.05    | 7.53    | 64.50          | 5.42   | 10.01   |
| 4                         | Leaf width at 90 DAT(cm)          | 1.27±0.05    | 1.18-1.40       | 0.01     | 0.08     | 1.01    | 5.95    | 2.87           | 0.02   | 0.35    |
| 5                         | Duration of crop                  | 108.50±1.30  | 100.00-114.00   | 13.64    | 17.04    | 3.40    | 3.80    | 80.08          | 6.81   | 6.28    |
| 6                         | Collar thickness(cm)              | 1.24±0.03    | 1.04-1.39       | 0.07     | 0.08     | 5.37    | 6.59    | 66.39          | 0.11   | 9.02    |
| 7                         | Neck thickness (cm)               | 0.54±0.03    | 0.42-0.71       | 0.01     | 0.01     | 13.56   | 16.02   | 71.65          | 0.13   | 23.64   |
| <b>Yield Parameters</b>   |                                   |              |                 |          |          |         |         |                |        |         |
| 1                         | Polar diameter(cm)                | 5.11±0.19    | 4.15-6.50       | 0.18     | 0.25     | 8.32    | 9.87    | 71.04          | 0.74   | 14.44   |
| 2                         | Equatorial diameter(cm)           | 6.13±0.19    | 4.55-7.45       | 0.23     | 0.31     | 7.90    | 9.09    | 75.54          | 0.87   | 14.14   |
| 3                         | Average bulb weight(g)            | 92.74±3.89   | 38.40-33.75     | 245.06   | 275.37   | 16.88   | 17.89   | 88.99          | 30.42  | 32.80   |
| 4                         | Average ten bulb weight(g)        | 935.34±55.53 | 388.50-1351.00  | 24890.46 | 31056.73 | 16.87   | 18.84   | 80.15          | 290.95 | 31.11   |
| 5                         | Yield per plot (kg)               | 5.53±0.19    | 3.39-6.69       | 0.55     | 0.62     | 13.35   | 14.18   | 88.62          | 1.43   | 25.88   |
| 6                         | Yield per hectare (t)             | 31.08±2.57   | 18.55-37.58     | 12.26    | 25.45    | 11.27   | 16.23   | 48.18          | 5.01   | 16.11   |
| 7                         | Marketable yield (t/ha)           | 29.52±2.62   | 15.79-36.57     | 14.58    | 28.28    | 12.93   | 18.01   | 51.53          | 5.65   | 19.12   |
| 8                         | Unmarketable yield (t/ha)         | 1.56±0.12    | 1.02-2.75       | 0.11     | 0.14     | 20.84   | 23.59   | 78.02          | 0.59   | 37.92   |
| <b>Quality parameters</b> |                                   |              |                 |          |          |         |         |                |        |         |
| 1                         | Number of rings                   | 8.60±0.37    | 6.88-10.43      | 0.51     | 0.78     | 8.31    | 10.29   | 65.23          | 1.19   | 13.83   |
| 2                         | Number of centers                 | 2.26±0.15    | 1.25-3.25       | 0.36     | 0.41     | 26.71   | 28.29   | 89.09          | 1.17   | 51.93   |
| 3                         | TSS(°brix)                        | 12.71±0.35   | 11.30-17.36     | 1.40     | 1.64     | 9.31    | 10.09   | 85.22          | 2.25   | 17.71   |
| 4                         | Pungency(pyruvic acidµmoles/g FW) | 5.42±0.32    | 4.06-6.39       | 0.26     | 0.68     | 9.43    | 12.58   | 56.21          | 0.79   | 14.57   |
| 5                         | Dry matter (%)                    | 13.25±0.37   | 9.70-19.55      | 4.76     | 5.04     | 16.46   | 16.93   | 94.46          | 4.37   | 32.95   |

**Where,**

GV: Genotypic variance

PV: Phenotypic variance

GCV: Genotypic coefficient variation

PCV: Phenotypic coefficient variation

h<sup>2</sup>: Heritability in broad sense

GA: Genetic advance

GAM: Genetic advance as per cent mean

The leaf width at 90 DAT, ranged from 1.18 cm (Suvarna) to 1.40 cm (Super Flare) with an average mean of 1.27 cm. The GV and PV were 0.01 and 0.08, respectively. The low estimate of GCV (1.01%) and PCV (5.95%) were observed. Low heritability (2.87%) was observed along with low genetic advance as per cent of mean (0.35%) and genetic advance (0.02) for this trait (Table 6).

#### **4.1.1.5 Plant establishment (%)**

The data pertaining to per cent plant establishment at 30 days after transplanting indicated there was no significant difference among the onion genotypes during *Kharif and Rabi* seasons (Table 7).

In pooled analysis, the maximum per cent plant establishment was observed in Sataragarvha (92.09%), followed by Arka Pragathi (89.19%). However, Suvarna (80.39%) registered lowest per cent plant establishment. A total of fourteen genotypes exceeded the grand mean of 86.21%.

#### **4.1.1.6 Duration of crop (days)**

Among the different genotypes Arka Bindu recorded minimum number of days to harvest (102 days) followed by Prema-178 (103 days). Whereas, Super Flare recorded maximum days to harvest (115 days) during *Kharif* season (Table 7).

In *Rabi* season, the variety Arka Bindu recorded minimum number of days to harvest (97 days) followed by Prema-178 (98 days). While, Super Flare recorded maximum days to harvest (112 days).

In pooled data, Arka Bindu and Prema-178 were recorded minimum number of days to harvest (100 days). However, Super Flare recorded maximum days to maturity (114 days). Nine genotypes recorded minimum number of days than the average of 109 days.

The minimum duration (100 days) was recorded in Arka Bindu and it was maximum in Super Flare (114 days) with a grand mean of 109 days. The estimates of GV (13.64) and PV (17.04) were recorded. The estimates of GCV and PCV were low (3.40% and 3.80%, respectively). The heritability was high (80.08%) with low genetic advance over per cent mean of 6.28 per cent and genetic advance (6.81) for this trait (Table 6).

**Table 7. Plant establishment and duration of different onion genotypes as influenced by *Kharif* and *Rabi* seasons**

| Sl. No.                      | Genotypes            | Plant establishment (%) |              |              | Duration of crop (Days) |               |               |
|------------------------------|----------------------|-------------------------|--------------|--------------|-------------------------|---------------|---------------|
|                              |                      | <i>Kharif</i>           | <i>Rabi</i>  | Pooled       | <i>Kharif</i>           | <i>Rabi</i>   | Pooled        |
| <b>Varieties</b>             |                      |                         |              |              |                         |               |               |
| 1                            | Arka Pragathi        | 88.75                   | 89.63        | <b>89.19</b> | 114.00                  | 109.00        | <b>112.00</b> |
| 2                            | Arka Kalyan          | 85.32                   | 84.57        | <b>84.95</b> | 107.00                  | 103.00        | <b>105.00</b> |
| 3                            | Arka Bindu           | 86.42                   | 88.76        | <b>87.59</b> | 102.00                  | 97.00         | <b>100.00</b> |
| 4                            | Arka Niketan         | 87.17                   | 86.32        | <b>86.75</b> | 115.00                  | 110.00        | <b>113.00</b> |
| 5                            | Nasik Red            | 88.26                   | 89.75        | <b>89.01</b> | 114.00                  | 109.00        | <b>112.00</b> |
| 6                            | Rampur Local         | 87.32                   | 88.46        | <b>87.89</b> | 110.00                  | 107.00        | <b>109.00</b> |
| 7                            | Bellary Red          | 82.53                   | 83.64        | <b>83.09</b> | 115.00                  | 111.00        | <b>113.00</b> |
| 8                            | Sataragarvha (check) | 91.45                   | 92.73        | <b>92.09</b> | 112.00                  | 107.00        | <b>110.00</b> |
| 9                            | Poona Furusungi      | 85.16                   | 87.24        | <b>86.20</b> | 108.00                  | 105.00        | <b>107.00</b> |
| 10                           | Agrifound Light Red  | 83.12                   | 85.32        | <b>84.22</b> | 107.00                  | 104.00        | <b>106.00</b> |
| 11                           | S-780                | 88.65                   | 87.15        | <b>87.90</b> | 112.00                  | 107.00        | <b>110.00</b> |
| 12                           | Light Red            | 86.73                   | 87.48        | <b>87.11</b> | 108.00                  | 105.00        | <b>107.00</b> |
| 13                           | Prema-178            | 85.67                   | 86.72        | <b>86.20</b> | 102.00                  | 98.00         | <b>100.00</b> |
| <b>F<sub>1</sub> Hybrids</b> |                      |                         |              |              |                         |               |               |
| 14                           | Arka Kirthiman       | 86.78                   | 88.35        | <b>87.57</b> | 113.00                  | 110.00        | <b>112.00</b> |
| 15                           | Arka Lalima          | 87.92                   | 89.47        | <b>88.70</b> | 111.00                  | 107.00        | <b>109.00</b> |
| 16                           | Super Flare          | 87.23                   | 89.31        | <b>88.27</b> | 115.00                  | 112.00        | <b>114.00</b> |
| 17                           | Lucifer              | 83.42                   | 84.15        | <b>83.79</b> | 113.00                  | 109.00        | <b>111.00</b> |
| 18                           | BSS-827              | 85.35                   | 83.12        | <b>84.24</b> | 109.00                  | 105.00        | <b>107.00</b> |
| 19                           | Suvarna              | 79.16                   | 81.61        | <b>80.39</b> | 119.00                  | 104.00        | <b>112.00</b> |
| 20                           | Samruddhi            | 82.73                   | 83.16        | <b>82.95</b> | 109.00                  | 106.00        | <b>108.00</b> |
| 21                           | Sudharshan           | 80.65                   | 81.75        | <b>81.20</b> | 105.00                  | 104.00        | <b>112.00</b> |
| 22                           | Super Red            | 83.15                   | 82.65        | <b>82.90</b> | 112.00                  | 109.00        | <b>105.00</b> |
| 23                           | Flare                | 87.32                   | 90.16        | <b>88.74</b> | 114.00                  | 111.00        | <b>100.00</b> |
| <b>Synthetics</b>            |                      |                         |              |              |                         |               |               |
| 24                           | Arka Bheem           | 86.32                   | 87.44        | <b>86.88</b> | 108.00                  | 105.00        | <b>113.00</b> |
| 25                           | Marshall             | 88.44                   | 86.42        | <b>87.43</b> | 112.00                  | 109.00        | <b>112.00</b> |
| <b>Mean</b>                  |                      | <b>85.80</b>            | <b>86.61</b> | <b>86.21</b> | <b>111.00</b>           | <b>107.00</b> | <b>109.00</b> |
| <b>SEm±</b>                  |                      | <b>4.15</b>             | <b>3.81</b>  | <b>2.81</b>  | <b>2.06</b>             | <b>2.47</b>   | <b>1.30</b>   |
| <b>CD at 5%</b>              |                      | <b>NS</b>               | <b>NS</b>    | <b>NS</b>    | <b>6.02</b>             | <b>7.20</b>   | <b>3.86</b>   |
| <b>CV (%)</b>                |                      | <b>NS</b>               | <b>NS</b>    | <b>NS</b>    | <b>7.64</b>             | <b>7.28</b>   | <b>6.70</b>   |

NS: Non significant

#### **4.1.1.7 Bolting per cent**

Data pertaining to per cent of bolting recorded by different onion genotypes differed significantly during *Kharif* and *Rabi* seasons (Table 8) (Fig 2).

Among the genotypes, Poona Furusungi, Agrifound light red, S-780, Light Red, Suvarna, Super Red and Arka Bheem have recorded no bolting per cent (0.00%) in both *Kharif* and *Rabi* seasons. Whereas, Prema-178 registered the highest bolting per cent (3.65%) in *Kharif* and Arka Bindu recorded maximum bolting per cent (9.85%) in *Rabi*.

In pooled analysis, Poona Furusungi, Agrifound Light Red, S-780, Light Red, Suvarna, Super Red and Arka Bheem have recorded no bolting per cent (0.00%). Whereas, Arka Bindu registered the maximum bolting per cent (6.30%) followed by Prema-178 (4.15%). However, thirteen genotypes recorded lowest bolting than the mean of 1.45 per cent.

#### **4.1.1.8 Collar thickness at harvest (cm)**

The data related to collar thickness at harvest differed significantly among the onion genotypes during *Kharif* and *Rabi* (Table 9).

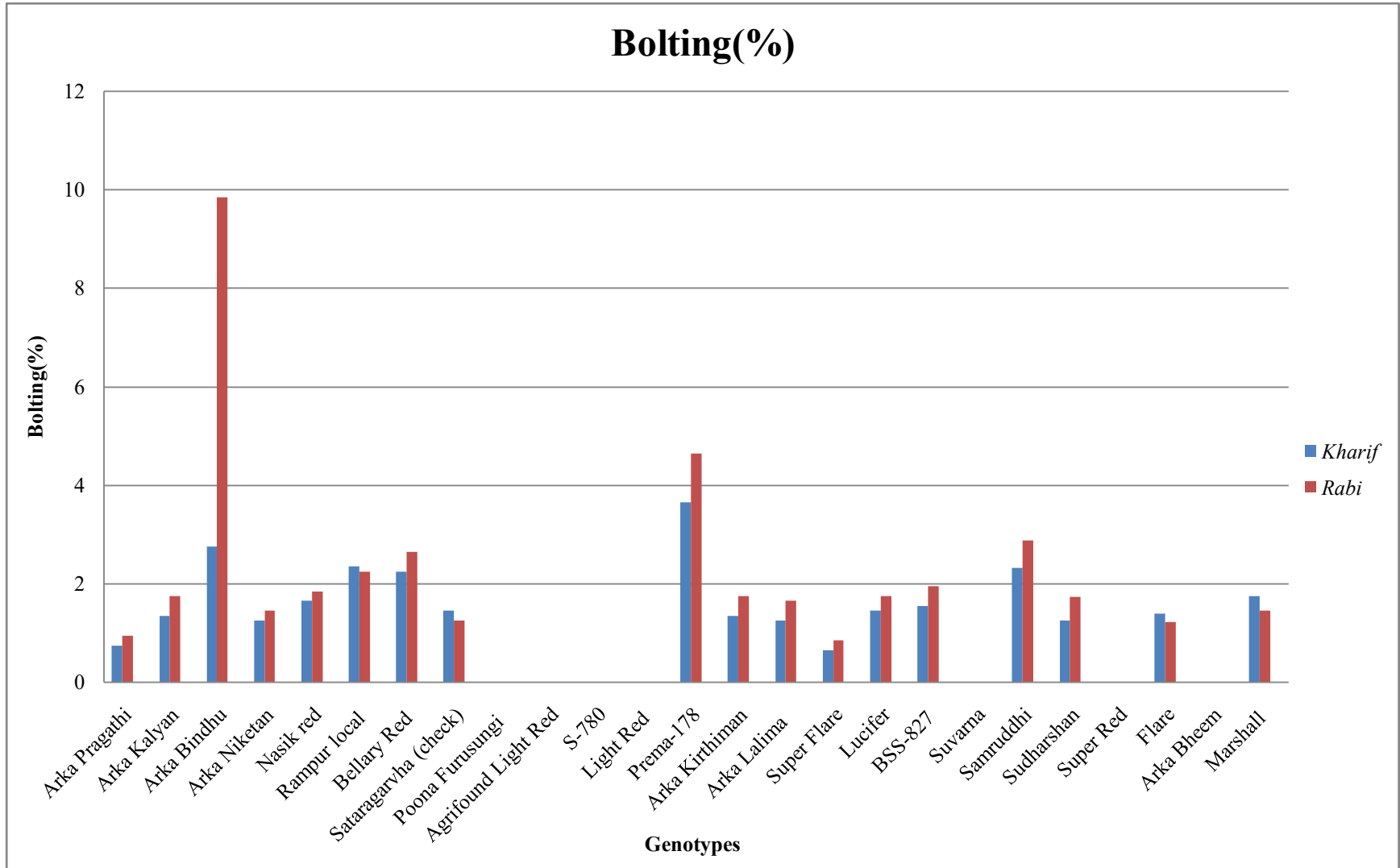
The cultivar Arka Bindu noticed the lowest collar thickness in *Kharif* and *Rabi* season (1.10 cm and 0.98 cm, respectively). Whereas, Super Flare recorded the highest bulb collar thickness in *Kharif* and *Rabi* seasons (1.38 cm and 1.39 cm, respectively).

In pooled analysis, the lowest collar thickness was registered in Arka Bindu (1.04 cm) followed by Light Red (1.16 cm). While, Super Flare registered maximum collar thickness (1.39 cm). However, twelve genotypes recorded lowest collar thickness than the grand mean of 1.24 cm.

**Table 8. Bolting percentage of different onion genotypes as influenced by *Kharif* and *Rabi* seasons**

| Sl. No.                      | Genotypes            | Bolting (%)   |         |              |         |              |                |
|------------------------------|----------------------|---------------|---------|--------------|---------|--------------|----------------|
|                              |                      | <i>Kharif</i> |         | <i>Rabi</i>  |         | Pooled       |                |
| <b>Varieties</b>             |                      |               |         |              |         |              |                |
| 1                            | Arka Pragathi        | 0.75          | (4.89)  | 0.95         | (5.56)  | <b>0.85</b>  | <b>(5.28)</b>  |
| 2                            | Arka Kalyan          | 1.35          | (6.65)  | 1.75         | (7.58)  | <b>1.55</b>  | <b>(7.15)</b>  |
| 3                            | Arka Bindu           | 2.75          | (9.50)  | 9.85         | (18.29) | <b>6.30</b>  | <b>(14.53)</b> |
| 4                            | Arka Niketan         | 1.25          | (6.41)  | 1.45         | (6.89)  | <b>1.35</b>  | <b>(6.67)</b>  |
| 5                            | Nasik Red            | 1.65          | (7.36)  | 1.85         | (7.81)  | <b>1.75</b>  | <b>(7.59)</b>  |
| 6                            | Rampur Local         | 2.35          | (8.81)  | 2.25         | (8.62)  | <b>2.30</b>  | <b>(8.71)</b>  |
| 7                            | Bellary Red          | 2.25          | (8.62)  | 2.65         | (9.36)  | <b>2.45</b>  | <b>(9.00)</b>  |
| 8                            | Sataragarvha (check) | 1.45          | (6.89)  | 1.25         | (6.39)  | <b>1.35</b>  | <b>(6.65)</b>  |
| 9                            | Poona Furusungi      | 0.00          | (0.40)  | 0.00         | (0.40)  | <b>0.00</b>  | <b>(0.40)</b>  |
| 10                           | Agrifound Light Red  | 0.00          | (0.40)  | 0.00         | (0.40)  | <b>0.00</b>  | <b>(0.40)</b>  |
| 11                           | S-780                | 0.00          | (0.40)  | 0.00         | (0.40)  | <b>0.00</b>  | <b>(0.40)</b>  |
| 12                           | Light Red            | 0.00          | (0.40)  | 0.00         | (0.40)  | <b>0.00</b>  | <b>(0.40)</b>  |
| 13                           | Prema-178            | 3.65          | (11.01) | 4.65         | (12.43) | <b>4.15</b>  | <b>(11.75)</b> |
| <b>F<sub>1</sub> Hybrids</b> |                      |               |         |              |         |              |                |
| 14                           | Arka Kirthiman       | 1.35          | (6.66)  | 1.75         | (7.57)  | <b>1.55</b>  | <b>(7.14)</b>  |
| 15                           | Arka Lalima          | 1.25          | (6.41)  | 1.65         | (7.36)  | <b>1.45</b>  | <b>(6.91)</b>  |
| 16                           | Super Flare          | 0.65          | (4.61)  | 0.85         | (5.25)  | <b>0.75</b>  | <b>(4.94)</b>  |
| 17                           | Lucifer              | 1.45          | (6.89)  | 1.75         | (7.58)  | <b>1.60</b>  | <b>(7.26)</b>  |
| 18                           | BSS-827              | 1.55          | (7.13)  | 1.95         | (7.98)  | <b>1.75</b>  | <b>(7.59)</b>  |
| 19                           | Suvarna              | 0.00          | (0.40)  | 0.00         | (0.40)  | <b>0.00</b>  | <b>(0.40)</b>  |
| 20                           | Samruddhi            | 2.33          | (8.77)  | 2.88         | (9.76)  | <b>2.61</b>  | <b>(9.28)</b>  |
| 21                           | Sudharshan           | 1.25          | (6.41)  | 1.74         | (7.56)  | <b>1.50</b>  | <b>(7.01)</b>  |
| 22                           | Super Red            | 0.00          | (0.40)  | 0.00         | (0.40)  | <b>0.00</b>  | <b>(0.40)</b>  |
| 23                           | Flare                | 1.40          | (6.77)  | 1.22         | (6.33)  | <b>1.31</b>  | <b>(6.56)</b>  |
| <b>Synthetics</b>            |                      |               |         |              |         |              |                |
| 24                           | Arka Bheem           | 0.00          | (0.40)  | 0.00         | (0.40)  | <b>0.00</b>  | <b>(0.40)</b>  |
| 25                           | Marshall             | 1.75          | (7.59)  | 1.45         | (6.89)  | <b>1.60</b>  | <b>(7.26)</b>  |
| <b>Mean</b>                  |                      | <b>1.22</b>   |         | <b>1.68</b>  |         | <b>1.45</b>  |                |
| <b>SEm±</b>                  |                      | <b>0.17</b>   |         | <b>0.19</b>  |         | <b>0.11</b>  |                |
| <b>CD at 5%</b>              |                      | <b>0.49</b>   |         | <b>0.56</b>  |         | <b>0.33</b>  |                |
| <b>CV (%)</b>                |                      | <b>19.69</b>  |         | <b>16.08</b> |         | <b>10.89</b> |                |

Values in parenthesis are Arc sin transformed



**Fig. 2. Bolting percentage of different onion genotypes as influenced by *Kharif* and *Rabi* season**

The minimum collar thickness (1.04 cm) was noticed in Arka Bindu and it was maximum in Super Flare (1.39 cm) with a grand mean of 1.24 cm. The estimates of GV (0.07) and PV (0.08) were recorded. The estimates of GCV and PCV were low (5.37% and 6.59%, respectively). The heritability was high (66.39%) with low genetic advance over per cent mean of 9.02 per cent and genetic advance (0.11) for this trait (Table 6).

#### **4.1.1.9 Neck thickness after curing (cm)**

Data pertaining to neck thickness after curing differed significantly among the onion genotypes during *Kharif* and *Rabi* (Table 9).

The cultivar Rampur Local recorded lowest neck thickness in *Kharif* and *Rabi* season (0.40 cm and 0.43 cm, respectively). Whereas, Super Flare recorded the highest bulb neck thickness in *Kharif* and *Rabi* season (0.70 cm and 0.72 cm, respectively).

In pooled analysis, the lowest neck thickness was registered in Rampur Local (0.42 cm), followed Arka Bindu (0.45 cm). However, Super Flare recorded maximum neck thickness (0.71 cm). While, thirteen genotypes recorded lowest neck thickness than the grand mean of 0.54 cm.

The minimum neck thickness (0.42 cm) was recorded in Rampur Local and it was maximum in Super Flare (0.71 cm) with a grand mean of 0.54 cm. The estimates of GV (0.07) and PV (0.09) were recorded. The estimates of GCV and PCV were moderate (13.56% and 16.02%, respectively). The heritability was high (71.65%) with high genetic advance over per cent mean of 23.64 per cent and genetic advance (0.13) for this trait (Table 6).

#### **4.1.2 Yield parameters**

##### **4.1.2.1 Polar diameter of bulb (cm)**

The results revealed that polar diameter of bulb produced by different onion genotypes was differed significantly during *Kharif* and *Rabi* (Table 10).

Table 9. Collar thickness at harvest and Neck thickness after curing of bulbs in different onion genotypes as influenced by *Kharif* and *Rabi* seasons

| Sl. No.                      | Genotypes            | Collar thickness (cm) |             |             | Neck thickness (cm) |              |             |
|------------------------------|----------------------|-----------------------|-------------|-------------|---------------------|--------------|-------------|
|                              |                      | <i>Kharif</i>         | <i>Rabi</i> | Pooled      | <i>Kharif</i>       | <i>Rabi</i>  | Pooled      |
| <b>Varieties</b>             |                      |                       |             |             |                     |              |             |
| 1                            | Arka Pragathi        | 1.12                  | 1.27        | <b>1.20</b> | 0.43                | 0.52         | <b>0.48</b> |
| 2                            | Arka Kalyan          | 1.24                  | 1.29        | <b>1.27</b> | 0.53                | 0.57         | <b>0.55</b> |
| 3                            | Arka Bindu           | 1.10                  | 0.98        | <b>1.04</b> | 0.42                | 0.48         | <b>0.45</b> |
| 4                            | Arka Niketan         | 1.22                  | 1.24        | <b>1.23</b> | 0.50                | 0.52         | <b>0.51</b> |
| 5                            | Nasik Red            | 1.24                  | 1.26        | <b>1.25</b> | 0.56                | 0.58         | <b>0.57</b> |
| 6                            | Rampur Local         | 1.16                  | 1.19        | <b>1.18</b> | 0.40                | 0.43         | <b>0.42</b> |
| 7                            | Bellary Red          | 1.18                  | 1.21        | <b>1.20</b> | 0.48                | 0.47         | <b>0.48</b> |
| 8                            | Sataragarvha (check) | 1.29                  | 1.31        | <b>1.30</b> | 0.60                | 0.61         | <b>0.61</b> |
| 9                            | Poona Furusungi      | 1.17                  | 1.23        | <b>1.20</b> | 0.42                | 0.48         | <b>0.45</b> |
| 10                           | Agrifound Light Red  | 1.25                  | 1.27        | <b>1.26</b> | 0.56                | 0.54         | <b>0.55</b> |
| 11                           | S-780                | 1.23                  | 1.24        | <b>1.24</b> | 0.53                | 0.51         | <b>0.52</b> |
| 12                           | Light Red            | 1.17                  | 1.15        | <b>1.16</b> | 0.48                | 0.47         | <b>0.48</b> |
| 13                           | Prema-178            | 1.27                  | 1.25        | <b>1.26</b> | 0.58                | 0.59         | <b>0.59</b> |
| <b>F<sub>1</sub> Hybrids</b> |                      |                       |             |             |                     |              |             |
| 14                           | Arka Kirthiman       | 1.35                  | 1.34        | <b>1.35</b> | 0.68                | 0.65         | <b>0.67</b> |
| 15                           | Arka Lalima          | 1.32                  | 1.36        | <b>1.34</b> | 0.63                | 0.66         | <b>0.65</b> |
| 16                           | Super Flare          | 1.38                  | 1.39        | <b>1.39</b> | 0.70                | 0.72         | <b>0.71</b> |
| 17                           | Lucifer              | 1.23                  | 1.26        | <b>1.25</b> | 0.52                | 0.54         | <b>0.53</b> |
| 18                           | BSS-827              | 1.27                  | 1.31        | <b>1.29</b> | 0.55                | 0.58         | <b>0.57</b> |
| 19                           | Suvarna              | 1.15                  | 1.19        | <b>1.17</b> | 0.47                | 0.45         | <b>0.46</b> |
| 20                           | Samruddhi            | 1.31                  | 1.34        | <b>1.33</b> | 0.61                | 0.64         | <b>0.63</b> |
| 21                           | Sudharshan           | 1.16                  | 1.27        | <b>1.22</b> | 0.43                | 0.47         | <b>0.45</b> |
| 22                           | Super Red            | 1.25                  | 1.29        | <b>1.27</b> | 0.56                | 0.58         | <b>0.57</b> |
| 23                           | Flare                | 1.33                  | 1.35        | <b>1.34</b> | 0.62                | 0.66         | <b>0.64</b> |
| <b>Synthetics</b>            |                      |                       |             |             |                     |              |             |
| 24                           | Arka Bheem           | 1.18                  | 1.21        | <b>1.20</b> | 0.45                | 0.48         | <b>0.47</b> |
| 25                           | Marshall             | 1.15                  | 1.23        | <b>1.19</b> | 0.43                | 0.51         | <b>0.47</b> |
| Mean                         |                      | <b>1.23</b>           | <b>1.26</b> | <b>1.24</b> | <b>0.53</b>         | <b>0.55</b>  | <b>0.54</b> |
| SEm±                         |                      | <b>0.05</b>           | <b>0.05</b> | <b>0.03</b> | <b>0.05</b>         | <b>0.04</b>  | <b>0.03</b> |
| CD at 5%                     |                      | <b>0.14</b>           | <b>0.14</b> | <b>0.10</b> | <b>0.14</b>         | <b>0.13</b>  | <b>0.09</b> |
| CV (%)                       |                      | <b>5.67</b>           | <b>5.53</b> | <b>3.82</b> | <b>12.67</b>        | <b>11.18</b> | <b>8.53</b> |

Among different onion genotypes, Arka Bheem recorded the highest polar diameter in *Kharif* and *Rabi* season (6.40 cm and 6.60 cm, respectively). Whereas, the lowest polar diameter was observed in Arka Bindu in *Kharif* and *Rabi* season (4.10 cm and 4.20 cm, respectively).

In pooled analysis, the maximum Polar diameter was registered in Arka Bheem (6.50 cm) followed by Arka Lalima (5.68 cm). While Arka Bindu recorded lowest thickness (4.15 cm each). Whereas, eleven genotypes recorded maximum polar diameter than the grand mean of 5.11 cm.

Polar bulb diameter ranged from 4.15 cm (Arka Bindu) to 6.50 cm (Arka Bheem) with a mean of 5.11 cm. The estimates of phenotypic variance and genotypic variance were (0.25 and 0.18, respectively). The estimates of GCV and PCV were low (8.32% and 9.87% respectively). A high heritability (71.04%) coupled with a moderate genetic advance as per cent over mean (14.44%) and genetic advance (0.74) was observed for this trait (Table 6).

#### **4.1.2.2 Equatorial diameter of bulb (cm)**

Data pertaining to equatorial diameter of bulb produced by different onion genotypes differed significantly during *Kharif* and *Rabi* (Table 10)

The results revealed that, Super Flare recorded the significantly highest equatorial diameter in *Kharif* and *Rabi* season (7.40 cm and 7.50 cm, respectively). A lowest Equatorial diameter was observed in Arka Bindu in *Kharif* and *Rabi* season (4.45 cm and 4.65, cm respectively).

In pooled data analysis, the maximum equatorial diameter was registered in Super Flare (7.45 cm), followed by Marshall (6.90 cm). While, Arka Bindu recorded lowest equatorial diameter of 4.55 cm. Of twenty five genotypes eleven exceeded the grand mean of 6.13 cm. Equatorial bulb diameter ranged from 4.55 cm (Arka Bindu) to 7.45 cm (Super Flare) with a mean of 6.13 cm. The estimates of phenotypic variance and genotypic variance were (0.31 and 0.23, respectively). The estimates of GCV and PCV were low (7.90% and 9.09% respectively).

Table 10. Polar and equatorial diameter of bulb in different onion genotypes as influenced by *Kharif* and *Rabi* seasons

| Sl. No.                      | Genotypes            | Polar diameter (cm) |             |             | Equatorial diameter (cm) |             |             |
|------------------------------|----------------------|---------------------|-------------|-------------|--------------------------|-------------|-------------|
|                              |                      | <i>Kharif</i>       | <i>Rabi</i> | Pooled      | <i>Kharif</i>            | <i>Rabi</i> | Pooled      |
| <b>Varieties</b>             |                      |                     |             |             |                          |             |             |
| 1                            | ArkaPragathi         | 4.95                | 5.10        | <b>5.03</b> | 5.60                     | 5.80        | <b>5.70</b> |
| 2                            | ArkaKalyan           | 4.75                | 4.45        | <b>4.60</b> | 6.10                     | 5.70        | <b>5.90</b> |
| 3                            | ArkaBindu            | 4.10                | 4.20        | <b>4.15</b> | 4.45                     | 4.65        | <b>4.55</b> |
| 4                            | ArkaNiketan          | 4.60                | 4.80        | <b>4.70</b> | 6.10                     | 6.40        | <b>6.25</b> |
| 5                            | Nasik Red            | 4.20                | 5.30        | <b>4.75</b> | 5.90                     | 6.10        | <b>6.00</b> |
| 6                            | Rampur Local         | 5.10                | 5.50        | <b>5.30</b> | 6.50                     | 6.70        | <b>6.60</b> |
| 7                            | Bellary Red          | 5.20                | 5.60        | <b>5.40</b> | 5.85                     | 6.10        | <b>5.98</b> |
| 8                            | Sataragarvha (check) | 4.90                | 4.75        | <b>4.83</b> | 6.05                     | 5.85        | <b>5.95</b> |
| 9                            | Poona Furusungi      | 5.35                | 5.65        | <b>5.50</b> | 6.25                     | 6.50        | <b>6.38</b> |
| 10                           | Agrifound Light Red  | 5.10                | 5.30        | <b>5.20</b> | 6.00                     | 6.20        | <b>6.10</b> |
| 11                           | S-780                | 5.20                | 5.65        | <b>5.43</b> | 6.60                     | 6.50        | <b>6.55</b> |
| 12                           | Light Red            | 4.60                | 4.90        | <b>4.75</b> | 5.40                     | 5.60        | <b>5.50</b> |
| 13                           | Prema-178            | 4.80                | 5.20        | <b>5.00</b> | 6.30                     | 6.20        | <b>6.25</b> |
| <b>F<sub>1</sub> Hybrids</b> |                      |                     |             |             |                          |             |             |
| 14                           | ArkaKirthiman        | 5.25                | 5.55        | <b>5.40</b> | 5.90                     | 6.30        | <b>6.10</b> |
| 15                           | ArkaLalima           | 5.50                | 5.85        | <b>5.68</b> | 5.90                     | 6.10        | <b>6.00</b> |
| 16                           | Super Flare          | 5.35                | 5.95        | <b>5.65</b> | 7.40                     | 7.50        | <b>7.45</b> |
| 17                           | Lucifer              | 5.20                | 5.45        | <b>5.33</b> | 5.90                     | 6.30        | <b>6.10</b> |
| 18                           | BSS-827              | 5.20                | 4.80        | <b>5.00</b> | 6.40                     | 6.20        | <b>6.30</b> |
| 19                           | Suvarna              | 4.65                | 4.85        | <b>4.75</b> | 5.80                     | 5.90        | <b>5.85</b> |
| 20                           | Samruddhi            | 5.25                | 5.10        | <b>5.18</b> | 6.50                     | 5.90        | <b>6.20</b> |
| 21                           | Sudharshan           | 4.60                | 4.80        | <b>4.70</b> | 5.70                     | 5.90        | <b>5.80</b> |
| 22                           | Super Red            | 4.85                | 4.65        | <b>4.75</b> | 6.60                     | 6.40        | <b>6.50</b> |
| 23                           | Flare                | 4.85                | 5.25        | <b>5.05</b> | 6.30                     | 6.60        | <b>6.45</b> |
| <b>Synthetics</b>            |                      |                     |             |             |                          |             |             |
| 24                           | ArkaBheem            | 6.40                | 6.60        | <b>6.50</b> | 5.90                     | 6.00        | <b>5.95</b> |
| 25                           | Marshall             | 5.10                | 5.35        | <b>5.23</b> | 7.00                     | 6.80        | <b>6.90</b> |
| <b>Mean</b>                  |                      | <b>5.00</b>         | <b>5.22</b> | <b>5.11</b> | <b>6.10</b>              | <b>6.17</b> | <b>6.13</b> |
| <b>SEm±</b>                  |                      | <b>0.27</b>         | <b>0.25</b> | <b>0.19</b> | <b>0.27</b>              | <b>0.27</b> | <b>0.19</b> |
| <b>CD at 5%</b>              |                      | <b>0.78</b>         | <b>0.73</b> | <b>0.56</b> | <b>0.80</b>              | <b>0.80</b> | <b>0.57</b> |
| <b>CV (%)</b>                |                      | <b>7.56</b>         | <b>6.78</b> | <b>5.31</b> | <b>6.33</b>              | <b>6.26</b> | <b>4.49</b> |

A high heritability (75.54%) coupled with a moderate genetic advance as per cent over mean (14.14%) and genetic advance (0.87) was observed for this trait (Table 6).

#### **4.1.2.3 Average bulb weight (g)**

The data pertaining to average bulb weight of different onion genotypes differed significantly during *Kharif* and *Rabi* (Table 11).

In *Kharif* and *Rabi* seasons, the hybrid Super Flare recorded the highest average bulb weight (135.00 and 132.50 g, respectively). Whereas, lowest was recorded in Arka Bindu (37.50 and 39.30 g, respectively).

In pooled analysis, maximum average bulb weight was registered in Super Flare (133.75 g) followed by Arka Bheem (107.75 g). However, lowest average bulb weight was registered in Arka Bindu (38.40 g). While, ten genotypes exceeded the grand mean of 92.74g.

Average bulb weight ranged from 38.40 g (Arka Bindu) to 133.75 g (Super Flare) with a grand mean of 92.74 g. The phenotypic (275.37) and genotypic variance (245.06) were recorded. There was a moderate GCV (16.88%) and PCV (17.89%) observed for this trait. The heritability was high (88.99%) with a high genetic advance as per cent over mean (32.80%) and genetic advance (30.42) (Table 6).

#### **4.1.2.4 Average ten bulb weight (g)**

The data with respect to average ten bulb weight of different onion genotypes differed significantly during *Kharif* and *Rabi* seasons (Table 11).

In *Kharif* and *Rabi* seasons, the hybrid Super Flare recorded the significantly highest average ten bulb weight (1380 g and 1322 g, respectively). Whereas, lowest was observed in Arka Bindu (380 g and 397 g, respectively).

Table 11. Average bulb weight and average ten bulb weight of different onion genotypes as influenced by *Kharif* and *Rabi* seasons

| Sl. No.                      | Genotypes            | Average bulb weight (g) |              |               | Average ten bulb weight (g) |               |                |
|------------------------------|----------------------|-------------------------|--------------|---------------|-----------------------------|---------------|----------------|
|                              |                      | <i>Kharif</i>           | <i>Rabi</i>  | Pooled        | <i>Kharif</i>               | <i>Rabi</i>   | Pooled         |
| <b>Varieties</b>             |                      |                         |              |               |                             |               |                |
| 1                            | Arka Pragathi        | 86.30                   | 92.70        | <b>89.50</b>  | 865.00                      | 935.00        | <b>900.00</b>  |
| 2                            | Arka Kalyan          | 94.50                   | 88.40        | <b>91.45</b>  | 932.00                      | 890.00        | <b>911.00</b>  |
| 3                            | Arka Bindu           | 37.50                   | 39.30        | <b>38.40</b>  | 380.00                      | 397.00        | <b>388.50</b>  |
| 4                            | Arka Niketan         | 91.20                   | 94.20        | <b>92.70</b>  | 908.00                      | 942.00        | <b>925.00</b>  |
| 5                            | Nasik Red            | 87.60                   | 96.50        | <b>92.05</b>  | 867.00                      | 984.00        | <b>925.50</b>  |
| 6                            | Rampur Local         | 101.30                  | 105.30       | <b>103.30</b> | 1030.00                     | 1075.00       | <b>1052.50</b> |
| 7                            | Bellary Red          | 88.40                   | 95.50        | <b>91.95</b>  | 892.00                      | 974.00        | <b>933.00</b>  |
| 8                            | Sataragarvha (check) | 93.40                   | 90.40        | <b>91.90</b>  | 947.00                      | 918.00        | <b>932.50</b>  |
| 9                            | Poona Furusungi      | 106.00                  | 108.30       | <b>107.15</b> | 1082.00                     | 1105.00       | <b>1093.50</b> |
| 10                           | Agrifound Light Red  | 83.50                   | 86.40        | <b>84.95</b>  | 828.00                      | 878.00        | <b>853.00</b>  |
| 11                           | S-780                | 103.50                  | 104.60       | <b>104.05</b> | 1056.00                     | 1084.00       | <b>1070.00</b> |
| 12                           | Light Red            | 78.30                   | 82.60        | <b>80.45</b>  | 762.00                      | 806.00        | <b>784.00</b>  |
| 13                           | Prema-178            | 87.90                   | 89.10        | <b>88.50</b>  | 865.00                      | 898.00        | <b>881.50</b>  |
| <b>F<sub>1</sub> Hybrids</b> |                      |                         |              |               |                             |               |                |
| 14                           | Arka Kirthiman       | 88.20                   | 93.20        | <b>90.70</b>  | 890.00                      | 942.00        | <b>916.00</b>  |
| 15                           | Arka Lalima          | 89.10                   | 97.60        | <b>93.35</b>  | 895.00                      | 988.00        | <b>941.50</b>  |
| 16                           | Super Flare          | 135.00                  | 132.50       | <b>133.75</b> | 1380.00                     | 1322.00       | <b>1351.00</b> |
| 17                           | Lucifer              | 96.70                   | 98.20        | <b>97.45</b>  | 982.00                      | 993.00        | <b>987.50</b>  |
| 18                           | BSS-827              | 89.20                   | 85.30        | <b>87.25</b>  | 895.00                      | 842.00        | <b>868.50</b>  |
| 19                           | Suvarna              | 86.30                   | 84.10        | <b>85.20</b>  | 867.00                      | 833.00        | <b>850.00</b>  |
| 20                           | Samruddhi            | 110.00                  | 101.30       | <b>105.65</b> | 1125.00                     | 1008.00       | <b>1066.50</b> |
| 21                           | Sudharshan           | 77.90                   | 76.50        | <b>77.20</b>  | 783.00                      | 756.00        | <b>769.50</b>  |
| 22                           | Super Red            | 88.70                   | 84.50        | <b>86.60</b>  | 890.00                      | 853.00        | <b>871.50</b>  |
| 23                           | Flare                | 89.40                   | 96.40        | <b>92.90</b>  | 896.00                      | 992.00        | <b>944.00</b>  |
| <b>Synthetics</b>            |                      |                         |              |               |                             |               |                |
| 24                           | Arka Bheem           | 107.00                  | 108.50       | <b>107.75</b> | 1087.00                     | 1103.00       | <b>1095.00</b> |
| 25                           | Marshall             | 103.50                  | 105.20       | <b>104.35</b> | 1060.00                     | 1085.00       | <b>1072.50</b> |
| <b>Mean</b>                  |                      | <b>92.02</b>            | <b>93.46</b> | <b>92.74</b>  | <b>926.56</b>               | <b>944.12</b> | <b>935.34</b>  |
| <b>SEm±</b>                  |                      | <b>5.15</b>             | <b>5.45</b>  | <b>3.89</b>   | <b>61.60</b>                | <b>73.00</b>  | <b>55.53</b>   |
| <b>CD at 5%</b>              |                      | <b>15.04</b>            | <b>15.92</b> | <b>11.36</b>  | <b>179.79</b>               | <b>213.08</b> | <b>162.07</b>  |
| <b>CV (%)</b>                |                      | <b>7.92</b>             | <b>8.25</b>  | <b>5.94</b>   | <b>9.40</b>                 | <b>10.94</b>  | <b>8.40</b>    |

In pooled analysis, the maximum ten bulb weight was registered in Super Flare (1351 g) followed by Arka Bheem (1095 g). However, lowest ten bulb weight was recorded in Arka Bindu (388.50 g). While, ten genotypes exceeded the grand mean of 935.34 g.

Average ten bulb weight ranged from 388.50 g (Arka Bindu) to 1351.00 g (Super Flare) with a grand mean of 935.34 g. The phenotypic (31056.73) and genotypic variance (24890.46) were recorded. There was a moderate GCV (16.87 %) and PCV (18.84%) observed for this trait. The heritability was high (80.15%) with a high genetic advance as per cent over mean (31.11%) and genetic advance (290.95) (Table 5).

#### **4.1.2.5 Bulb yield per plot (kg)**

The bulb yield per plot produced by different onion genotypes differed significantly during *Kharif* and *Rabi* (Table 12).

Super Flare recorded maximum bulb yield per plot (6.79 kg) followed by S-780 (6.49 kg) and Arka Bindu recorded minimum bulb yield per plot (3.25 kg) in *Kharif* season. However Flare recorded significantly maximum bulb yield per plot (6.85 kg) followed by Super Flare (6.58 kg) and Arka Bindu recorded minimum bulb yield per plot (3.52 kg) in *Rabi* season.

In pooled analysis, the maximum total bulb yield per plot was registered in Super Flare (6.69 kg/plot) followed by Flare (6.60 kg/plot). While, Arka Bindu recorded lowest yield per plot (3.39 kg). Fifteen genotypes exceeded the grand mean of 5.53 kg per plot.

The minimum bulb yield per plot (3.39 kg) was documented in Arka Bindu and it was maximum in Super Flare (6.69 kg) with a grand mean of 5.53 kg. The estimates of GV (0.55) and PV (0.62) were recorded. The estimates of GCV and PCV were moderate (13.35% and 14.18%, respectively). The heritability was high (88.62%) with high genetic advance over per cent mean of 25.88 per cent and genetic advance (1.43) (Table 6).

#### 4.1.2.6 Bulb yield per hectare (t)

Data pertaining to bulb yield per hectare produced by different onion genotypes differed significantly during *Kharif* and *Rabi* seasons (Table 12) (Fig 3). Promising onion genotypes for *Kharif* and *Rabi* season is shown in plate 3a and plate 3b, respectively.

The hybrid Super Flare recorded significantly maximum bulb yield (38.16 t/ha) followed by S-780 (36.50 t/ha) and Arka Bindu recorded minimum bulb yield (17.33 t/ha) in *Kharif* season. While, Flare recorded significantly maximum bulb yield (38.50 t/ha) followed by Super Flare (37.00 t/ha) and Arka Bindu recorded minimum bulb yield (19.77 t/ha) in *Rabi* season.

In pooled analysis, the maximum total bulb yield per hectare was registered in Super Flare (37.58 t/ha), followed by Flare (37.08 t/ha). Whereas, lowest yield per hectare was registered in Arka Bindu (18.55 t/ha). Out of total genotypes fourteen genotypes exceeded the grand mean of 31.08 tonnes per hectare.

The minimum bulb yield (18.5 t/ha) was recorded in Arka Bindu and it was maximum in Super Flare (37.58 t/ha) with a grand mean (31.08 t/ha). The estimates of GV (12.26) and PV (25.45) were registered. An estimates of GCV and PCV were moderate (11.27% and 16.23%, respectively). The heritability was moderate (48.18%) with moderate genetic advance over per cent mean of 16.11 per cent and genetic advance (5.01) (Table 6).

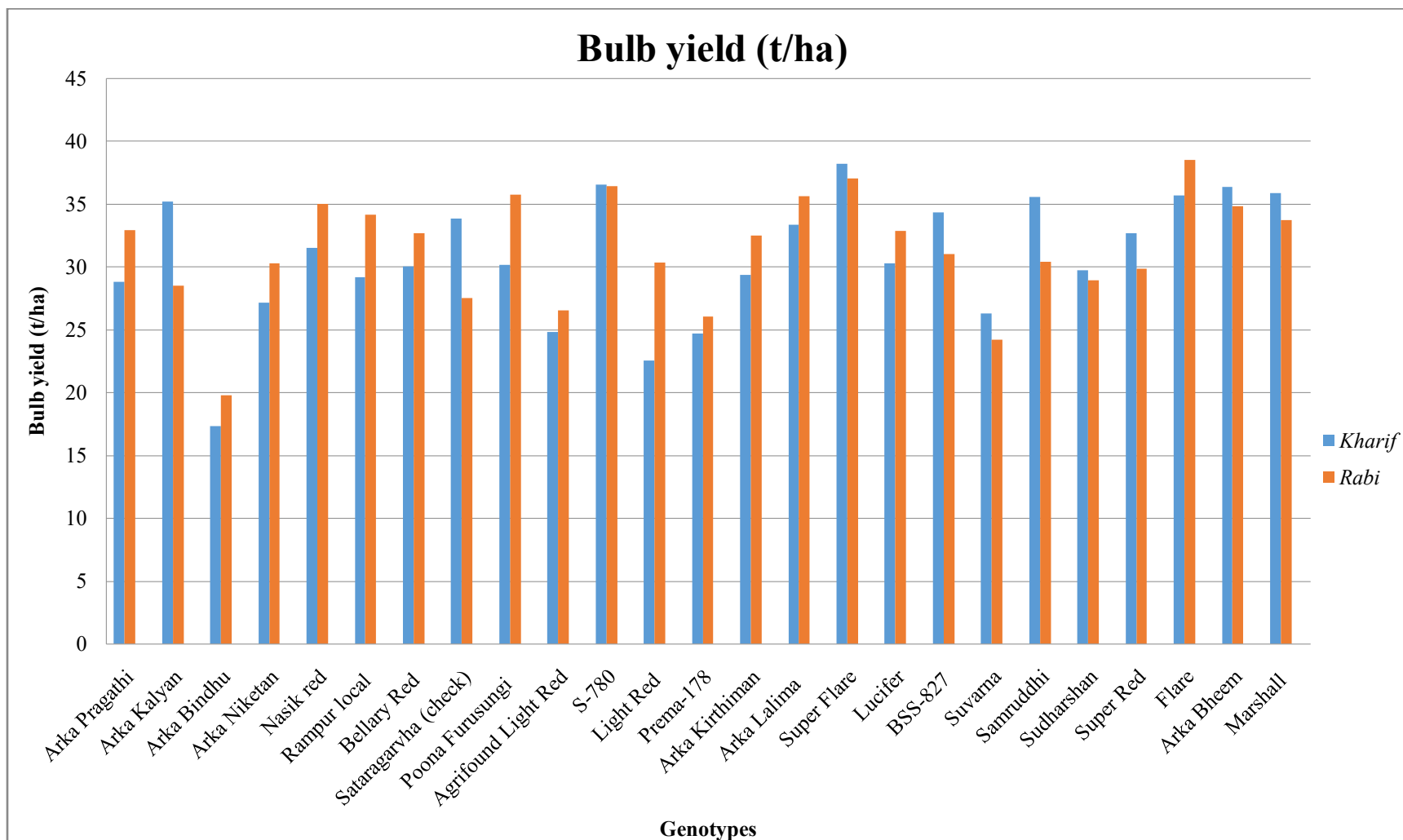
#### 4.1.2.7 Marketable bulb yield (t/ha)

The data pertaining to marketable bulb yield per hectare produced by different onion genotypes differed significantly during *Kharif* and *Rabi* seasons (Table 13).

In *Kharif* season maximum marketable bulb yield per hectare was documented in hybrid Super Flare (37.23 t/ha) followed by S-780 (35.52 t/ha), whereas the Arka Bindu recorded the lowest (14.50 t/ha). While, Flare recorded significantly highest marketable bulb yield (37.03 t/ha) followed by Super Flare (35.90 t/ha) and Arka Bindu recorded minimum bulb yield (17.07 t/ha) in *Rabi* season.

**Table 12. Bulb yield of different onion genotypes as influenced by *Kharif* and *Rabi* seasons**

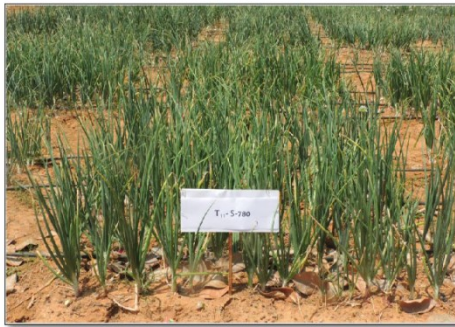
| Sl. No.                      | Genotypes            | Yield per plot (Kg/plot) |             |             | Yield per hectare (t/ha) |              |              |
|------------------------------|----------------------|--------------------------|-------------|-------------|--------------------------|--------------|--------------|
|                              |                      | <i>Kharif</i>            | <i>Rabi</i> | Pooled      | <i>Kharif</i>            | <i>Rabi</i>  | Pooled       |
| <b>Varieties</b>             |                      |                          |             |             |                          |              |              |
| 1                            | Arka Pragathi        | 5.13                     | 5.86        | <b>5.50</b> | 28.82                    | 32.92        | <b>30.87</b> |
| 2                            | Arka Kalyan          | 6.25                     | 5.07        | <b>5.66</b> | 35.16                    | 28.50        | <b>31.83</b> |
| 3                            | Arka Bindu           | 3.25                     | 3.52        | <b>3.39</b> | 17.33                    | 19.77        | <b>18.55</b> |
| 4                            | Arka Niketan         | 4.83                     | 5.38        | <b>5.11</b> | 27.16                    | 30.26        | <b>28.71</b> |
| 5                            | Nasik Red            | 5.60                     | 6.23        | <b>5.92</b> | 31.50                    | 35.00        | <b>33.25</b> |
| 6                            | Rampur Local         | 5.19                     | 6.08        | <b>5.64</b> | 29.16                    | 34.16        | <b>31.66</b> |
| 7                            | Bellary Red          | 5.35                     | 5.81        | <b>5.58</b> | 30.05                    | 32.64        | <b>31.35</b> |
| 8                            | Sataragarvha (check) | 6.02                     | 4.89        | <b>5.46</b> | 33.82                    | 27.50        | <b>30.66</b> |
| 9                            | Poona Furusungi      | 5.36                     | 6.36        | <b>5.86</b> | 30.16                    | 35.73        | <b>32.95</b> |
| 10                           | Agrifound Light Red  | 4.42                     | 4.71        | <b>4.57</b> | 24.83                    | 26.50        | <b>25.67</b> |
| 11                           | S-780                | 6.49                     | 6.47        | <b>6.48</b> | 36.50                    | 36.40        | <b>36.45</b> |
| 12                           | Light Red            | 4.05                     | 5.39        | <b>4.72</b> | 22.50                    | 30.33        | <b>26.42</b> |
| 13                           | Prema-178            | 4.39                     | 4.62        | <b>4.51</b> | 24.66                    | 26.00        | <b>25.33</b> |
| <b>F<sub>1</sub> Hybrids</b> |                      |                          |             |             |                          |              |              |
| 14                           | Arka Kirthiman       | 5.22                     | 5.78        | <b>5.50</b> | 29.33                    | 32.50        | <b>30.92</b> |
| 15                           | Arka Lalima          | 5.93                     | 6.33        | <b>6.13</b> | 33.33                    | 35.60        | <b>34.47</b> |
| 16                           | Super Flare          | 6.79                     | 6.58        | <b>6.69</b> | 38.16                    | 37.00        | <b>37.58</b> |
| 17                           | Lucifer              | 5.39                     | 5.85        | <b>5.62</b> | 30.28                    | 32.86        | <b>31.57</b> |
| 18                           | BSS-827              | 6.11                     | 5.51        | <b>5.81</b> | 34.33                    | 31.00        | <b>32.67</b> |
| 19                           | Suvarna              | 4.67                     | 4.30        | <b>4.49</b> | 26.26                    | 24.16        | <b>25.21</b> |
| 20                           | Samruddhi            | 6.33                     | 5.41        | <b>5.87</b> | 35.56                    | 30.40        | <b>32.98</b> |
| 21                           | Sudharshan           | 5.29                     | 5.14        | <b>5.22</b> | 29.73                    | 28.90        | <b>29.32</b> |
| 22                           | Super Red            | 5.81                     | 5.31        | <b>5.56</b> | 32.66                    | 29.83        | <b>31.25</b> |
| 23                           | Flare                | 6.34                     | 6.85        | <b>6.60</b> | 35.66                    | 38.50        | <b>37.08</b> |
| <b>Synthetics</b>            |                      |                          |             |             |                          |              |              |
| 24                           | Arka Bheem           | 6.46                     | 6.20        | <b>6.33</b> | 36.33                    | 34.83        | <b>35.58</b> |
| 25                           | Marshall             | 6.37                     | 6.04        | <b>6.21</b> | 35.83                    | 33.73        | <b>34.78</b> |
|                              | <b>Mean</b>          | <b>5.48</b>              | <b>5.59</b> | <b>5.53</b> | <b>30.76</b>             | <b>31.40</b> | <b>31.08</b> |
|                              | <b>SEm±</b>          | <b>0.27</b>              | <b>0.31</b> | <b>0.19</b> | <b>2.93</b>              | <b>3.00</b>  | <b>2.57</b>  |
|                              | <b>CD at 5%</b>      | <b>0.79</b>              | <b>0.92</b> | <b>0.55</b> | <b>8.55</b>              | <b>8.76</b>  | <b>7.50</b>  |
|                              | <b>CV (%)</b>        | <b>6.99</b>              | <b>7.96</b> | <b>4.78</b> | <b>13.46</b>             | <b>13.52</b> | <b>11.68</b> |



**Fig. 3. Bulb yield of different onion genotypes as influenced by *Kharif* and *Rabi* seasons**



**Plate 3a. Promising onion genotypes for *Kharif* season**



**Plate 3b. Promising onion genotypes for *Rabi* season**

In pooled analysis, the maximum marketable bulb yield per hectare was registered in Super Flare (36.57 t/ha) followed by Flare (35.61 t/ha). While, Arka Bindu recorded lowest marketable yield (15.79 t/ha). Fourteen genotypes exceeded the grand mean of 29.52 tonnes per hectare.

The minimum marketable bulb yield (15.79 t/ha) was recorded in Arka Bindu and it was maximum in Super Flare (36.57 t/ha) with a grand mean (29.52 t/ha). The estimates of GV (14.58) and PV (28.29) were documented. An estimate of GCV and PCV were moderate (12.93% and 18.01%, respectively). The heritability was moderate (51.53%) with moderate genetic advance over per cent mean (19.12%) and genetic advance (5.65) (Table 6).

#### **4.1.2.8 Unmarketable bulb yield (t/ha)**

Data pertaining to Unmarketable bulb yield per hectare produced by different onion genotypes differed significantly during *Kharif* and *Rabi* (Table 13).

Super Flare recorded significantly minimum unmarketable bulb yield (0.93 t/ha) followed by S-780 (0.98 t/ha) and Arka Bindu recorded maximum unmarketable bulb yield (2.80 t/ha) in *Kharif* season. Whereas, S-780 and Super Flare recorded significantly minimum unmarketable bulb yield (1.10 t/ha) followed by Samruddhi (1.15 t/ha) and Arka Bindu documented maximum unmarketable bulb yield (2.70 t/ha) in *Rabi* season.

In pooled analysis, the minimum unmarketable yield per hectare was registered in Super Flare (1.02 t/ha), followed by S-780 (1.04 t/ha). While, maximum unmarketable bulb yield was registered in Arka Bindu (2.75 t/ha). However, fourteen genotypes recorded lowest unmarketable yield than the grand mean of 1.56 tonnes per hectare.

The minimum Unmarketable bulb yield (1.02 t/ha) was observed in Super Flare and it was maximum in Arka Bindu (2.75 t ha<sup>-1</sup>) with a grand mean (1.56 t/ha). The estimates of GV (0.11) and PV (0.14) were documented. The estimates of GCV and PCV were high (20.84% and 23.59%, respectively). The heritability was high (78.02%) with high genetic advance over per cent mean (37.92%) and genetic advance (0.59) (Table 6).

Table 13. Marketable and Unmarketable yield of different onion genotypes as influenced by *Kharif* and *Rabi* seasons

| Sl. No.                      | Genotypes            | Marketable yield (t/ha) |              |              | Unmarketable yield (t/ha) |              |              |
|------------------------------|----------------------|-------------------------|--------------|--------------|---------------------------|--------------|--------------|
|                              |                      | <i>Kharif</i>           | <i>Rabi</i>  | Pooled       | <i>Kharif</i>             | <i>Rabi</i>  | Pooled       |
| <b>Varieties</b>             |                      |                         |              |              |                           |              |              |
| 1                            | Arka Pragathi        | 27.12                   | 31.40        | <b>29.26</b> | 1.70                      | 1.52         | <b>1.61</b>  |
| 2                            | Arka Kalyan          | 33.66                   | 27.14        | <b>30.40</b> | 1.50                      | 1.36         | <b>1.43</b>  |
| 3                            | Arka Bindu           | 14.50                   | 17.07        | <b>15.79</b> | 2.80                      | 2.70         | <b>2.75</b>  |
| 4                            | Arka Niketan         | 25.53                   | 28.43        | <b>26.98</b> | 1.63                      | 1.83         | <b>1.73</b>  |
| 5                            | Nasik Red            | 30.03                   | 33.34        | <b>31.69</b> | 1.47                      | 1.66         | <b>1.57</b>  |
| 6                            | Rampur Local         | 27.43                   | 32.71        | <b>30.07</b> | 1.73                      | 1.45         | <b>1.59</b>  |
| 7                            | Bellary Red          | 27.85                   | 30.78        | <b>29.32</b> | 2.20                      | 1.86         | <b>2.03</b>  |
| 8                            | Sataragarvha (check) | 32.58                   | 25.77        | <b>29.18</b> | 1.24                      | 1.73         | <b>1.49</b>  |
| 9                            | Poona Furusungi      | 28.99                   | 34.53        | <b>31.76</b> | 1.17                      | 1.87         | <b>1.52</b>  |
| 10                           | Agrifound Light Red  | 22.98                   | 24.73        | <b>23.86</b> | 1.85                      | 1.77         | <b>1.81</b>  |
| 11                           | S-780                | 35.52                   | 34.63        | <b>35.08</b> | 0.98                      | 1.10         | <b>1.04</b>  |
| 12                           | Light Red            | 20.53                   | 29.01        | <b>24.77</b> | 1.97                      | 1.32         | <b>1.65</b>  |
| 13                           | Prema-178            | 22.56                   | 24.04        | <b>23.30</b> | 2.10                      | 1.96         | <b>2.03</b>  |
| <b>F<sub>1</sub> Hybrids</b> |                      |                         |              |              |                           |              |              |
| 14                           | Arka Kirthiman       | 27.76                   | 31.13        | <b>29.45</b> | 1.57                      | 1.37         | <b>1.47</b>  |
| 15                           | Arka Lalima          | 31.90                   | 34.63        | <b>33.27</b> | 1.43                      | 1.22         | <b>1.33</b>  |
| 16                           | Super Flare          | 37.23                   | 35.90        | <b>36.57</b> | 0.93                      | 1.10         | <b>1.02</b>  |
| 17                           | Lucifer              | 28.60                   | 31.09        | <b>29.85</b> | 1.68                      | 1.77         | <b>1.73</b>  |
| 18                           | BSS-827              | 32.99                   | 29.57        | <b>31.28</b> | 1.34                      | 1.43         | <b>1.39</b>  |
| 19                           | Suvarna              | 24.51                   | 22.70        | <b>23.61</b> | 1.75                      | 1.46         | <b>1.61</b>  |
| 20                           | Samruddhi            | 34.31                   | 29.25        | <b>31.78</b> | 1.25                      | 1.15         | <b>1.20</b>  |
| 21                           | Sudharshan           | 28.07                   | 27.54        | <b>27.81</b> | 1.66                      | 1.36         | <b>1.51</b>  |
| 22                           | Super Red            | 31.29                   | 28.41        | <b>29.85</b> | 1.37                      | 1.42         | <b>1.40</b>  |
| 23                           | Flare                | 34.18                   | 37.03        | <b>35.61</b> | 1.48                      | 1.47         | <b>1.48</b>  |
| <b>Synthetics</b>            |                      |                         |              |              |                           |              |              |
| 24                           | Arka Bheem           | 34.81                   | 33.60        | <b>34.21</b> | 1.52                      | 1.23         | <b>1.38</b>  |
| 25                           | Marshall             | 34.36                   | 32.44        | <b>33.40</b> | 1.47                      | 1.29         | <b>1.38</b>  |
| <b>Mean</b>                  |                      | <b>29.17</b>            | <b>29.87</b> | <b>29.52</b> | <b>1.59</b>               | <b>1.54</b>  | <b>1.56</b>  |
| <b>SEm±</b>                  |                      | <b>3.27</b>             | <b>3.01</b>  | <b>2.62</b>  | <b>0.20</b>               | <b>0.12</b>  | <b>0.12</b>  |
| <b>CD at 5%</b>              |                      | <b>9.53</b>             | <b>8.79</b>  | <b>7.64</b>  | <b>0.59</b>               | <b>0.36</b>  | <b>0.36</b>  |
| <b>CV (%)</b>                |                      | <b>15.83</b>            | <b>14.25</b> | <b>12.54</b> | <b>17.87</b>              | <b>11.39</b> | <b>11.06</b> |

### 4.1.3 Quality parameters

#### 4.1.3.1 Number of rings

A significant differences was observed for number of rings per bulb among the onion genotypes evaluated during *Kharif* and *Rabi* seasons (Table 14).

Among the genotypes the maximum number of rings per bulb was recorded in case of Super Flare (10.34) followed by Suvarna (9.72). Whereas, Arka Niketan recorded the minimum number of rings per bulb (6.60) during *Kharif* season. In *Rabi* season, cultivar Super Flare recorded maximum number of rings per bulb (10.52) followed by S-780 (9.65). While, Arka Niketan registered lowest number of rings per bulb (7.15).

In pooled analysis, the maximum number of rings was registered in Super Flare (10.43) followed by Suvarna (9.60). While, Arka Nikethan recorded lowest number of rings per bulb (6.88). Of twenty five genotypes ten exceeded the grand mean of 8.60.

Number of rings per bulb ranged from 6.88 (Arka Nikethan) to 10.43 (Super Flare) with a mean of 8.60. The estimates of phenotypic variance and genotypic variance were (0.51 and 0.78, respectively). There was a low GCV (8.31%) and moderate PCV (10.29%), high heritability (65.23%) coupled with a moderate genetic advance as per cent over mean (13.83%) and genetic advance (1.19) was observed for this trait (Table 6).

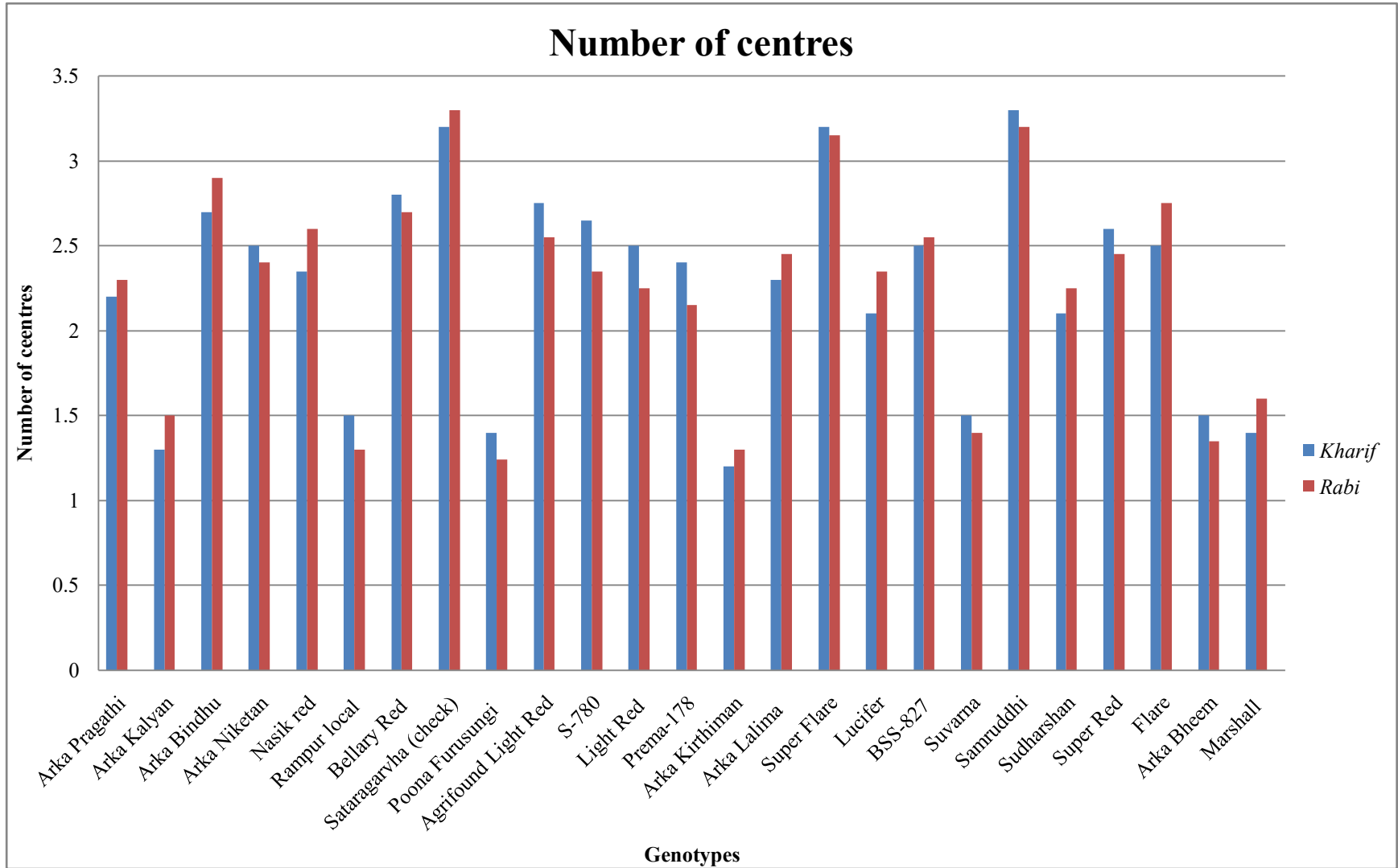
#### 4.1.3.2 Number of centers

The data with reference to number of centers in different onion genotypes differed significantly during *Kharif* and *Rabi* seasons (Table 14) (Fig 4).

The number of centers was found to be minimum in hybrid Arka Kirthiman (1.20) which was on par with Arka Kalyan (1.30), followed by Poona Furusungi (1.40) and Marshall (1.40). Whereas, Samrudhi recorded the highest number of centres per bulb (3.30) during *Kharif* season. In *Rabi* season, variety Poona Furusungi (1.24) registered minimum number of centres, followed by Arka Kirthiman (1.30). While, highest number of centres per bulb recorded in Sataragarvha (3.30).

**Table 14. Number of rings and centres per bulb in different onion genotypes as influenced by *Kharif* and *Rabi* seasons**

| Sl. No.                      | Genotypes            | No. of Rings  |             |              | No. of Centres |              |             |
|------------------------------|----------------------|---------------|-------------|--------------|----------------|--------------|-------------|
|                              |                      | <i>Kharif</i> | <i>Rabi</i> | Pooled       | <i>Kharif</i>  | <i>Rabi</i>  | Pooled      |
| <b>Varieties</b>             |                      |               |             |              |                |              |             |
| 1.                           | Arka Pragathi        | 8.50          | 8.40        | <b>8.45</b>  | 2.20           | 2.30         | <b>2.25</b> |
| 2.                           | Arka Kalyan          | 7.50          | 7.70        | <b>7.60</b>  | 1.30           | 1.50         | <b>1.40</b> |
| 3.                           | Arka Bindu           | 9.20          | 9.35        | <b>9.28</b>  | 2.70           | 2.90         | <b>2.80</b> |
| 4.                           | Arka Niketan         | 6.60          | 7.15        | <b>6.88</b>  | 2.50           | 2.40         | <b>2.45</b> |
| 5.                           | Nasik Red            | 8.50          | 8.35        | <b>8.43</b>  | 2.35           | 2.60         | <b>2.48</b> |
| 6.                           | Rampur Local         | 8.20          | 8.10        | <b>8.15</b>  | 1.50           | 1.30         | <b>1.40</b> |
| 7.                           | Bellary Red          | 9.40          | 9.20        | <b>9.30</b>  | 2.80           | 2.70         | <b>2.75</b> |
| 8.                           | Sataragarvha (check) | 8.50          | 8.35        | <b>8.43</b>  | 3.20           | 3.30         | <b>3.25</b> |
| 9.                           | Poona Furusungi      | 9.30          | 9.15        | <b>9.23</b>  | 1.40           | 1.24         | <b>1.32</b> |
| 10.                          | Agrifound Light Red  | 8.60          | 8.85        | <b>8.73</b>  | 2.75           | 2.55         | <b>2.65</b> |
| 11.                          | S-780                | 9.40          | 9.65        | <b>9.53</b>  | 2.65           | 2.35         | <b>2.50</b> |
| 12.                          | Light Red            | 8.20          | 8.30        | <b>8.25</b>  | 2.50           | 2.25         | <b>2.38</b> |
| 13.                          | Prema-178            | 8.40          | 8.50        | <b>8.45</b>  | 2.40           | 2.15         | <b>2.28</b> |
| <b>F<sub>1</sub> Hybrids</b> |                      |               |             |              |                |              |             |
| 14.                          | Arka Kirthiman       | 7.50          | 7.30        | <b>7.40</b>  | 1.20           | 1.30         | <b>1.25</b> |
| 15.                          | Arka Lalima          | 8.40          | 8.65        | <b>8.53</b>  | 2.30           | 2.45         | <b>2.38</b> |
| 16.                          | Super Flare          | 10.34         | 10.52       | <b>10.43</b> | 3.20           | 3.15         | <b>3.18</b> |
| 17.                          | Lucifer              | 9.27          | 9.45        | <b>9.36</b>  | 2.10           | 2.35         | <b>2.23</b> |
| 18.                          | BSS-827              | 8.48          | 8.32        | <b>8.40</b>  | 2.50           | 2.55         | <b>2.53</b> |
| 19.                          | Suvarna              | 9.72          | 9.47        | <b>9.60</b>  | 1.50           | 1.40         | <b>1.45</b> |
| 20.                          | Samruddhi            | 8.25          | 8.40        | <b>8.33</b>  | 3.30           | 3.20         | <b>3.25</b> |
| 21.                          | Sudharshan           | 9.12          | 9.32        | <b>9.22</b>  | 2.10           | 2.25         | <b>2.18</b> |
| 22.                          | Super Red            | 7.63          | 7.79        | <b>7.71</b>  | 2.60           | 2.45         | <b>2.53</b> |
| 23.                          | Flare                | 8.30          | 8.42        | <b>8.36</b>  | 2.50           | 2.75         | <b>2.63</b> |
| <b>Synthetics</b>            |                      |               |             |              |                |              |             |
| 24.                          | Arka Bheem           | 9.32          | 9.25        | <b>9.29</b>  | 1.50           | 1.35         | <b>1.43</b> |
| 25.                          | Marshall             | 7.62          | 7.85        | <b>7.74</b>  | 1.40           | 1.60         | <b>1.50</b> |
| <b>Mean</b>                  |                      | <b>8.57</b>   | <b>8.63</b> | <b>8.60</b>  | <b>2.26</b>    | <b>2.25</b>  | <b>2.26</b> |
| <b>SEm±</b>                  |                      | <b>0.46</b>   | <b>0.48</b> | <b>0.37</b>  | <b>0.19</b>    | <b>0.20</b>  | <b>0.15</b> |
| <b>CD at 5%</b>              |                      | <b>1.35</b>   | <b>1.39</b> | <b>1.08</b>  | <b>0.57</b>    | <b>0.58</b>  | <b>0.44</b> |
| <b>CV (%)</b>                |                      | <b>7.66</b>   | <b>7.82</b> | <b>6.07</b>  | <b>12.13</b>   | <b>12.56</b> | <b>9.34</b> |



**Fig. 4. Number of centres per bulb in different onion genotypes as influenced by *Kharif* and *Rabi* seasons**

In pooled analysis, the lowest number of centres was registered in Arka Kirthiman (1.25) followed by Poona Furusungi (1.32). However, maximum number of centres was noticed in Sataragarvha and Samruddhi (3.25 each). While, ten genotypes recorded lowest number of centres than the grand mean of 2.26.

Number of centres per bulb ranged from 1.25 (Arka Kirthiman) to 3.25 (Sataragarvha and samruddhi) with a mean of 2.26. The estimates of phenotypic variance and genotypic variance were (0.41 and 0.36, respectively). The estimates of GCV and PCV were high (26.71% and 28.29%, respectively). High heritability (89.09%) coupled with a high genetic advance as per cent over mean (51.93%) and genetic advance (1.17) was observed for this trait (Table 6).

#### **4.1.3.3 Total soluble solids (° brix)**

The data pertaining to total soluble solids in different onion genotypes differed significantly during *Kharif* and *Rabi* seasons (Table 15).

During *Kharif* season, the maximum total soluble solids was noticed in the variety Arka Bindu (17.33° brix) followed by Arka Lalima (13.67 ° brix). Whereas, the minimum total soluble solids was recorded in the hybrid Super Flare (11.27° brix). In *Rabi* season, the maximum total soluble solids was recorded in the variety Arka Bindu (17.38 °brix) followed by Arka Nikethan (13.69 °brix). While, the minimum total soluble solids was registered in the hybrid BSS-827 (11.33 °brix).

In pooled analysis, the maximum TSS was registered in Arka Bindu (17.36 °brix) followed by Arka Niketan (13.67 °brix). Whereas, lowest TSS was recorded in Super Flare (11.30 °brix). Out of twenty five genotypes, eleven genotypes recorded maximum TSS than the grand mean of 12.71° brix.

Total soluble solids ranged from 11.30 °brix (Super Flare) to 17.36 °brix (Arka Bindu) with a grand mean of 12.71 brix. The phenotypic (1.64) and genotypic variance (1.40) were recorded. There was a low GCV (9.31 %) and PCV (10.09%) observed for this trait. The heritability was high (85.22%) with a moderate genetic advance as per cent over mean (17.71%) and genetic advance (2.25) (Table 6).

#### **4.1.3.4 Pungency (Pyruvic acid content $\mu$ moles/gram of fresh weight)**

The data owing to pungency in different onion genotypes differed significantly during *Kharif* and *Rabi* seasons (Table 15) (Fig 5).

The results revealed that, Arka Bindu recorded the significantly highest pungency in *Kharif* and *Rabi* season (6.36  $\mu$ mol/gram fresh weight and 6.41  $\mu$ mol/gram fresh weight respectively). Lowest Pungency was observed in Super Flare in *Kharif* and *Rabi* seasons (4.04 and 4.08  $\mu$ mol/gram fresh weight, respectively).

In pooled analysis, the maximum pungency was recorded in Arka Bindu (6.39  $\mu$ mol/gram FW) followed by Flare (6.15  $\mu$ mol/gram fresh weight). Whereas minimum pungency noticed in Super Flare (4.06  $\mu$ mol/gram fresh weight). Fifteen genotypes recorded maximum TSS than the grand mean of 5.42  $\mu$ mol/gram fresh weight.

The minimum Pungency (4.06  $\mu$ mol/gram fresh weight) was recorded in Super Flare and it was maximum in Arka Bindu (6.39  $\mu$ mol/gram fresh weight) with a grand mean (5.42  $\mu$ mol/gram fresh weight). The estimates of GV (0.26) and PV (0.46) were recorded. The estimates of GCV (9.43%) was low and PCV (12.58%) was moderate. The heritability (56.21%) was moderate with moderate genetic advance over per cent mean (14.57%) and genetic advance (0.79) (Table 6).

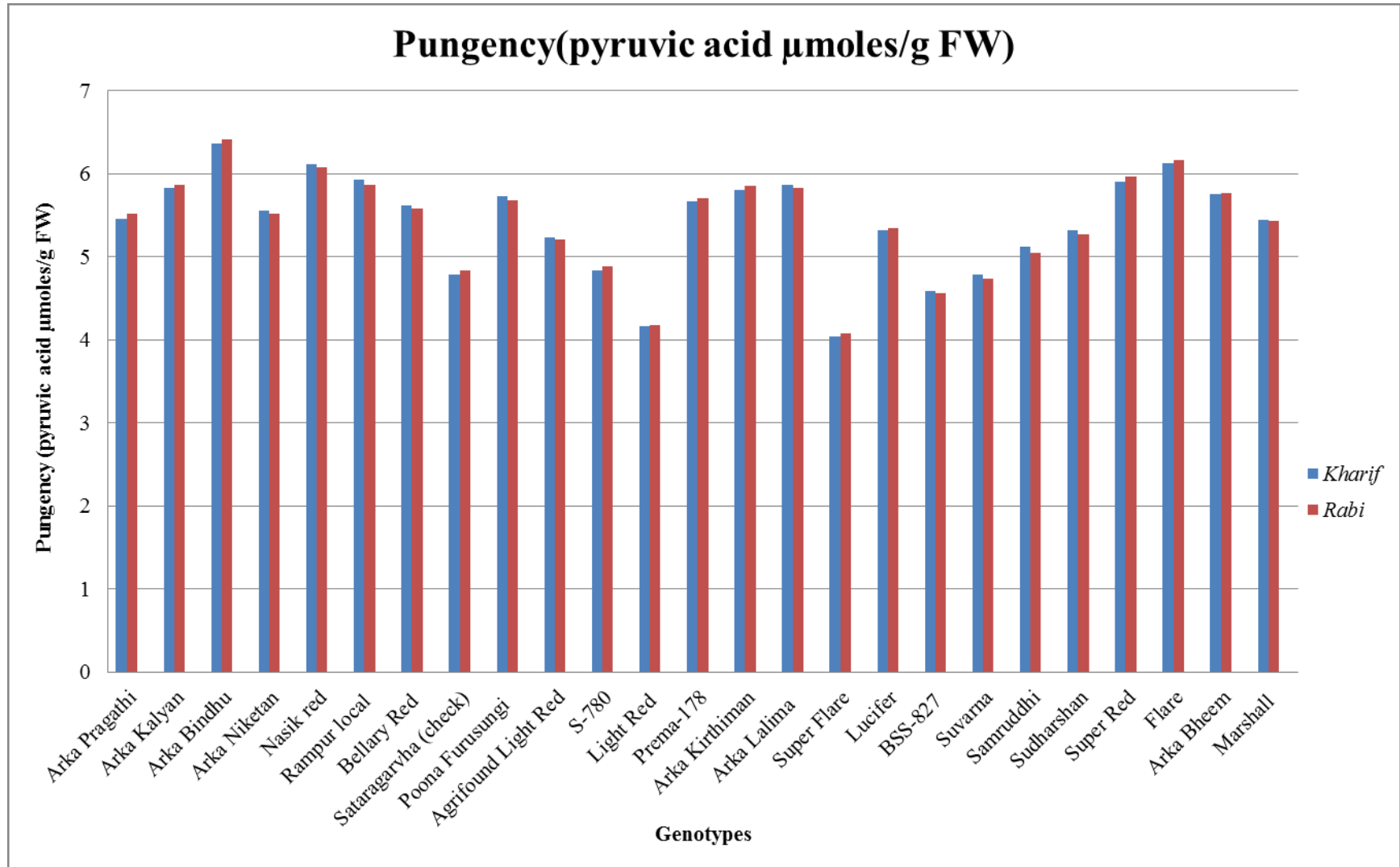
#### **4.1.3.5 Dry matter content (%)**

The data related to dry matter content in different onion genotypes differed significantly during *Kharif* and *Rabi* seasons (Table 16).

Among different genotypes, the variety Arka Bindu recorded the maximum dry matter during *Kharif* and *Rabi* seasons (19.40% and 19.70%, respectively). Whereas, the lowest dry matter was observed in Agrifound Light Red in *Kharif* and *Rabi* seasons (9.60% and 9.80%, respectively).

Table 15. TSS and Pungency of different onion genotypes as influenced by *Kharif* and *Rabi* seasons

| Sl. No.                      | Genotypes            | TSS (°brix)   |              |              | Pungency (Pyruvic acid $\mu$ moles/g FW) |             |             |
|------------------------------|----------------------|---------------|--------------|--------------|--|-------------|-------------|
|                              |                      | <i>Kharif</i> | <i>Rabi</i>  | Pooled       | <i>Kharif</i>                            | <i>Rabi</i> | Pooled      |
| <b>Varieties</b>             |                      |               |              |              |  |             |             |
| 1                            | Arka Pragathi        | 12.87         | 12.81        | <b>12.84</b> | 5.46                                     | 5.52        | <b>5.49</b> |
| 2                            | Arka Kalyan          | 13.21         | 13.25        | <b>13.23</b> | 5.83                                     | 5.87        | <b>5.85</b> |
| 3                            | Arka Bindu           | 17.33         | 17.38        | <b>17.36</b> | 6.36                                     | 6.41        | <b>6.39</b> |
| 4                            | Arka Niketan         | 13.65         | 13.69        | <b>13.67</b> | 5.55                                     | 5.52        | <b>5.54</b> |
| 5                            | Nasik Red            | 12.51         | 12.49        | <b>12.50</b> | 6.12                                     | 6.08        | <b>6.10</b> |
| 6                            | Rampur Local         | 13.16         | 13.22        | <b>13.19</b> | 5.93                                     | 5.87        | <b>5.90</b> |
| 7                            | Bellary Red          | 11.42         | 11.46        | <b>11.44</b> | 5.62                                     | 5.58        | <b>5.60</b> |
| 8                            | Sataragarvha (check) | 12.61         | 12.65        | <b>12.63</b> | 4.79                                     | 4.83        | <b>4.81</b> |
| 9                            | Poona Furusungi      | 11.47         | 11.41        | <b>11.44</b> | 5.73                                     | 5.68        | <b>5.71</b> |
| 10                           | Agrifound Light Red  | 12.43         | 12.47        | <b>12.45</b> | 5.23                                     | 5.21        | <b>5.22</b> |
| 11                           | S-780                | 11.32         | 11.35        | <b>11.34</b> | 4.83                                     | 4.88        | <b>4.86</b> |
| 12                           | Light Red            | 12.22         | 12.26        | <b>12.24</b> | 4.16                                     | 4.18        | <b>4.17</b> |
| 13                           | Prema-178            | 12.17         | 12.21        | <b>12.19</b> | 5.67                                     | 5.71        | <b>5.69</b> |
| <b>F<sub>1</sub> Hybrids</b> |                      |               |              |              |  |             |             |
| 14                           | Arka Kirthiman       | 13.54         | 13.58        | <b>13.56</b> | 5.81                                     | 5.85        | <b>5.83</b> |
| 15                           | Arka Lalima          | 13.67         | 13.61        | <b>13.64</b> | 5.87                                     | 5.83        | <b>5.85</b> |
| 16                           | Super Flare          | 11.27         | 11.33        | <b>11.30</b> | 4.04                                     | 4.08        | <b>4.06</b> |
| 17                           | Lucifer              | 12.35         | 12.31        | <b>12.33</b> | 5.32                                     | 5.35        | <b>5.34</b> |
| 18                           | BSS-827              | 11.28         | 11.33        | <b>11.31</b> | 4.59                                     | 4.56        | <b>4.58</b> |
| 19                           | Suvarna              | 11.76         | 11.82        | <b>11.79</b> | 4.78                                     | 4.74        | <b>4.76</b> |
| 20                           | Samruddhi            | 12.31         | 12.27        | <b>12.29</b> | 5.12                                     | 5.05        | <b>5.09</b> |
| 21                           | Sudharshan           | 12.36         | 12.32        | <b>12.34</b> | 5.32                                     | 5.27        | <b>5.30</b> |
| 22                           | Super Red            | 12.83         | 12.81        | <b>12.82</b> | 5.91                                     | 5.96        | <b>5.94</b> |
| 23                           | Flare                | 13.17         | 13.15        | <b>13.16</b> | 6.13                                     | 6.16        | <b>6.15</b> |
| <b>Synthetics</b>            |                      |               |              |              |  |             |             |
| 24                           | Arka Bheem           | 13.45         | 13.42        | <b>13.44</b> | 5.75                                     | 5.77        | <b>5.76</b> |
| 25                           | Marshall             | 13.12         | 13.17        | <b>13.15</b> | 5.45                                     | 5.43        | <b>5.44</b> |
| <b>Mean</b>                  |                      | <b>12.70</b>  | <b>12.71</b> | <b>12.71</b> | <b>5.41</b>                              | <b>5.42</b> | <b>5.42</b> |
| <b>SEm<math>\pm</math></b>   |                      | <b>0.57</b>   | <b>0.69</b>  | <b>0.35</b>  | <b>0.42</b>                              | <b>0.36</b> | <b>0.32</b> |
| <b>CD at 5%</b>              |                      | <b>1.67</b>   | <b>2.00</b>  | <b>1.02</b>  | <b>1.23</b>                              | <b>1.04</b> | <b>0.93</b> |
| <b>CV (%)</b>                |                      | <b>6.36</b>   | <b>7.64</b>  | <b>3.88</b>  | <b>11.00</b>                             | <b>9.31</b> | <b>8.33</b> |



**Fig. 5. Pungency of different onion genotypes as influenced by *Kharif* and *Rabi* seasons**

In pooled analysis, the maximum per cent of dry matter was registered in Arka Bindu (19.55%) followed by Arka Bheem (16.85%). While, lowest dry matter was recorded in Agrifound Light Red (9.70%). However, Eleven genotypes recorded maximum TSS than the grand mean of 13.25 per cent.

Dry matter ranged from 9.70 per cent (Agrifound Light Red) to 19.55 per cent (Arka Bindu) with a grand mean of 13.25 per cent. The phenotypic (5.04) and genotypic variance (4.76) were recorded. There was a moderate GCV (16.46%) and PCV (16.93%) observed for this trait. The heritability was high (94.46%) with a high genetic advance as per cent over mean (32.95%) and genetic advance (4.37) (Table 6).

#### **4.1.3.6 Firmness of bulb (kg/ sq. cm)**

The firmness of bulb indicated there was no significant difference among the onion genotypes during *Kharif and Rabi* seasons (Table 16).

In pooled analysis, the maximum firmness of bulb was recorded in Arka Bindu (9.93 kg/ sq. cm) followed by Light Red (9.85 kg/ sq. cm). However, minimum firmness was registered in Sataragarvha (8.65 kg/ sq. cm). Fourteen genotypes exceeded the grand mean of 9.18 kg per sq.cm.

#### **4.1.3.7 Split bulbs (%)**

Data related to percentage of split bulbs produced in different onion genotypes differed significantly during *Kharif and Rabi* seasons (Table 17).

Among genotypes, no split bulbs were observed in genotypes Arka Kalyan (0.00 %), Rampur Local (0.00 %), Super Flare (0.00 %), Samruddhi (0.00 %), Arka Bheem and Marshall (0.00 %) in both *Kharif* and *rabi*. Whereas, highest percentage of double bulbs was observed in Agrifound Light Red during both *Kharif* and *rabi* (7.32% and 7.52%, respectively).

In pooled analysis, no split bulbs were observed in genotypes Arka Kalyan (0.00 %), Rampur Local (0.00 %), Super Flare (0.00 %), Samruddhi (0.00 %), Arka Bheem and Marshall (0.00 %). Whereas, highest percentage of double bulbs was observed in Agrifound light red (7.42%) followed by light red (4.59%).

Table 16. Dry matter and firmness of bulb of different onion genotypes as influenced by *Kharif* and *Rabi* seasons

| Sl. No.                      | Genotypes            | Dry matter (%) |              |              | Firmness (kg/cm <sup>2</sup> ) |             |             |
|------------------------------|----------------------|----------------|--------------|--------------|--------------------------------|-------------|-------------|
|                              |                      | <i>Kharif</i>  | <i>Rabi</i>  | Pooled       | <i>Kharif</i>                  | <i>Rabi</i> | Pooled      |
| <b>Varieties</b>             |                      |                |              |              |                                |             |             |
| 1                            | Arka Pragathi        | 12.60          | 12.70        | <b>12.65</b> | 9.36                           | 9.38        | <b>9.37</b> |
| 2                            | Arka Kalyan          | 12.90          | 13.10        | <b>13.00</b> | 9.23                           | 9.25        | <b>9.24</b> |
| 3                            | Arka Bindu           | 19.40          | 19.70        | <b>19.55</b> | 9.91                           | 9.94        | <b>9.93</b> |
| 4                            | Arka Niketan         | 10.30          | 10.50        | <b>10.40</b> | 9.65                           | 9.67        | <b>9.66</b> |
| 5                            | Nasik Red            | 12.40          | 12.50        | <b>12.45</b> | 9.72                           | 9.69        | <b>9.71</b> |
| 6                            | Rampur Local         | 11.30          | 11.20        | <b>11.25</b> | 9.32                           | 9.37        | <b>9.35</b> |
| 7                            | Bellary Red          | 13.90          | 13.30        | <b>13.60</b> | 9.48                           | 9.46        | <b>9.47</b> |
| 8                            | Sataragarvha (check) | 12.80          | 12.60        | <b>12.70</b> | 8.63                           | 8.67        | <b>8.65</b> |
| 9                            | Poona Furusungi      | 13.30          | 13.50        | <b>13.40</b> | 8.92                           | 8.87        | <b>8.90</b> |
| 10                           | Agrifound Light Red  | 9.60           | 9.80         | <b>9.70</b>  | 9.41                           | 9.44        | <b>9.43</b> |
| 11                           | S-780                | 14.10          | 14.30        | <b>14.20</b> | 9.27                           | 9.31        | <b>9.29</b> |
| 12                           | Light Red            | 11.10          | 11.30        | <b>11.20</b> | 9.83                           | 9.86        | <b>9.85</b> |
| 13                           | Prema-178            | 16.30          | 16.60        | <b>16.45</b> | 9.52                           | 9.49        | <b>9.51</b> |
| <b>F<sub>1</sub> Hybrids</b> |                      |                |              |              |                                |             |             |
| 14                           | Arka Kirthiman       | 12.10          | 12.70        | <b>12.40</b> | 9.33                           | 9.35        | <b>9.34</b> |
| 15                           | Arka Lalima          | 13.80          | 13.10        | <b>13.45</b> | 9.37                           | 9.39        | <b>9.38</b> |
| 16                           | Super Flare          | 13.10          | 13.50        | <b>13.30</b> | 9.35                           | 9.31        | <b>9.33</b> |
| 17                           | Lucifer              | 14.60          | 14.80        | <b>14.70</b> | 8.92                           | 8.89        | <b>8.91</b> |
| 18                           | BSS-827              | 12.80          | 12.30        | <b>12.55</b> | 8.88                           | 8.91        | <b>8.90</b> |
| 19                           | Suvarna              | 14.20          | 14.70        | <b>14.45</b> | 9.16                           | 9.19        | <b>9.18</b> |
| 20                           | Samruddhi            | 12.30          | 12.90        | <b>12.60</b> | 8.79                           | 8.83        | <b>8.81</b> |
| 21                           | Sudharshan           | 15.80          | 16.30        | <b>16.05</b> | 8.89                           | 8.85        | <b>8.87</b> |
| 22                           | Super Red            | 11.80          | 12.20        | <b>12.00</b> | 9.33                           | 9.31        | <b>9.32</b> |
| 23                           | Flare                | 11.30          | 11.80        | <b>11.55</b> | 9.46                           | 9.49        | <b>9.48</b> |
| <b>Synthetics</b>            |                      |                |              |              |                                |             |             |
| 24                           | Arka Bheem           | 16.60          | 17.10        | <b>16.85</b> | 9.83                           | 9.85        | <b>9.84</b> |
| 25                           | Marshall             | 10.60          | 11.10        | <b>10.85</b> | 9.71                           | 9.67        | <b>9.69</b> |
| <b>Mean</b>                  |                      | <b>13.16</b>   | <b>13.34</b> | <b>13.25</b> | <b>9.33</b>                    | <b>9.34</b> | <b>9.33</b> |
| <b>SEm±</b>                  |                      | <b>0.56</b>    | <b>0.57</b>  | <b>0.37</b>  | <b>0.56</b>                    | <b>0.47</b> | <b>0.44</b> |
| <b>CD at 5%</b>              |                      | <b>1.65</b>    | <b>1.67</b>  | <b>0.53</b>  | <b>NS</b>                      | <b>NS</b>   | <b>NS</b>   |
| <b>CV (%)</b>                |                      | <b>6.06</b>    | <b>6.07</b>  | <b>3.98</b>  | <b>NS</b>                      | <b>NS</b>   | <b>NS</b>   |

NS: Non significant

Table 17. Percentage of split bulb of different onion genotypes as influenced by *Kharif* and *Rabi* seasons

| Sl. No.                      | Genotypes            | Split bulb (%) |              |              |
|------------------------------|----------------------|----------------|--------------|--------------|
|                              |                      | <i>Kharif</i>  | <i>Rabi</i>  | Pooled       |
| <b>Varieties</b>             |                      |                |              |              |
| 1                            | Arka Pragathi        | 1.50 (7.01)    | 1.65 (7.36)  | 1.58 (7.19)  |
| 2                            | Arka Kalyan          | 0.00 (0.40)    | 0.00 (0.40)  | 0.00 (0.40)  |
| 3                            | Arka Bindu           | 3.27 (10.41)   | 3.45 (10.68) | 3.36 (10.55) |
| 4                            | Arka Niketan         | 2.15 (8.42)    | 2.25 (8.61)  | 2.20 (8.52)  |
| 5                            | Nasik Red            | 3.17 (10.24)   | 3.35 (10.54) | 3.26 (10.40) |
| 6                            | Rampur Local         | 0.00 (0.40)    | 0.00 (0.40)  | 0.00 (0.40)  |
| 7                            | Bellary Red          | 3.87 (11.33)   | 3.91 (11.40) | 3.89 (11.36) |
| 8                            | Sataragarvha (check) | 1.50 (7.02)    | 1.66 (7.38)  | 1.58 (7.22)  |
| 9                            | Poona Furusungi      | 2.25 (8.61)    | 2.22 (8.55)  | 2.24 (8.59)  |
| 10                           | Agrifound Light Red  | 7.32 (15.69)   | 7.52 (15.91) | 7.42 (15.80) |
| 11                           | S-780                | 2.23 (8.57)    | 2.35 (8.81)  | 2.29 (8.70)  |
| 12                           | Light Red            | 4.42 (12.13)   | 4.76 (12.59) | 4.59 (12.36) |
| 13                           | Prema-178            | 3.65 (11.01)   | 3.92 (11.41) | 3.79 (11.21) |
| <b>F<sub>1</sub> Hybrids</b> |                      |                |              |              |
| 14                           | Arka Kirthiman       | 2.25 (8.61)    | 2.35 (8.81)  | 2.30 (8.72)  |
| 15                           | Arka Lalima          | 1.87 (7.84)    | 2.12 (8.35)  | 2.00 (8.10)  |
| 16                           | Super Flare          | 0.00 (0.40)    | 0.00 (0.40)  | 0.00 (0.40)  |
| 17                           | Lucifer              | 2.56 (9.18)    | 2.85 (9.71)  | 2.71 (9.46)  |
| 18                           | BSS-827              | 3.23 (10.34)   | 3.55 (10.85) | 3.39 (10.60) |
| 19                           | Suvarna              | 3.33 (10.50)   | 3.65 (11.01) | 3.49 (10.76) |
| 20                           | Samruddhi            | 0.00 (0.40)    | 0.00 (0.40)  | 0.00 (0.40)  |
| 21                           | Sudharshan           | 3.21 (10.31)   | 3.32 (10.49) | 3.27 (10.40) |
| 22                           | Super Red            | 1.35 (6.66)    | 1.65 (7.36)  | 1.50 (7.02)  |
| 23                           | Flare                | 1.20 (6.27)    | 1.45 (6.89)  | 1.33 (6.59)  |
| <b>Synthetics</b>            |                      |                |              |              |
| 24                           | Arka Bheem           | 0.00 (0.40)    | 0.00 (0.40)  | 0.00 (0.40)  |
| 25                           | Marshall             | 0.00 (0.40)    | 0.00 (0.40)  | 0.00 (0.40)  |
| Mean                         |                      | 2.17           | 2.32         | 2.25         |
| SEm±                         |                      | 0.19           | 0.19         | 0.14         |
| CD at 5%                     |                      | 0.55           | 0.55         | 0.41         |
| CV (%)                       |                      | 12.23          | 11.54        | 8.81         |

## 4.2 Storage behavior and keeping quality of bulbs

### 4.2.1 Sprouting (%)

The data pertaining to sprouting percentage of bulbs in different genotypes harvested during *Kharif* and *Rabi* seasons differed significantly during storage under ambient conditions (Table 18 and Table 19).

The results revealed that, one month after storage the per cent loss due to sprouting of bulbs was not observed in any of the genotypes during both the seasons.

In *Kharif* harvested onion crop no sprouting was observed in genotypes Arka Kalyan (0.00%), Arka Bindu (0.00%), Rampur local (0.00%), Prema-178 (0.00%), Arka Kirthiman (0.00%), Arka Lalima (0.00%), Lucifer (0.00%) and Arka Bheem (0.00%). Whereas, maximum was recorded in Nasik Red (12.50%) at two months after storage (Table 18).

After two months of storage the percent loss due to sprouting of bulbs was not observed in any of the genotypes during *Rabi* season crop.

At three months of storage no sprouting was recorded in Arka Kalyan (0.00%), Arka Bindu (0.00%), Lucifer (0.00%) and Arka Bheem (0.00%). Whereas, the Nasik Red recorded the maximum (16.66%) in *Kharif* season crop.

In *Rabi* season harvested crop no sprouting was observed in Arka Kalyan (0.00%), Arka Bindu (0.00%), Lucifer (0.00%) and Arka Bheem (0.00%). However maximum sprouting was observed in Nasik Red (9.52%) during three months of storage (Table 19).

#### 4.2.2 Rotting (%)

Data pertaining to percentage of rotten bulbs in different genotypes harvested during *Kharif* and *Rabi* seasons differed significantly during storage under ambient conditions (Table 18 and 19).

The results revealed that, after one month of storage the per cent loss due to rotten bulbs was not observed in any of the genotypes during both *Kharif* and *Rabi* seasons.

After two months of storage no rotten bulbs was observed in Arka Kalyan (0.00%), Arka Bindu (0.00%), Rampur local (0.00%), Bellary Red (0.00%), Prema-178 (0.00%), Arka Kirthiman (0.00%), Arka Lalima (0.00%), Super Flare (0.00%), Lucifer (0.00%), BSS-827 (0.00%), Samruddhi (0.00%), Arka Bheem(0.00%), and Marshall (0.00%). Whereas, the variety Nasik Red recorded the maximum rottage (8.33%) in *Kharif* season crop (Table 18).

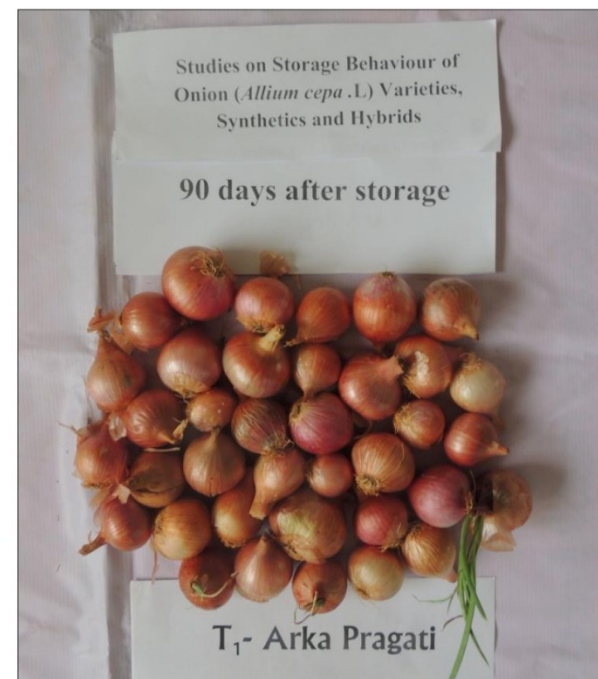
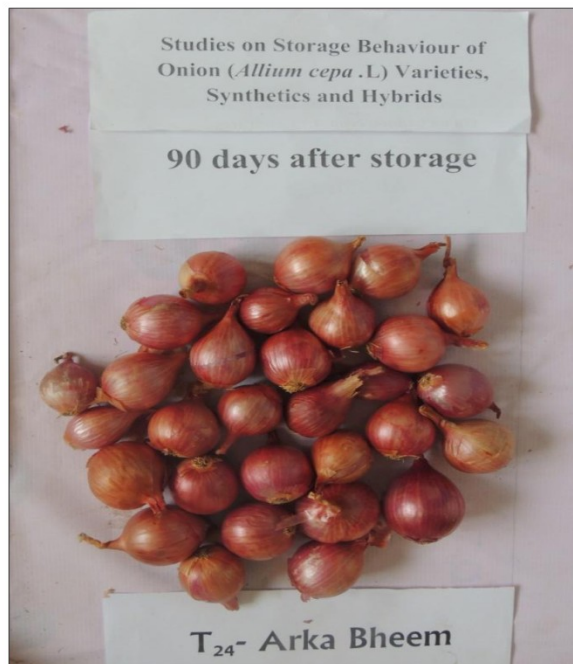
In *Rabi* season harvested onion crop after two months of storage no rotten bulbs was observed in any of the genotypes.

After three months of storage no rotting was noticed in Arka Kalyan (0.00%), Arka Bindu (0.00%), Lucifer (0.00%) and Arka Bheem (0.00%). Whereas, the Sataragarvha recorded the maximum rottage (14.25%) in *Kharif* season crop.

In *Rabi* season harvested crop no rotting was observed in Arka Kalyan (0.00%), Arka Bindu (0.00%), Lucifer (0.00%) and Arka Bheem (0.00%). However maximum rottage was revealed in Super Red (12.00%) after three months of storage (Table 19).

#### 4.2.3 Physiological loss in weight [PLW (%)]

Data pertaining to physiological loss in weight in different genotypes harvested during *Kharif* and *Rabi* seasons differed significantly during storage under ambient conditions (Table 18 and Table 19) (Fig 6 and Fig 7). Onion genotypes suitable for long term storage in both *Kharif* and *Rabi* season is shown in plate 4.



**Plate 4. Onion genotypes suitable for long term storage in both *Kharif* and *Rabi* season**

After one month of storage the minimum PLW was observed in Arka Bheem (2.14%), followed by Arka Niketan (2.55%). Whereas, maximum weight loss registered in Poona Furusungi (5.26%) in *Kharif* season crop (Table 18)

In *Rabi* season crop, after one month of storage minimum PLW was recorded in Arka Bheem (1.76%), followed by Arka Nikethan (1.98%). However, maximum PLW was registered in Poona Furusungi (4.45%) (Table 19).

After two months of storage the minimum PLW was observed in Arka Bheem (7.72%), followed by Arka Pragathi (8.20%). Whereas, maximum PLW was recorded in Poona Furusungi (15.42%) in *Kharif* season crop.

In *Rabi* harvested crop Arka Bheem recorded lowest PLW (7.05%), followed by Arka Pragathi (7.72%). However, maximum PLW was observed in Poona Furusungi (14.76%) at two months of storage.

After three months of storage the minimum PLW was observed in Arka Bheem (15.76%), followed by Arka Pragathi (16.58%). Whereas, maximum PLW was recorded in Poona Furusungi (36.33%) in *Kharif* season crop.

In *Rabi* harvested crop Arka Bheem recorded lowest PLW (15.32%), followed by Arka Pragathi (16.23%). However, maximum PLW was observed in Poona Furusungi (35.49%) at three months of storage.

After three months of storage the maximum yield recovery in weight was observed in Arka Bheem (1.69kg), followed by Arka Pragathi (1.67kg). Whereas, minimum yield recovery in weight was recorded in Poona Furusungi (1.28kg) in *Kharif* season crop.

In *Rabi* harvested crop Arka Bheem recorded maximum yield recovery in weight (1.70kg), followed by Arka Pragathi (1.68kg). However, minimum yield recovery in weight was observed in Poona Furusungi (1.30kg) at three months after storage.

#### **4.2.4 Black Molds (%)**

The data related to the percentage of black molds in different genotypes harvested during *Kharif* and *Rabi* seasons differed significantly during storage under ambient conditions. (Table 18 and Table 19).

The results revealed that, two months after storage the percent loss due to black molds of bulbs was not observed in any of the genotypes during both the seasons.

At three months after storage no black molds bulbs were observed in Arka Kalyan (0.00%), Arka Bindu (0.00%), Rampur local (0.00%), Prema-178 (0.00%), Arka Kirthiman (0.00%), Arka Lalima (0.00%), Super Flare (0.00%), Lucifer (0.00%), Arka Bheem(0.00%), and Marshall(0.00%). While, the Nasik Red recorded the maximum infection due to molds (8.33%) in *Kharif* season crop (Table 18).

In *Rabi* season harvested crop no black molds was noticed in Arka Kalyan (0.00%), Arka Bindu (0.00%), Rampur Local (0.00%), Prema-178 (0.00%), Arka Kirthiman (0.00%), Arka Lalima (0.00%), Super Flare (0.00%), Lucifer (0.00%), Arka Bheem(0.00%), and Marshall(0.00%). Whereas, the Sudarshan recorded the maximum incidence (7.69%) at three months after storage (Table 19).

### **4.3 Screening for purple blotch disease and thrips**

#### **4.3.1 Screening of different genotypes of onion against purple blotch disease (*Alternaria porri*)**

A total of twenty five onion genotypes were screened in field under natural condition during both *Kharif* and *Rabi* seasons. The genotypes were grouped as per the scale of Bhangale and Joi (1985) and data is presented in Table (20).

During *Kharif* season, among different genotypes none of them were found immune, while two genotypes Arka Bindu (10%) and Poona Furusungi (8.75%) were found resistant (1-10 %), with grade scale of 1. Nine genotypes such as Arka Kalyan (16.85%), Sataragarvha (20%), S-780 (17.50%), Prema-178 (13.75%), Arka Lalima (16.85%),

**Table 18. Storage behaviour and keeping quality of *Kharif* crop onion bulbs of different genotypes during storage (January to March 2016)**

| Sl. No. | genotypes            | No. of bulbs per 2kg | One month (30 DAS) |             |         | Two months (60 DAS) |                 |         | Three months (60 DAS) |                  |                 |         |         |
|---------|----------------------|----------------------|--------------------|-------------|---------|---------------------|-----------------|---------|-----------------------|------------------|-----------------|---------|---------|
|         |                      |                      | Sprouting (%)      | Rottage (%) | PLW (%) | Sprouting (%)       | Rotten (%)      | PLW (%) | Sprouting (%)         | Rottage (%)      | Black molds (%) | PLW (%) | YR (kg) |
| 1       | Arka Pragathi        | 24                   | 0                  | 0           | 2.65    | 4.16<br>(11.76)     | 4.16<br>(11.76) | 8.20    | 8.33<br>(16.76)       | 12.50<br>(20.67) | 4.16<br>(11.76) | 16.58   | 1.67    |
| 2       | Arka Kalyan          | 22                   | 0                  | 0           | 2.82    | 0.00<br>(0.40)      | 0.00<br>(0.40)  | 9.32    | 0.00<br>(0.40)        | 0.00<br>(0.40)   | 0.00<br>(0.40)  | 17.56   | 1.65    |
| 3       | Arka Bindhu          | 52                   | 0                  | 0           | 2.93    | 0.00<br>(0.40)      | 0.00<br>(0.40)  | 10.00   | 0.00<br>(0.40)        | 0.00<br>(0.40)   | 0.00<br>(0.40)  | 18.58   | 1.63    |
| 4       | Arka Niketan         | 23                   | 0                  | 0           | 2.55    | 4.34<br>(12.01)     | 4.34<br>(12.01) | 11.65   | 8.69<br>(17.13)       | 8.69<br>(17.11)  | 4.34<br>(11.99) | 22.37   | 1.56    |
| 5       | Nasik red            | 24                   | 0                  | 0           | 4.46    | 12.50<br>(20.69)    | 8.33<br>(16.76) | 12.36   | 16.66<br>(24.08)      | 12.50<br>(20.64) | 8.33<br>(16.74) | 24.87   | 1.51    |
| 6       | Rampur local         | 20                   | 0                  | 0           | 2.82    | 0.00<br>(0.40)      | 0.00<br>(0.40)  | 11.65   | 5.00<br>(12.91)       | 10.00<br>(18.41) | 0.00<br>(0.40)  | 23.16   | 1.54    |
| 7       | Bellary Red          | 23                   | 0                  | 0           | 2.72    | 4.34<br>(12.00)     | 0.00<br>(0.40)  | 9.00    | 8.69<br>(17.13)       | 13.04<br>(21.15) | 4.34<br>(12.02) | 17.22   | 1.66    |
| 8       | Sataragarvha (check) | 21                   | 0                  | 0           | 5.12    | 4.76<br>(12.59)     | 4.76<br>(12.58) | 14.36   | 9.52<br>(17.86)       | 14.25<br>(22.17) | 4.76<br>(12.59) | 31.36   | 1.38    |
| 9       | Poona Furusungi      | 20                   | 0                  | 0           | 5.26    | 5.00<br>(12.91)     | 5.00<br>(12.91) | 15.42   | 10.00<br>(18.41)      | 15.00<br>(22.77) | 5.00<br>(12.91) | 36.33   | 1.28    |
| 10      | Agrifound Light Red  | 25                   | 0                  | 0           | 3.23    | 4.00<br>(11.52)     | 4.00<br>(11.52) | 12.26   | 8.00<br>(16.42)       | 12.00<br>(20.25) | 8.00<br>(16.39) | 25.67   | 1.49    |
| 11      | S-780                | 20                   | 0                  | 0           | 4.32    | 5.00<br>(12.91)     | 5.00<br>(12.91) | 11.87   | 10.00<br>(18.41)      | 10.00<br>(18.41) | 5.00<br>(12.91) | 24.36   | 1.52    |
| 12      | Light Red            | 27                   | 0                  | 0           | 2.97    | 3.70<br>(11.08)     | 3.70<br>(11.08) | 11.35   | 7.40<br>(15.77)       | 11.11<br>(19.44) | 7.40<br>(15.77) | 24.48   | 1.52    |
| 13      | Prema-178            | 23                   | 0                  | 0           | 4.12    | 0.00<br>(0.40)      | 0.00<br>(0.40)  | 12.32   | 8.69<br>(17.13)       | 8.69<br>(17.11)  | 0.00<br>(0.40)  | 25.32   | 1.50    |

| Sl. No.  | genotypes      | No. of bulbs per 2kg | One month (30 DAS) |             |              | Two months (60 DAS) |                 |             | Three months (60 DAS) |                  |                 |             |             |
|----------|----------------|----------------------|--------------------|-------------|--------------|---------------------|-----------------|-------------|-----------------------|------------------|-----------------|-------------|-------------|
|          |                |                      | Sprouting (%)      | Rottage (%) | PLW (%)      | Sprouting (%)       | Rotten (%)      | PLW (%)     | Sprouting (%)         | Rottage (%)      | Black molds (%) | PLW (%)     | YR (kg)     |
| 14       | Arka Kirthiman | 23                   | 0                  | 0           | 3.22         | 0.00<br>(0.40)      | .000<br>(0.40)  | 12.56       | 4.34<br>(2.02)        | 4.34<br>(12.00)  | 0.00<br>(0.40)  | 24.38       | 1.52        |
| 15       | Arka Lalima    | 22                   | 0                  | 0           | 3.06         | 0.00<br>(0.40)      | 0.00<br>(0.40)  | 11.32       | 4.54<br>(12.29)       | 4.54<br>(12.28)  | 0.00<br>(0.40)  | 24.88       | 1.51        |
| 16       | Super Flare    | 15                   | 0                  | 0           | 3.56         | 6.66<br>(14.95)     | 0.00<br>(0.40)  | 14.36       | 13.33<br>(21.40)      | 6.66<br>(14.95)  | 0.00<br>(0.40)  | 30.56       | 1.39        |
| 17       | Lucifer        | 21                   | 0                  | 0           | 2.83         | 0.00<br>(0.40)      | 0.00<br>(0.40)  | 9.86        | 0.00<br>(0.40)        | 0.00<br>(0.40)   | 0.00<br>(0.40)  | 19.26       | 1.62        |
| 18       | BSS-827        | 23                   | 0                  | 0           | 3.12         | 8.69<br>(17.13)     | 0.00<br>(0.40)  | 10.23       | 13.04<br>(21.15)      | 8.69<br>(17.14)  | 4.34<br>(12.02) | 20.76       | 1.59        |
| 19       | Suvarna        | 24                   | 0                  | 0           | 4.56         | 8.33<br>(16.77)     | 4.16<br>(11.73) | 13.39       | 12.50<br>(20.70)      | 8.33<br>(16.77)  | 4.16<br>(11.76) | 32.36       | 1.36        |
| 20       | Samruddhi      | 17                   | 0                  | 0           | 3.32         | 5.88<br>(14.02)     | 0.00<br>(0.40)  | 12.56       | 11.76<br>(20.05)      | 11.76<br>(20.03) | 5.88<br>(14.01) | 30.34       | 1.40        |
| 21       | Sudharshan     | 25                   | 0                  | 0           | 5.05         | 8.00<br>(16.42)     | 4.00<br>(11.53) | 15.12       | 12.00<br>(20.26)      | 8.00<br>(16.42)  | 4.00<br>(11.52) | 33.63       | 1.33        |
| 22       | Super Red      | 24                   | 0                  | 0           | 3.26         | 4.16<br>(11.75)     | 4.16<br>(11.76) | 13.26       | 8.33<br>(16.76)       | 12.50<br>(20.68) | 4.16<br>(11.76) | 31.64       | 1.37        |
| 23       | Flare          | 24                   | 0                  | 0           | 3.85         | 4.16<br>(11.76)     | 4.16<br>(11.76) | 11.22       | 8.33<br>(16.76)       | 12.50<br>(20.68) | 4.16<br>(11.76) | 28.56       | 1.43        |
| 24       | Arka Bheem     | 20                   | 0                  | 0           | 2.14         | 0.00<br>(0.40)      | 0.00<br>(0.40)  | 7.72        | 0.00<br>(0.40)        | 0.00<br>(0.40)   | 0.00<br>(0.40)  | 15.76       | 1.69        |
| 25       | Marshall       | 20                   | 0                  | 0           | 3.56         | 5.00<br>(12.91)     | 0.00<br>(0.40)  | 11.36       | 10.00<br>(18.41)      | 10.00<br>(18.41) | 0.00<br>(0.40)  | 28.86       | 1.43        |
| S Em±    |                |                      |                    |             | <b>0.39</b>  | <b>0.33</b>         | <b>0.27</b>     | <b>0.63</b> | <b>1.50</b>           | <b>0.89</b>      | <b>0.37</b>     | <b>1.65</b> | <b>0.23</b> |
| CD at 5% |                |                      |                    |             | <b>1.14</b>  | <b>0.95</b>         | <b>0.80</b>     | <b>1.84</b> | <b>4.38</b>           | <b>2.60</b>      | <b>1.07</b>     | <b>4.81</b> | <b>0.68</b> |
| CV (%)   |                |                      |                    |             | <b>15.84</b> | <b>11.69</b>        | <b>17.35</b>    | <b>7.59</b> | <b>16.67</b>          | <b>14.66</b>     | <b>16.61</b>    | <b>9.26</b> | <b>5.21</b> |

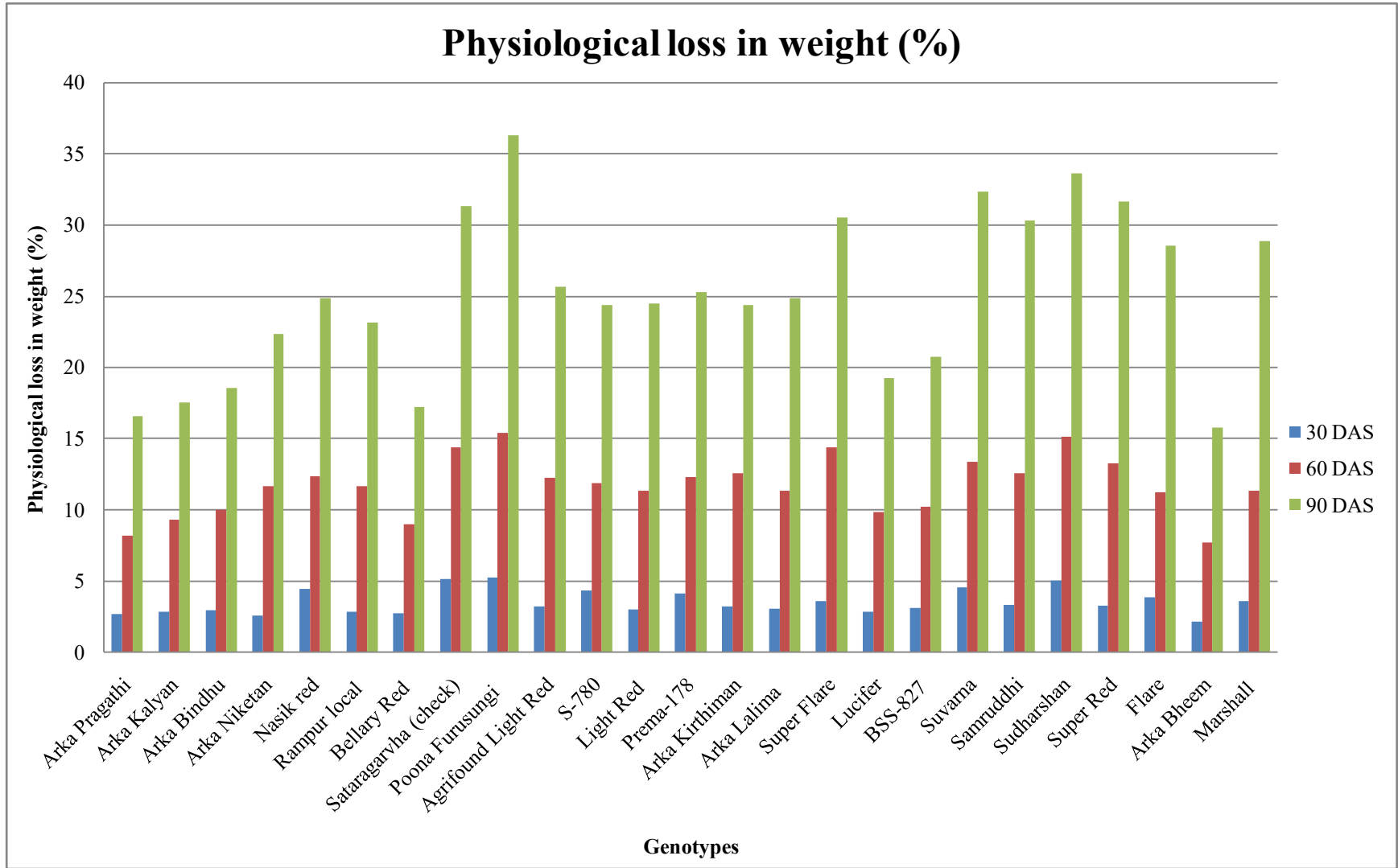
Note: DAS-Days after storage;PLW-physiological loss in weight;YR-Yield recovery;SEm-Standard error of mean;CD-Critical difference;CV-Co-efficient of variation, values in parenthesis are Arc sin transformed

**Table 19. Storage behaviour and keeping quality of *Rabi* crop onion bulbs of different landraces during storage (March to June 2016)**

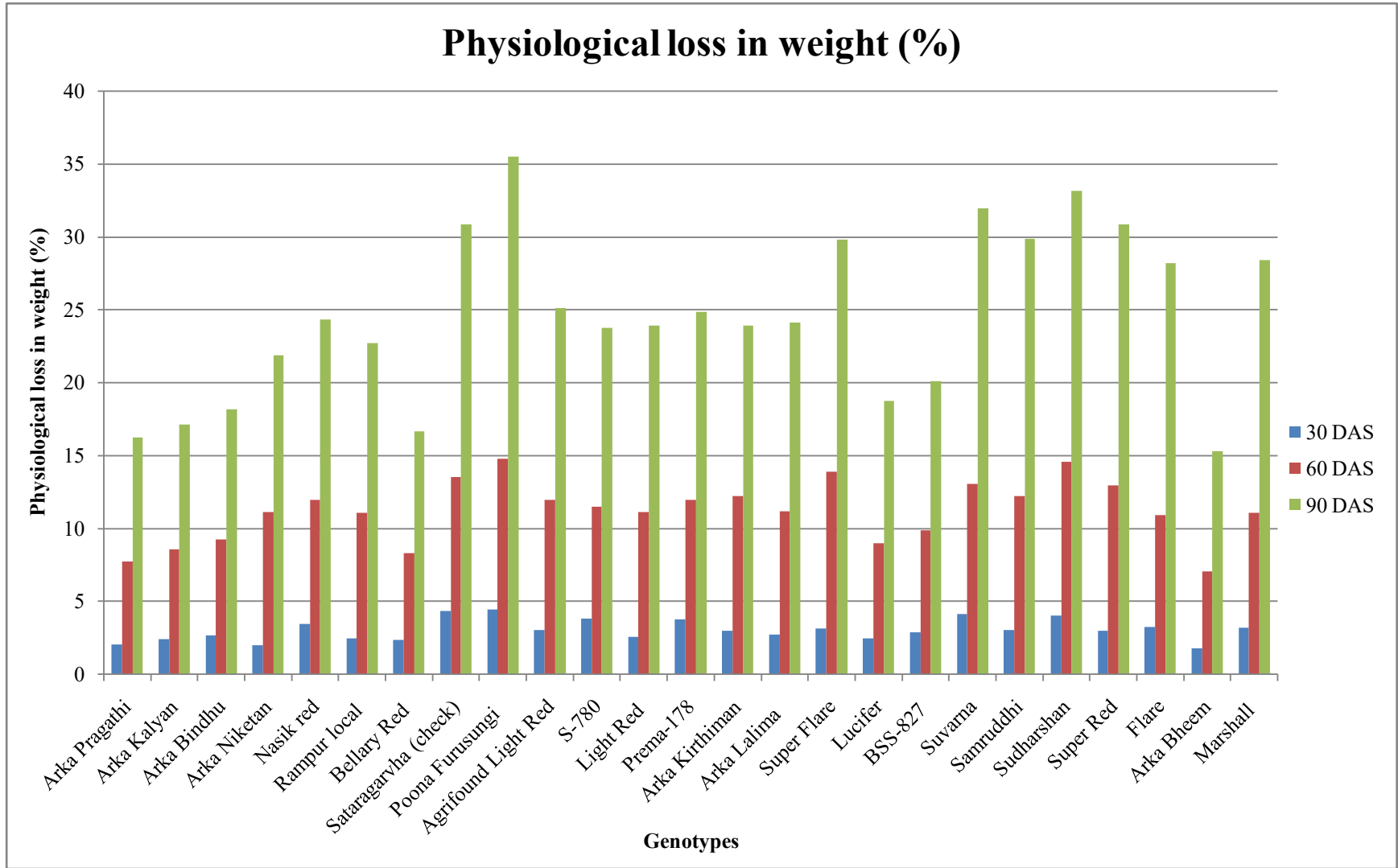
| Sl. No. | Cultivars            | Number of bulbs per 2kg | One month (30 DAS) |             |         | Two months (60 DAS) |             |         | Three months (60 DAS) |                  |                  |         |         |
|---------|----------------------|-------------------------|--------------------|-------------|---------|---------------------|-------------|---------|-----------------------|------------------|------------------|---------|---------|
|         |                      |                         | Sprouting (%)      | Rottage (%) | PLW (%) | Sprouting (%)       | Rottage (%) | PLW (%) | Sprouting (%)         | Rottage (%)      | Black moulds (%) | PLW (%) | YR (kg) |
| 1       | Arka Pragathi        | 22                      | 0                  | 0           | 2.03    | 0                   | 0           | 7.72    | 4.54<br>(12.29)       | 9.09<br>(17.52)  | 4.54<br>(12.29)  | 16.23   | 1.68    |
| 2       | Arka Kalyan          | 24                      | 0                  | 0           | 2.42    | 0                   | 0           | 8.56    | 0.00<br>(0.40)        | 0.00<br>(0.40)   | 0.00<br>(0.40)   | 17.12   | 1.66    |
| 3       | Arka Bindhu          | 49                      | 0                  | 0           | 2.64    | 0                   | 0           | 9.26    | 0.00<br>(0.40)        | 0.00<br>(0.40)   | 0.00<br>(0.40)   | 18.16   | 1.64    |
| 4       | Arka Niketan         | 22                      | 0                  | 0           | 1.98    | 0                   | 0           | 11.12   | 4.54<br>(12.28)       | 9.09<br>(17.51)  | 4.54<br>(12.29)  | 21.89   | 1.57    |
| 5       | Nasik red            | 21                      | 0                  | 0           | 3.47    | 0                   | 0           | 11.96   | 9.52<br>(17.96)       | 9.52<br>(17.94)  | 4.76<br>(12.59)  | 24.32   | 1.52    |
| 6       | Rampur local         | 20                      | 0                  | 0           | 2.47    | 0                   | 0           | 11.05   | 5.00<br>(12.91)       | 5.00<br>(12.90)  | 0.00<br>(0.40)   | 22.74   | 1.55    |
| 7       | Bellary Red          | 21                      | 0                  | 0           | 2.35    | 0                   | 0           | 8.32    | 4.76<br>(12.58)       | 9.52<br>(17.94)  | 4.76<br>(12.59)  | 16.67   | 1.67    |
| 8       | Sataragarvha (check) | 21                      | 0                  | 0           | 4.36    | 0                   | 0           | 13.55   | 4.76<br>(12.58)       | 9.52<br>(17.94)  | 4.76<br>(12.59)  | 30.85   | 1.39    |
| 9       | Poona Furusungi      | 20                      | 0                  | 0           | 4.45    | 0                   | 0           | 14.76   | 10.00<br>(17.90)      | 10.00<br>(18.41) | 5.00<br>(12.91)  | 35.49   | 1.30    |
| 10      | Agrifound Light Red  | 24                      | 0                  | 0           | 3.04    | 0                   | 0           | 11.98   | 4.16<br>(11.76)       | 4.16<br>(11.76)  | 4.16<br>(11.76)  | 25.12   | 1.50    |
| 11      | S-780                | 20                      | 0                  | 0           | 3.79    | 0                   | 0           | 11.47   | 5.00<br>(12.91)       | 10.00<br>(18.41) | 5.00<br>(12.91)  | 23.76   | 1.53    |
| 12      | Light Red            | 25                      | 0                  | 0           | 2.55    | 0                   | 0           | 11.10   | 4.00<br>(11.53)       | 8.00<br>(16.42)  | 4.00<br>(11.52)  | 23.92   | 1.53    |
| 13      | Prema-178            | 22                      | 0                  | 0           | 3.76    | 0                   | 0           | 11.96   | 4.54<br>(12.29)       | 4.54<br>(12.29)  | 0.00<br>(0.40)   | 24.86   | 1.51    |

| Sl. No.  | Cultivars      | Number of bulbs per 2kg | One month (30 DAS) |             |              | Two months (60 DAS) |             |             | Three months (60 DAS) |                  |                  |              |             |
|----------|----------------|-------------------------|--------------------|-------------|--------------|---------------------|-------------|-------------|-----------------------|------------------|------------------|--------------|-------------|
|          |                |                         | Sprouting (%)      | Rottage (%) | PLW (%)      | Sprouting (%)       | Rottage (%) | PLW (%)     | Sprouting (%)         | Rottage (%)      | Black moulds (%) | PLW (%)      | YR (kg)     |
| 14       | Arka Kirthiman | 22                      | 0                  | 0           | 2.97         | 0                   | 0           | 12.22       | 4.54<br>(12.29)       | 4.54<br>(12.29)  | 0.00<br>(0.40)   | 23.92        | 1.53        |
| 15       | Arka Lalima    | 21                      | 0                  | 0           | 2.72         | 0                   | 0           | 11.16       | 4.76<br>(12.59)       | 4.76<br>(12.59)  | 0.00<br>(0.40)   | 24.12        | 1.52        |
| 16       | Super Flare    | 15                      | 0                  | 0           | 3.12         | 0                   | 0           | 13.87       | 6.66<br>(14.95)       | 6.66<br>(14.95)  | 0.00<br>(0.40)   | 29.82        | 1.41        |
| 17       | Lucifer        | 21                      | 0                  | 0           | 2.43         | 0                   | 0           | 8.99        | 0.00<br>(0.40)        | 0.00<br>(0.40)   | 0.00<br>(0.40)   | 18.74        | 1.63        |
| 18       | BSS-827        | 24                      | 0                  | 0           | 2.87         | 0                   | 0           | 9.87        | 8.33<br>(16.76)       | 8.33<br>(16.76)  | 4.16<br>(11.76)  | 20.12        | 1.60        |
| 19       | Suvarna        | 25                      | 0                  | 0           | 4.12         | 0                   | 0           | 13.05       | 8.00<br>(16.42)       | 8.00<br>(16.42)  | 4.00<br>(11.53)  | 31.95        | 1.37        |
| 20       | Samruddhi      | 18                      | 0                  | 0           | 3.03         | 0                   | 0           | 12.22       | 5.55<br>(13.62)       | 5.55<br>(13.60)  | 5.55<br>(13.60)  | 29.85        | 1.41        |
| 21       | Sudharshan     | 26                      | 0                  | 0           | 4.02         | 0                   | 0           | 14.55       | 7.69<br>(16.09)       | 7.69<br>(16.08)  | 7.69<br>(16.06)  | 33.15        | 1.34        |
| 22       | Super Red      | 25                      | 0                  | 0           | 2.99         | 0                   | 0           | 12.96       | 8.00<br>(16.42)       | 12.00<br>(20.25) | 4.00<br>(11.53)  | 30.86        | 1.39        |
| 23       | Flare          | 22                      | 0                  | 0           | 3.22         | 0                   | 0           | 10.9        | 4.54<br>(12.29)       | 9.09<br>(17.52)  | 4.54<br>(12.29)  | 28.22        | 1.44        |
| 24       | Arka Bheem     | 20                      | 0                  | 0           | 1.76         | 0                   | 0           | 7.05        | 0.00<br>(0.40)        | 0.00<br>(0.40)   | 0.00<br>(0.40)   | 15.32        | 1.70        |
| 25       | Marshall       | 20                      | 0                  | 0           | 3.16         | 0                   | 0           | 11.05       | 5.00<br>(12.91)       | 10.00<br>(18.41) | 0.00<br>(0.40)   | 28.42        | 1.44        |
| S Em±    |                |                         | -                  | -           | <b>0.22</b>  | -                   | -           | <b>0.55</b> | <b>1.00</b>           | <b>0.70</b>      | <b>0.32</b>      | <b>2.04</b>  | <b>0.24</b> |
| CD at 5% |                |                         | -                  | -           | <b>0.64</b>  | -                   | -           | <b>1.61</b> | <b>2.91</b>           | <b>2.04</b>      | <b>0.94</b>      | <b>5.94</b>  | <b>0.71</b> |
| CV (%)   |                |                         | -                  | -           | <b>10.17</b> | -                   | -           | <b>6.93</b> | <b>18.47</b>          | <b>14.97</b>     | <b>15.96</b>     | <b>11.69</b> | <b>6.70</b> |

Note: DAS-Days after storage;PLW-physiological loss in weight;YR-Yield recovery;SEm-Standard error of mean;CD-Critical difference;values in parenthesis are Arc sin transformed



**Fig. 6. Physiological loss in weight of different onion genotypes in *Kharif* season harvested crop**



**Fig. 7. Physiological loss in weight of different onion genotypes in *Rabi* season harvested crop**

BSS-827 (17.50%), Suvarna (11.25%), Sudarshan (18.75%), and Arka Bheem (13.75%) found moderately resistant (11-20%) with grade scale 2. Eleven genotypes viz., Arka Pragathi (30.62%), Arka Niketan (31.25%), Rampur Local (29.37%), Bellary Red (23.75%), Agrifound Light Red (23.12%), Arka Kirthiman (35.62%), Super Flare (23.75%), Lucifer (30%), Samruddhi (29.37%), Flare (26.25%) and Marshall (35.62%) were found under moderately susceptible group (21-40%) and the grade scale was 3. Nasik Red (41.87%) and Super Red (43.12%) were found susceptible with grade scale 4 (41-60%) and Light Red (76.25%) were highly susceptible (above 61 %) with grade scale 5.

In *Rabi* season, no genotypes noticed the purple blotch incidence including susceptible varieties of *Kharif* season.

#### **4.4.2 Screening for onion thrips damage (*Thrips tabaci*)**

For recording the Plant Thrips Index (PTI), 0-5 scale rating technique was used based on the infestation occurred due to thrips feeding, injury rating and curling.

A total of twenty five onion genotypes were screened in the field under natural conditions during both *Kharif* and *Rabi* seasons. The genotypes were grouped as per the scale based on PTI and data is presented in (Table 20).

During *Kharif* season, because of heavy down pour of rain at maturity stage of onion results no thrips incidence was observed.

In *Rabi* season, results revealed that, among different genotypes none of them were found immune. While, two genotypes Rampur Local (8%) and Arka Lalima (8%) were found resistant with grade scale of 1. Whereas, Six genotypes viz., Arka Kalyan (15%), S-780 (15%), Arka Kirthiman (16%), Suvarna (18%), Flare (12%) and Arka Bheem (15%) were found moderately resistant with grade scale 2. The per cent leaf area infection ranged from 11-20 per cent. Nine genotypes Arka Pragathi (25%), Arka Bindu (36%), Arka Niketan (30%), Poona Furusungi (24%), Lucifer (25%), BSS-827 (27%), Sudarshan (36%), Super Red (31%) and Marshall (26%) were grouped under moderately susceptible group and the grade scale was 3 with 21-40 per cent leaf area infection and five genotypes Sataragarvha (44%), Agrifound Light Red (45%), Light Red (55%), Super Flare (45%) and Samruddhi (42%) were susceptible with grade scale 4

with leaf area infection of 41-60 per cent and three genotypes Nasik Red (65%), Bellary Red (68%) and Prema-178 (62%) showed highly susceptibility (above 60%) during *Rabi* season.

**Table 20. Screening of different onion genotypes against purple blotch disease and Thrips**

| Sl. No.                      | Genotypes                   | Purple blotch           |                        | Thrips                 |                        |
|------------------------------|-----------------------------|-------------------------|------------------------|------------------------|------------------------|
|                              |                             | Plant Disease index (%) | Category of resistance | Plant Thrips index (%) | Category of resistance |
| <b>varieties</b>             |                             |                         |                        |                        |                        |
| 1                            | <b>Arka Pragathi</b>        | 30.62                   | MS                     | 25.00                  | MS                     |
| 2                            | <b>Arka Kalyan</b>          | 16.85                   | MR                     | 15.00                  | MR                     |
| 3                            | <b>Arka Bindu</b>           | 10.00                   | R                      | 36.00                  | MS                     |
| 4                            | <b>Arka Niketan</b>         | 31.25                   | MS                     | 30.00                  | MS                     |
| 5                            | <b>Nasik Red</b>            | 41.87                   | S                      | 65.00                  | HS                     |
| 6                            | <b>Rampur Local</b>         | 29.37                   | MS                     | 08.00                  | R                      |
| 7                            | <b>Bellary Red</b>          | 23.75                   | MS                     | 68.00                  | HS                     |
| 8                            | <b>Sataragarvha (check)</b> | 20.00                   | MR                     | 44.00                  | S                      |
| 9                            | <b>Poona Furusungi</b>      | 8.75                    | R                      | 24.00                  | MS                     |
| 10                           | <b>Agrifound Light Red</b>  | 23.12                   | MS                     | 45.00                  | S                      |
| 11                           | <b>S-780</b>                | 17.50                   | MR                     | 15.00                  | MR                     |
| 12                           | <b>Light Red</b>            | 76.25                   | HS                     | 55.00                  | S                      |
| 13                           | <b>Prema-178</b>            | 13.75                   | MR                     | 62.00                  | HS                     |
| <b>F<sub>1</sub> Hybrids</b> |                             |                         |                        |                        |                        |
| 14                           | <b>Arka Kirthiman</b>       | 35.62                   | MS                     | 16.00                  | MR                     |
| 15                           | <b>Arka Lalima</b>          | 16.85                   | MR                     | 08.00                  | R                      |
| 16                           | <b>Super Flare</b>          | 23.75                   | MS                     | 45.00                  | S                      |
| 17                           | <b>Lucifer</b>              | 30.00                   | MS                     | 25.00                  | MS                     |
| 18                           | <b>BSS-827</b>              | 17.50                   | MR                     | 27.00                  | MS                     |
| 19                           | <b>Suvarna</b>              | 11.25                   | MR                     | 18.00                  | MR                     |
| 20                           | <b>Samruddhi</b>            | 29.37                   | MS                     | 42.00                  | S                      |
| 21                           | <b>Sudharshan</b>           | 18.75                   | MR                     | 36.00                  | MS                     |
| 22                           | <b>Super Red</b>            | 43.12                   | S                      | 31.00                  | MS                     |
| 23                           | <b>Flare</b>                | 26.25                   | MS                     | 12.00                  | MR                     |
| <b>Synthetics</b>            |                             |                         |                        |                        |                        |
| 24                           | <b>Arka Bheem</b>           | 13.75                   | MR                     | 15.00                  | MR                     |
| 25                           | <b>Marshall</b>             | 35.62                   | MS                     | 26.00                  | MS                     |

# *Discussion*

## V. DISCUSSION

Onion (*Allium cepa* L.) is the most important species of the *Allium* group, belongs to the family Alliaceae and it can be regarded as the single most important vegetable species in the world after tomatoes. India has the largest area in the world, but productivity is very low when compared to major onion growing countries. A systematic breeding work was done at Indian Institute of Horticultural Research, Bengaluru resulted in development of male sterility system which led to release of new onion F<sub>1</sub> hybrids and synthetic varieties, besides development of F<sub>1</sub> hybrids from private sector. In addition Directorate of Onion and Garlic Research (DOGR), Rajgurunagar, Pune, National Horticultural Research and Development Foundation, Nasik, State Agricultural and Horticultural Universities have been released some improved varieties. However, an attempt has been made to compare improved onion varieties, F<sub>1</sub> hybrids and synthetics performance for their bulb yield, quality, diseases, insect pests resistance and storage quality.

The success of crop improvement programme depends on the extent of genetic variability existing in the population of different germplasm. The magnitude of genetic variability can determine the pace and quantum of genetic improvement through selection or through hybridization followed by selection. This necessitated the present investigation for various attributes under Eastern Dry Zone of Karnataka and the results of the experiments are discussed in this chapter.

### **5.1 Evaluation of varieties, F<sub>1</sub> hybrids and synthetics of onion for growth, bulb yield and quality traits**

The selection of a cultivar for particular region is of much significance as it shows considerable variability in several characters when grown under a particular ecological situation. The yield of any crop largely depends on the vigour of the plant as reflected by various growth parameters like plant height, number of leaves, collar thickness, neck thickness, plant population, etc. The growth and development of any plant is generally governed by the genetic constitution of the cultivars grown under identical conditions which intern genetic factors determines the yield of the plant.

### **5.1.1 Growth parameters**

#### **5.1.1.1 Vegetative traits**

Among different genotypes evaluated Super Flare, Super Red, Flare, Arka Bheem, Arka Lalima, Rampur Local and Marshall revealed better growth with higher plant height, number of leaves, leaf length and leaf width compared to other genotypes grown during *Kharif*, *Rabi* and in both the seasons after combined analysis. While, Arka Bindu recorded lowest plant height and number of leaves during *Kharif*, *Rabi* and in both the seasons after combined analysis. Thus the increased plant height, leaf length, leaf width and number of leaves might helped in better synthesis of carbohydrates and their utilization for build-up of new cells, apart from better absorption of nutrients for increased dry matter production in the plant. Besides, variations in vegetative parameters could be due to varietal characters governed by genetic factors. Such variations in the growth of different genotypes were reported by several workers (Patil *et al.*, 1990; Sharma and Choudhary, 1995; Khan, 1997; Gowda *et al.*, 1998a, Gowda *et al.*, 1998b; Patil *et al.*, 1991; Somkumar *et al.*, 1994, Mohanty and Prusti, 2001a; Mohanty and Prusti, 2002; Mahantesh, 2002; Mahantesh *et al.*, 2005; Sharma, 2009 and Ram *et al.*, 2011a).

#### **5.1.1.2 Plant establishment (%)**

A significant difference among the genotypes was observed with respect to per cent plant establishment at 30 DAT. The genotype Sataragarvha (91.45, 92.73 and 92.09%) noticed the highest per cent plant establishment during *Kharif*, *Rabi* and in both the seasons after combined analysis, respectively. While, lowest per cent of plant establishment documented in Suvarna during *Kharif* (79.16%) and *Rabi* (81.61%) seasons and in both the seasons after combined analysis (80.39%). The percentage of plant establishment depends on the genotype, weather factors, soil type and soil moisture. Sometimes depends on the method of nursery raising, age and sturdiness of the seedlings.

### **5.1.1.3 Duration of crop (Days)**

The earliness is considered as one of the most important characters in any crop improvement programme. Most of the genotypes or accessions are preferred when high yield is coupled with earliness. Moreover, duration of crop mainly depends on genotype. In the present study also identified certain genotypes having significant earliness with respect to days to maturity. The genotype Arka Bindu (102, 97 and 100 days) had taken minimum number of days to harvest and Super Flare (115, 112 and 114 days) took maximum number of days to harvest in *Kharif*, *Rabi* and in both the seasons after combined analysis, respectively. Similarly, Yadav *et al.*, 2009, reported that cultivar Sindhudurg Local had taken less number of days (100.67 days), whereas maximum number of days to harvest documented in N-2-4-1 (120.67 days).

### **5.1.1.4 Collar thickness (cm)**

The reduced collar and neck thickness traits indirectly helps to increase the storage life and are therefore considered most important parameters in selecting onion genotypes for extended storage life.

In the present study, minimum collar thickness was observed in Arka Bindu during *Kharif* (1.10cm), *Rabi* (0.98cm) and in both the seasons after combined analysis (1.04cm). While, maximum collar thickness was noticed in Super Flare in *Kharif* (1.38cm), *Rabi* (1.39cm) and in both the seasons after combined analysis (1.39cm). This may be due to high soil moisture or intermittent rainfall received at maturity of bulbs or even due to excess application of nitrogenous fertiliser or varietal characters. Similar findings were reported by Patil *et al.*, 1990; Sharma and Choudhary, 1995; Khan, 1997; Gowda *et al.*, 1998a, Gowda *et al.*, 1998b; Patil *et al.*, 1991; Somkumar *et al.*, 1994, Mohanty and Prusti, 2001b; Mohanty and Prusti, 2002; Mahantesh, 2002; Mahantesh *et al.*, 2005; Sharma, 2009 and Ram *et al.*, 2011b.

### **5.1.1.5 Neck thickness after curing (cm)**

The minimum neck thickness was revealed in the Rampur Local in *Kharif* (0.40cm), *Rabi* (0.43cm) and in both the seasons after combined analysis (0.42cm). However, maximum neck thickness was recorded in Super Flare in *Kharif* (0.70cm), *Rabi* (0.72cm) and in both the seasons after combined analysis (0.71cm). Neck thickness of bulbs depends on genotype and also due to excess application of nitrogen for the crop. Sometimes it is influenced by temperature and rainfall received during

cropping period. Similar research findings reported by Patil *et al.*, 1990; Sharma and Choudhary, 1995; Khan, 1997; Gowda *et al.*, 1998a, Gowda *et al.*, 1998b; Patil *et al.*, 1991; Somkumar *et al.*, 1994, Mohanty and Prusti, 2001b; Mohanty and Prusti, 2002; Mahantesh, 2002; Mahantesh *et al.*, 2005; Sharma, 2009 and Ram *et al.*, 2011b.

#### **5.1.1.6 Bolting (%)**

Among different genotypes, Poona Furusungi, Agrifound Light Red, S-780, Light Red, Suvarna, Super Red and Arka Bheem were noticed no bolting percentage in *Kharif*, *Rabi* and in both the seasons after combined analysis. Whereas, Prema-178 registered the maximum bolting percentage (3.65%) in *Kharif*. While, Arka Bindu indicated maximum bolting percentage in *Rabi* (9.85%) and in both the seasons after combined analysis (6.30%). The bolting in onion mainly depends on genotype, temperature and seasonal effect. In onion, similar findings were obtained by Nagarjuna, 1988; Khar *et al.*, 2007; Yadav *et al.*, 2009 and Trivedi and Dhumal, 2010.

#### **5.1.2 Yield Parameters**

##### **5.1.2.1 Polar diameter of bulb (cm)**

A synthetic hybrid Arka Bheem measured the highest polar diameter of bulb during *Kharif* (6.40cm), *Rabi* (6.60cm) and in both the seasons after combined analysis (6.50cm). While, Arka Bindu registered lowest polar diameter during *Kharif* (4.10cm), *Rabi* (4.20cm) and in both the seasons after combined analysis (4.15cm).

##### **5.1.2.2 Equatorial diameter of bulb (cm)**

With respect to equatorial diameter of onion hybrid Super Flare recorded maximum during *Kharif* (7.40cm), *Rabi* (7.50cm) and also in both the seasons after combined analysis (7.45cm). Whereas, Arka Bindu documented lowest equatorial diameter during *Kharif* (4.45cm), *Rabi* (4.65cm) and in both the seasons after combined analysis (4.55cm).

As these components influence on weight of the bulb which ultimately contributes towards the bulb yield. The maximum growth and production of bulb could be attributed by better growth and vigour of the genotypes, as this helped in better synthesis and accumulation of

photosynthates in the bulbs which might be due to efficient metabolism, greater photosynthates mobilization, better source and sink relationship as explained by Sharma (2009). Similar findings in onion were published by Mohanty and Prusti, 2002; Mahantesh, 2002; Mahantesh *et al.*, 2005; Khar *et al.*, 2007; Sharma, 2009 and Ram *et al.*, 2011a.

#### **5.1.2.3 Average bulb weight (g)**

The maximum average bulb weight was registered in onion hybrid Super Flare (135.00, 132.50 and 133.75g) during *Kharif*, *Rabi* and in both the seasons after combined analysis, respectively. However, Arka Bindu registered lowest average bulb weight during *Kharif* (37.50g), *Rabi* (39.30 g) and in both the seasons after combined analysis (38.40g). The difference in bulb weight among different genotype may be governed by genetic factors.

#### **5.1.2.4 Average ten bulb weight (g)**

Average ten bulb weight was maximum in the genotype Super Flare during *Kharif* (1380g), *Rabi* (1322g) and in both the seasons after combined analysis (1351g). While, Arka Bindu recorded lowest ten bulb weight during *Kharif* (380 g), *Rabi* (397 g) and in both the seasons after combined analysis (388.50 g). The variation in ten bulb weight among different genotype might be due to difference in the weight and size of individual bulb and this might be due to genetic character of genotype.

#### **5.1.2.5 Bulb yield per plot (kg)**

The genotype Super Flare documented the highest bulb yield per plot during *Kharif* (6.79 kg/plot) and in both the seasons after combined analysis (6.69 kg/plot) and Flare in *Rabi* season (6.85 kg/plot). However, Arka Bindu registered lowest bulb yield per plot during *Kharif* (3.25 kg/plot), *Rabi* (3.52 kg/plot) and in both the seasons after combined analysis (3.39 kg/plot). The variation in the bulb yield per plot could be attributed from weight and size of different onion genotypes this might be contributed towards the production of higher bulb yield per plot.

#### **5.1.2.6 Total bulb yield per hectare (t)**

Total bulb yield per hectare, recorded highest in hybrid Super Flare during *Kharif* (38.16 t/ha) and in both the seasons after combined analysis

(37.58 t/ha) and Flare in *Rabi* season (38.50 t/ha). Whereas, Arka Bindu registered lowest bulb yield per hectare during *Kharif* (17.33 t/ha), *Rabi* (19.77 t/ha) and in both the seasons after combined analysis (18.55 t/ha). The highest bulb yield production per hectare may be due to genetic yield potential of the variety. This may also be contributed by higher individual bulb weight and size which might resulted in highest bulb yield.

#### **5.1.2.7 Marketable bulb yield per hectare (t)**

The highest marketable bulb yield per hectare was recorded in Super Flare during *Rabi* (37.23 t/ha) and in both the seasons after combined analysis (36.57 t/ha) and Flare during *Kharif* season (37.03 t/ha). Whereas, Arka Bindu documented least marketable yield than any other genotypes during *Kharif* (14.50 t/ha), *Rabi* (17.07 t/ha) and in both the seasons after combined analysis (15.79 t/ha).

The highest yield of onion bulbs from these genotypes could be attributed due to maximum plant height and number of leaves which are important component of growth which might resulted in accumulation of maximum photosynthates in bulbs and also maximum plant establishment which is directly proportional to number of bulbs produced. Apart from these, it may be due to maximum bulb polar diameter, bulb equatorial diameter and bulb weight which are major yield contributing components. Moreover, hybrid vigour might contributed towards the production of larger bulbs with higher individual bulb weight, which may resulted in highest marketable bulb yield per hectare. Sharma (2009) reported that highest yield manifested by Baswant-780 was accompanied by better growth, larger size bulbs and maximum bulb weight. Thus, it could be concluded that bulb yield is dependent on vigour of plant and yield components. The variations in the yields of different cultivars grown under similar conditions has been reported from several places by Jadhav *et al.*, 1990; Patil *et al.*, 1991; Katwale and Saraf, 1991; Khan, 1997; Somkumar *et al.*, 1994, Mohanty and Prusti, 2002; Mahantesh, 2002; Mahantesh *et al.*, 2005; Khar *et al.*, 2007; Sharma, 2009 and Ram *et al.*, 2011.

#### **5.1.2.8 Un-marketable bulb yield per hectare (t)**

Un-marketable bulb yield was minimum in onion hybrid Super Flare during *Kharif* (0.93 t/ha), *Rabi* (1.10 t/ha) and in both the seasons after combined analysis (1.02 t/ha). However, Arka Bindu registered highest un-marketable yield per hectare during *Kharif* (2.80 t/ha), *Rabi* (2.70 t/ha) and in both the seasons after combined analysis (2.75 t/ha). The highest un-

marketable bulbs in Arka Bindhu due to its genetical character and smaller size bulbs production.

### **5.1.3 Quality parameters**

#### **5.1.3.1 Number of rings**

A significant variations in number of rings per bulb was observed among the genotypes. The highest number of rings per bulb was noticed in hybrid Super Flare (10.34, 10.52 and 10.43) during both *Kharif*, *Rabi* and in both the seasons after combined analysis, respectively. While, Arka Niketan (6.60, 7.15 and 6.88) registered the lowest number of rings per bulb during *Kharif*, *Rabi* and in both the seasons after combined analysis, respectively.

#### **5.1.3.2 Number of centers**

With respect to number of centers in Arka Kirthiman (1.20, 1.30 and 1.25) noticed lowest number of centers during *Kharif*, *Rabi* and in both the seasons after combined analysis, respectively. However, Samruddhi revealed maximum number of centers during *Kharif* (3.30) and Satargarvha recorded maximum number of centers during *Rabi* (3.30) and in both the seasons after combined analysis (3.25).

In earlier studies also reported significant variation with respect to number of rings and number of centers per bulb among different cultivars grown under different conditions and seasons. Number of rings and number of centers mainly depends on genotype due to genetic make-up. (Jadhav *et al.*, 1990; Patil *et al.*, 1991; Khan, 1997; Patil *et al.*, 1990; Somkumar *et al.*, 1994, Mohanty and Prusti, 2001a; Mohanty and Prusti, 2002; Mahantesh, 2002; Mahantesh *et al.*, 2005; Khar *et al.*, 2007; Sharma, 2009; Trivedi and Dhumal 2010 and Ram *et al.*, 2011a).

#### **5.1.3.3 Total soluble solids (°brix)**

A significant variations in total soluble solids was noticed among the genotypes. The highest TSS was recorded in Arka Bindu (17.33, 17.38 and 17.36 °brix), while Super Flare registered the lowest TSS during both *Kharif* (11.27°brix), *Rabi* (11.33°brix) and in both the seasons after combined analysis (11.30°brix), respectively. Similar findings were noticed by Muthukrishnan *et al.* (1978), Bajaj *et al.* (1990), Jadhav *et al.* (1990),

Patil *et al.* (1991), Somkumar *et al.* (1994), Pathak and Gowda (1994), Khan *et al.* (1997), Gowda *et al.* (1998a), Gowda *et al.* (1998b) Mastanareddy and Sulikeri, (1998); Ananthan and Balakrishnamoorthy (2007), Shanmugasundaram (2000a), Khar *et al.* (2007), Mahantesh *et al.* (2009), Hosmani *et al.* (2010) and Trivedi and Dhumal (2010). Ram *et al.* (2011b) they reported the significant differences with respect to total soluble solids among varieties and hybrids grown under different seasons and conditions. Similarly, Mahantesh *et al.* (2009) documented highest total soluble solids in Bellary Red which was superior to other varieties in Central Dry Zone of Karnataka.

#### **5.1.3.4 Pungency (pyruvic acid content $\mu$ moles/gram of fresh weight)**

Among different genotypes, a significant difference was found with respect to pungency. The highest pungency was registered in case of Arka Bindu during *Kharif* (6.36 pyruvic acid  $\mu$  moles/gram of fresh weight), *Rabi* (6.41 pyruvic acid  $\mu$  moles/ gram of fresh weight) and in both the seasons after combined analysis (6.39 pyruvic acid  $\mu$  moles/ gram of fresh weight). While, in genotype Super Flare indicated lowest pungency during *Kharif* (4.04 pyruvic acid  $\mu$  moles/g FW), *Rabi* (4.08 pyruvic acid  $\mu$  moles/g FW) and in both the seasons after combined analysis (4.06 pyruvic acid  $\mu$  moles/g FW). TSS and pungency mainly depends on genotype due to genetic make-up. Similar results were obtained by Shanmugasundaram (2000), Mallor *et al.* (2011) and Gallina *et al.* (2012).

#### **5.1.3.5 Dry matter content (%)**

Data revealed that, the dry matter content of the bulbs differed significantly among the genotypes. The highest percentage of dry matter content was produced by the genotype Arka Bindu (19.40, 19.70 and 19.55 %) and lowest was recorded in Agrifound Light Red (9.60, 9.80 and 9.70 %) during *Kharif*, *Rabi* and in both the seasons after combined analysis, respectively. These findings are similar to the findings of Bajaj *et al.* (1990), Somkumar *et al.* (1997), Shanmugasundaram (2000), Ananthan and Balakrishnamoorthy (2007), Mahantesh *et al.* (2009) and Hosmani *et al.* (2010). Similarly Mahantesh *et al.* (2009) noticed maximum dry matter content of the bulb in cultivar Baswant-780 in Central Dry Zone of Karnataka during *Kharif* season under rainfed situation.

### **5.1.3.6 Firmness (kg/cm<sup>2</sup>)**

The firmness of bulb indicated there was no significant difference among the onion genotypes grown during *Kharif and Rabi* seasons. These results are similarly confirmed by Hosmani *et al.* (2010).

### **5.1.3.7 Split bulbs (%)**

Among different genotypes, Arka Kalyan, Rampur Local, Super Flare, Samruddhi, Arka Bheem and Marshall, were recorded no split bulbs during *Kharif, Rabi* and in both the seasons after combined analysis. While, maximum split bulb percentage was noticed in Agrifound Light Red during both *Kharif* (7.32%), *Rabi* (7.52%) and in both the seasons after combined analysis (7.42%). The production of split bulbs mainly depends on the genotype, weather conditions and agronomic practices. Similar observations were made by Nagarjuna, 1988; Khar *et al.*, 2007; Yadav *et al.*, 2009 and Trivedi and Dhumal, 2010.

## **5.2 Studies on variability of varieties, synthetics and F<sub>1</sub> hybrids of onion for growth, bulb yield and quality**

The range of variation observed for all the traits in the present study indicated the presence of sufficient amount of variation among the genotypes for all the characters studied. The range in the values reflects the amount of phenotypic variability which is not reliable, since it includes genotypic, environmental and genotype × environment interaction components and does not reveal as to which character is showing higher degree of variability. Further, the phenotypic traits of crop is influenced by additive gene effect (heritable fixable), dominance (heritable non-fixable) and epistasis (non-allelic interaction). Hence, it becomes necessary to split the observed variability into phenotypic and genotypic co-efficient of variation, which ultimately indicate the extent of variability existing for various traits. However, even this does not give a true picture about the extent of inheritance of the character. Therefore, the heritability of a character can be relied upon, as it enables the plant breeder to decide the extent of selection pressure to be applied under a particular environment, which separates the environmental influence from the total variability. Nevertheless, its use would be limited as this is prone to change with the environment, experimental material, etc.

An estimation of heritability has a greater role to play in determining the effectiveness of selection of a character provided it is considered in conjunction with the predicted genetic advance as suggested by Johnson and Robinson (1955). Then heritability is influenced by bio-metrical method, generation of hybrid, sample size of experimental material and environment. With these, the results of the present investigation on various parameters are discussed in this objective.

In the present investigation high genetic co-efficient of variation (GCV) and phenotypic co-efficient of variation (PCV) were noticed for number of centers and un-marketable bulb yield. This characters noticed higher range of variation and have better scope for crop improvement through selection. The higher estimates of GCV and PCV for number of centers and un-marketable yield are in agreement with earlier reports of Trivedi and Dhumal (2010).

Further, moderate GCV and PCV were observed for neck thickness, average bulb weight, marketable yield and dry matter content indicating moderate amount of variability. The moderate estimates of GCV and PCV for neck thickness are in agreement with earlier reports of Yadav *et al.* (2009) and Khar *et al.* (2007). In the same way, moderate estimates of GCV and PCV for total bulb yields were concluded by Singh *et al.* (2010), Mushtaq *et al.* (2013) and Tripathy *et al.* (2013). Chattopadhyay *et al.* (2013), Singh *et al.* (2012), Singh and Dubey (2011) and Singh *et al.* (2010) observed moderate estimates of GCV and PCV for marketable yield. In parallel to this, moderate estimates of GCV and PCV noticed for average bulb weight in the present study had similarity with the results of Bharti *et al.* (2011). However, the moderate estimates of GCV and PCV of all these traits indicates more possibility of improving these characters by selection.

The lower estimate of GCV and PCV were documented for plant height at 90 DAT, number of leaves at 90 DAT, leaf length at 90 DAT, leaf width at 90 DAT, collar thickness, days to maturity, equatorial diameter, polar diameter, number of rings, TSS and pungency. The lower estimates of GCV and PCV for number of leaves are in agreement with the reports of Rashid *et al.* (2012), Singh *et al.* (2010), Singh and Dubey (2011), Ram *et al.* (2011). Golani *et al.* (2006). While, Dhotre (2009) reported lower estimates of GCV and PCV for plant height. The lower estimates of GCV and PCV observed for equatorial diameter is in agreement with earlier reports of Dhotre (2009), Singh and Dubey (2011), Ram *et al.* (2011b). Similarly for polar diameter Dhotre (2009), Singh and Dubey (2011), Ram *et al.* (2011a) revealed lower estimates of GCV and PCV. The lower

estimates of GCV and PCV for days to maturity is in agreement with earlier reports of Patil (1997), Sendek *et al.* (2008) and Dhotre (2009). The lower GCV and PCV provides evidence of narrow range of variability for these traits and provides least scope for improvement through selection. Hence, the variability has to be generated through introduction and hybridizing diversified genotypes to generate transgressive segregants.

Very often, heritability in broad sense is not the true indicator of inheritance of traits, since only additive component of genetic variance is transferred from generation to generation. Therefore, heritability in broad sense may mislead in judging the effectiveness of selection for the trait. Considering heritability in broad sense along with genetic advance over mean may reveal the prevalence of specific components (additive or non-additive) for the trait more accurately.

In the present investigation, high heritability coupled with high genetic advance as per cent over mean was recorded for the characters *viz.*, neck thickness, yield, un-marketable yield, average bulb weight, number of centers and dry matter content. Therefore, additive component is predominant here. Thus, there is a ample scope for improving these characters through direct selection. Trivedi and Dhumal (2010) revealed high heritability and high genetic advance mean (GAM) for neck thickness. Singh *et al.* (2010), Singh *et al.* (2012) published high heritability and high GAM for total yield as observed in the present study. Sendek *et al.* (2008), Singh *et al.* (2010), Singh and Dubey (2011), Singh *et al.* (2012) and Chattopadhyay *et al.* (2013), indicated high heritability and high GAM for un-marketable yield. The high heritability with high GAM for average bulb weight is in accordance with the findings of Dhotre (2009), Hosamani *et al.* (2010) and Mohanty (2001).

The high heritability with moderate GAM was observed for number of leaves at 90 DAT, Leaf length at 90 DAT, equatorial diameter, polar diameter, number of rings and TSS .This indicates the importance of additive effects for this trait and there can be better response to selection. Patil (1997), Ibrahim *et al.* (2013) reported high heritability with moderate GAM for number of leaves at 90 DAT. Similarly, Yadav *et al.* (2009) indicated high heritability with moderate GAM for equatorial diameter and polar diameter as observed in the present study. Ahmed and Sharma (2014) revealed high heritability with moderate GAM for number of rings and TSS.

### **5.3 Studies on storage behaviour of varieties, synthetics and F<sub>1</sub> hybrids of onion**

#### **5.3.1 Sprouting (%)**

At first month after storage no genotypes noticed sprouting of bulbs produced during *Kharif* and *Rabi* seasons. Similarly, at two months after storage no sprouting was observed in Arka Kalyan, Arka Bindu, Rampur local, Prema-178, Arka Kirthiman, Arka Lalima, Lucifer and Arka Bheem. While, maximum sprouting was observed in Nasik Red (12.50%) grown in *Kharif* season crop. Besides, no sprouting of bulbs was observed in *Rabi* season crop at two months after storage in any of the genotypes.

Further at three months after storage, no sprouting was observed in Arka Kalyan, Arka Bindu, Lucifer and Arka Bheem during both *Kharif* and *Rabi*. Whereas, maximum sprouting was observed in Nasik Red grown during both *Kharif* (16.66%) and *Rabi* (9.52%) seasons. The maximum percentage of sprouting in *Kharif* season crop might be due to high temperature prevailed during the cropping period, which might be resulted in more sprouts in onion during storage. Singh *et al.* (1992), Satodiya and Singh (1993), Somkumar *et al.* (1997), Shanmugasundaram (1999b) and Trivedi and Dhumal (2010) also observed significant difference in sprouting of bulbs among onion cultivars. The sprouting mainly depends on dormancy, moisture content of the bulbs, temperature and also governed by genetic characters.

#### **5.3.2 Rotting (%)**

At one month after storage no varieties revealed rotting of bulbs produced during both *Kharif* and *Rabi* seasons. However, at two months after storage no rotting was observed in Arka Kalyan, Arka Bindu, Rampur local, Bellary Red, Prema-178, Arka Kirthiman, Arka Lalima, Super Flare, Lucifer, BSS-827, Samruddhi, Arka Bheem and Marshall. But Nasik Red indicated the maximum rottage in bulbs produced (8.33%) during *Kharif* season crop. While, bulbs harvested in *Rabi* crop showed no rottage in any of the genotypes.

Further, at three months after storage no rottage was observed in Arka Kalyan, Arka Bindu, Lucifer and Arka Bheem during both *Kharif* and *Rabi* seasons. Whereas, the Sataragarvha recorded the maximum rottage (14.25%) in bulbs produced during *Kharif* season crop. However, maximum rottage was observed in Super Red (12.00%) during *Rabi*. Singh *et al.* (1992), Satodiya and Singh (1993), Somkumar *et al.* (1997), Shanmugasundaram (1999a), Shanmugasundaram (2000b), Trivedi and

Dhumal (2010) also reported significant difference in rottage of bulbs among different onion cultivars. The rottage during storage mainly depends on moisture content of the bulbs, temperature and production season. In addition, improper curing after harvesting before storage might very much impact on the rottage during storage.

### **5.3.3 Physiological loss in weight [PLW (%)]**

After one month of storage the minimum PLW was observed in Arka Bheem (2.14%). Whereas, maximum PLW registered in Poona Furusungi (5.26%) bulbs produced in *Kharif*. In *Rabi* season crop, minimum PLW was recorded in Arka Bheem (1.76%). Whereas, maximum PLW was registered in Poona Furusungi (4.45%). Whereas, at two months after storage the minimum PLW was documented in Arka Pragathi (8.20%). While, maximum PLW was recorded in Poona Furusungi (15.42%) grown in *Kharif* season. In *Rabi* harvested crop Arka Pragathi registered lowest PLW (7.72%). But, maximum PLW was observed in Poona Furusungi (14.76%).

After three months of storage the minimum PLW was observed in Arka Bheem (15.76%). Whereas, maximum PLW was recorded in Poona Furusungi (36.33%) in *Kharif* season crop. In *Rabi* harvested crop, Arka Bheem recorded lowest PLW (15.32%). However, maximum physiological loss in weight was observed in Poona Furusungi (35.49%) at three months of storage. The loss in weight during the storage at room temperature depending upon the varietal characters, high temperature coupled with low relative humidity in the atmosphere during storage period. In parallel to our investigation, earlier studies also reported the significant difference in weight loss among the different onion cultivars by Singh *et al.* (1992), Satodiya and Singh (1993), Somkumar *et al.* (1997), Shanmugasundaram (1999b), Shanmugasundaram (2000b), Shanmugasundaram (2003a), Trivedi and Dhumal (2010) and Jamali *et al.* (2012).

### **5.3.4 Black molds (%)**

At one and two months after storage, the per cent loss due to black molds of bulbs was not observed in any of the genotypes during both the seasons. However, after three months of storage, no black molds infected bulbs were noticed in Arka Kalyan, Arka Bindu, Rampur local, Prema-178 Arka Kirthiman, Arka Lalima, Super Flare, Lucifer, Arka Bheem and Marshall. But Nasik Red registered the maximum infection of bulbs (8.33%) in *Kharif* season crop. Whereas, in *Rabi* season harvested bulbs, no black molds was observed in Arka Kalyan, Arka Bindu, Rampur Local,

Prema-178, Arka Kirthiman, Arka Lalima, Super Flare, Lucifer, Arka Bheem, and Marshall. While, Sudarshan documented the maximum incidence of black molds (7.69%) after three months of storage. The infection due to black molds might be due to varietal resistance or susceptability, presence of moisture and curing of bulbs before storage during both the seasons.

## **5.4 Screening for Purple blotch disease and Thrips**

### **5.4.1 Purple blotch disease incidence (%)**

Total twenty five onion genotypes were screened in field under natural conditions during both *Kharif* and *Rabi* seasons. The genotypes were grouped as per the scale developed by Bhangale and Joi (1985).

During *Kharif* season different genotypes were screened for their tolerance or resistance to purple blotch caused by *Alternaria porii*. However, none of them were found immune, while two genotypes Poona Furusungi (8.75%) and Arka Bindu (10.00 %) were found resistant to purple blotch. Nine genotypes such as Suvarna (11.25%), Prema-178 (13.75), Arka Bheem (13.75%), Arka Kalyan (16.85%), Arka Lalima (16.85%), S-780 (17.50%), BSS-827 (17.50%), Sudarshan (18.75 %) and Sataragarvha (20.00 %) were found to be moderately resistant. Eleven genotypes *viz.*, Agrifound Light Red (23.12%), Bellary Red (23.75%), Super Flare (23.75%), Flare (26.25%) Samruddhi (29.37%), Rampur Local (29.37%), Lucifer (30.00 %), Arka Pragathi (30.62%), Arka Niketan (31.25%), Arka Kirthiman (35.62%) and Marshall (35.62%) were observed to be moderately susceptible. Whereas, Nasik Red (41.87%) and Super Red (43.12%) were found susceptible and Light Red (76.25%) was found highly susceptible.

However, in *Rabi* season the purple blotch incidence was not noticed in any of the genotypes including the varieties that were susceptible in *Kharif* season. Since purple blotch incidence occurs more in high soil moisture, rainfall and humid conditions due to conducive climatic factors. Similar findings were reported by Sandhu *et al.* (1981), Dhiman *et al.* (1986), Pathak *et al.* (1986) and Upmanyu and Sharma (2007).

#### 5.4.2 Thrips infestation (%)

Similarly, twenty five genotypes of onion were screened in the field under natural conditions during both *Kharif* and *Rabi* seasons. The genotypes were classified as per the scale based on per cent thrips infestation (PTI).

During *Kharif* season crop, because of heavy down pour of rain at maturity stage of onion results in no thrips infestation was observed. But thrips infestation was high in *Rabi* crop due to favourable weather of high temperature during day coupled with cool night temperature and lack of rainfall might encouraged faster multiplication of thrips. In *Rabi* season, results revealed that among different genotypes none of them were found immune. While, two genotypes Rampur Local (8%) and Arka Lalima (8%) were showed resistant. Six genotypes viz., Flare (12%), Arka Kalyan (15%), Arka Bheem (15%), S-780 (15%), Arka Kirthiman (16%) and Suvarna (18%) were found moderately resistant. Nine genotypes Poona Furusungi (24%), Lucifer (25%), Marshall (26%), Arka Pragathi (25%), BSS-827 (27%), Arka Niketan (30%), Super Red (31%), Sudarshan (36%), Arka Bindu (36%) were grouped under moderately susceptible group and five genotypes Samruddhi (42%), Sataragarvha (44%), Super Flare(45%), Agrifound Light Red (45%) and Light Red (55%) were found susceptible. Whereas, three genotypes Prema-178 (62%), Nasik Red (65%) and Bellary Red (68%) noticed high susceptibility during *Rabi* season.

The wide difference in the infestation of thrips might be due to varietal characters and weather factors viz., dry weather with high temperature and lack of rainfall during *Rabi* season might encourages the faster multiplication of thrips and their infestation. Similar findings were reported by John Diaz-Montano *et al.* (2010), Anonymous (2011a) and Anonymous (2011b).

*Summary*

## VI. SUMMARY

Findings of the research work “Studies on performance of varieties, F<sub>1</sub> hybrids and synthetics of onion (*Allium cepa* L.) in Eastern Dry Zone of Karnataka.” are summarized here under. The work was carried out at Department of Vegetable Science, College of Horticulture, Kolar during the period between June-2015 to June-2016. The present study was undertaken to elicit information on the extent of adoptability, performance and storage potential in onion genotypes to Eastern Dry Zone of Karnataka.

The morphological characters of twenty five genotypes in present study differed significantly with regard to plant height, leaf length, leaf width and number of leaves per plant at 30, 60 and 90 DAT, collar thickness, neck thickness, days to harvest and bolting percentage.

The growth parameters like plant height, number of leaves, leaf length were highest in genotypes Super Flare and Flare in *Kharif* and *Rabi* seasons respectively. While, Super Flare recorded maximum leaf width in *Kharif* and Rampur Local in *Rabi* season compared to other genotypes.

The bolting percentage differed significantly among the genotypes, Poona Furusungi, Agrifound Light Red, S-780, Light Red, Suvarna, Super Red and Arka Bheem have recorded no bolting per cent (0.00%) in both *Kharif* and *Rabi* seasons. Among the genotypes Arka Bindu recorded less number of days to harvest during *Kharif* and *Rabi* seasons (102 and 97 days, respectively).

Arka Bindu noticed the lowest bulb collar thickness during both *Kharif* and *Rabi* season (0.88 and 0.98 cm, respectively). With respect to neck thickness Rampur Local revealed the minimum neck thickness during *Kharif* and *Rabi* seasons (0.40 and 0.43 cm, respectively).

Yield attributes like polar and equatorial diameter were significantly differed among the genotypes. The results revealed that, Arka Bheem documented the highest polar diameter in *Kharif* and *Rabi* season (6.40 cm and 6.60 cm, respectively). With respect to equatorial diameter of bulb Super Flare registered the significantly highest in *Kharif* and *Rabi* seasons (7.40 cm and 7.50 cm, respectively).

The yield parameters such as average bulb weight, average ten bulb weight, bulb yield per plot, total bulb yield and marketable bulb yields were significantly differed among the genotypes. Maximum average bulb weight was observed in Super Flare during *Kharif* (135.00 g) and *Rabi* season (132.50 g). With respect to ten bulb weight, Super Flare recorded the significantly highest in *Kharif* and *Rabi* seasons (1380.00 g and 1322.00 g, respectively).

Among the genotypes the bulb yield per plot and bulb yield per hectare were found to be highest in Super Flare during *Kharif* season (6.79 kg/plot and 38.16 t/ha, respectively) and Flare during *Rabi* season (6.85 kg/plot and 38.50 t/ha, respectively).

With respect to marketable bulb yield, maximum marketable bulb yield was recorded in Super Flare during *Kharif* season (37.23 t/ha) and Flare during *Rabi* season (37.03 t/ha). While, lowest unmarketable bulb yield was noticed in Super Flare during *Kharif* (0.93 t/ha) and S-780 during *Rabi* season (1.10 t/ha).

Among the genotypes the maximum number of rings per bulb was recorded in Super Flare during *Kharif* (10.34) and *Rabi* seasons (10.52). With respect to number of centers, Arka Kirthiman recorded lowest number of centers during *Kharif* (1.20) and Poonam Firusungi in *Rabi* season (1.24).

Quality traits were significantly differed with different genotypes. Among the different genotypes, significantly maximum total soluble solids content of onion bulb per cent recorded in Arka Bindu (17.33 and 17.38 °brix, respectively), higher dry matter content in Arka Bindu (19.40 and 19.70 %, respectively) and higher pyruvic acid content in Arka Bindu (6.36 and 6.41 pyruvic acid  $\mu$  moles/g FW, respectively) during both *Kharif* and *Rabi* Seasons, respectively.

Among different genotypes, no split bulbs was observed in genotypes Arka Kalyan (0.00 %), Rampur Local (0.00 %), Super Flare (0.00 %), Samruddhi (0.00 %), Arka Bheem and Marshall (0.00 %) in both seasons.

High GCV and PCV were observed for number of centers and unmarketable yield. This characters recorded higher range of variation and have better scope for improvement through selection. Moderate GCV and PCV were observed for neck thickness, yield, average bulb weight, marketable yield and dry matter indicating moderate amount of variability.

The moderate estimates of GCV and PCV of these traits indicates more possibility of improving these characters by selection.

The lower estimate of GCV and PCV were observed for plant height at 90 DAT, number of leaves at 90 DAT, leaf length at 90 DAT, leaf width at 90 DAT, collar thickness, days to maturity equatorial diameter, polar diameter, number of rings, TSS and pungency. Lower GCV and PCV for these traits provide evidence of low variability. Hence, the variability has to be generated through introduction and hybridizing diversified genotypes to generate transgressive segregants.

High heritability coupled with high genetic advance as per cent over mean was recorded for the characters *viz.*, neck thickness, yield, unmarketable yield, average bulb weight, number of centres and dry matter content. Therefore, additive component is predominant here. Thus, there is ample scope for improving these characters through direct selection.

The high heritability with moderate GAM was observed for number of leaves at 90 DAT, leaf length at 90 DAT, equatorial diameter, polar diameter, number of rings and TSS. This indicates the importance of additive effects for this trait and there can be better response to selection.

Genotypes significantly differed with respect to total physiological weight loss, sprouting and rottage of bulbs at different stages during storage period.

After one month of storage, the minimum PLW was observed in Arka Bheem during *Kharif* (2.14%) and *Rabi* (1.76%). At two months after storage the minimum PLW was observed in Arka Pragathi during *Kharif* (8.20%) and *Rabi* (7.72%). After three month of storage the minimum PLW was observed in Arka Bheem during *Kharif* (15.76%) and *Rabi* (15.32%) seasons.

The results revealed that, first month after storage the per cent loss due to sprouting of bulbs was not observed in any of the genotypes during both the seasons. In *Kharif* harvested onion crop no sprouting was observed in genotypes Arka Kalyan (0.00%), Arka Bindu (0.00%), Rampur Local (0.00%), Prema-178 (0.00%), Arka Kirthiman (0.00%), Arka Lalima (0.00%), Lucifer (0.00%) and Arka Bheem (0.00%). Whereas, no genotypes recorded sprouting during *Rabi* season during two months of storage. At three months after storage no sprouting was recorded in Arka

Kalyan (0.00%), Arka Bindu (0.00%), Lucifer (0.00%) and Arka Bheem (0.00%) during both the seasons.

At one month after storage the per cent loss due to rotting of bulbs was not observed in any of the genotypes during both the seasons. In *Kharif* harvested onion crop no rotten bulbs was observed in Arka Kalyan (0.00%), Arka Bindu (0.00%), Rampur local (0.00%), Bellary Red (0.00%), Prema-178 (0.00%), Arka Kirthiman (0.00%), Arka Lalima (0.00%), Super Flare (0.00%), Lucifer (0.00%), BSS-827 (0.00%), Samruddhi (0.00%), Arka Bheem(0.00%), and Marshall(0.00%). Whereas, no genotypes recorded rotting during *Rabi* season during two months after storage. At three months after storage no rotting was recorded in Arka Kalyan (0.00%), Arka Bindu (0.00%), Lucifer (0.00%) and Arka Bheem (0.00%) during both the seasons.

The data revealed that, at two months after storage the percent loss due to black molds in bulbs was not observed in any of the genotypes during both the seasons. After three months of storage no black mould bulbs was observed in Arka Kalyan (0.00%), Arka Bindu (0.00%), Rampur Local (0.00%), Prema-178 (0.00%), Arka Kirthiman (0.00%), Arka Lalima (0.00%), Super Flare (0.00%), Lucifer (0.00%), Arka Bheem(0.00%), and Marshall(0.00%) during both the seasons.

With respect to purple blotch disease index, during *Kharif* season, among different genotypes none of them were found immune, while two genotypes Arka Bindu (10%) and Poona Furusungi (8.75%) were found resistant (1-10 %), with grade scale of 1. While, Nine genotypes such as Arka Kalyan (16.85%), Sataragarvha (20%), S-780 (17.50%), Prema-178 (13.75%), Arka Lalima (16.85%), BSS-827 (17.50%), Suvarna (11.25%), Sudarshan (18.75%), and Arka Bheem (13.75%) found moderately resistant (11-20%) with grade scale 2. Eleven genotypes viz., Arka Pragathi (30.62%), Arka Niketan (31.25%), Rampur Local (29.37%), Bellary Red (23.75%), Agrifound Light Red (23.12%), Arka Kirthiman (35.62%), Super Flare (23.75%), Lucifer (30%), Samruddhi (29.37%), Flare (26.25%) and Marshall (35.62%) were found under moderately susceptible group (21-40%) and the grade scale was 3.

In *Rabi* season, no genotypes recorded the purple blotch incidence including susceptible varieties of *Kharif* season.

During *Kharif* season, because of heavy down pour of rain at maturity stage of onion results in no thrips incidence was observed.

In *Rabi* season, results revealed that, among different genotypes none of them were found immune to thrips. While, two genotypes Rampur Local (8%) and Arka Lalima (8%) were found resistant with grade scale of 1. Whereas, Six genotypes viz., Arka Kalyan (15%), S-780 (15%), Arka Kirthiman (16%), Suvarna (18%), Flare (12%) and Arka Bheem (15%) were found moderately resistant with grade scale 2. The per cent leaf area infection ranged from 11-20 per cent. Nine genotypes Arka Pragathi (25%), Arka Bindu (36%), Arka Niketan (30%), Poona Furusungi (24%), Lucifer (25%), BSS-827 (27%), Sudarshan (36%), Super Red (31%) and Marshall (26%) were grouped under moderately susceptible group and the grade scale was 3 with 21-40 per cent leaf area infection.

In the present study based on the results it is concluded that among all the genotypes Super Flare during *Kharif* and Flare during *Rabi* season proved to be superior with considering the growth, yield and quality characteristics for cultivation under Eastern Dry Zone of Karnataka. However in *Rabi* season the growth, yield, quality and storage attributes were found better compared to *Kharif* season. For quality traits like total soluble solids and dry matter content of bulbs genotypes Arka Bindu, Arka Bheem and Arka Niketan were found to be the best among all the genotypes, hence can be better utilized for dehydration and processing purpose.

With respect to storage behaviour and keeping quality of different genotypes indicated that Arka Bheem and Arka Pragathi were best suited for long term storage in *Kharif* and *Rabi* season crop as they were recorded minimum total physiological loss in weight. Among the onion genotypes Arka Bindu and Poona Furusungi were found resistant to purple blotch. Nine genotypes such as Arka Kalyan, Sataragarvha, S-780, Prema-178, Arka Lalima, BSS-827, Suvarna, Sudarshan, and Arka Bheem were found moderately resistant to purple blotch. Out of twenty five genotypes Rampur Local and Arka Lalima were found resistant to thrips infestation. While, Six genotypes viz., Arka Kalyan, S-780, Arka Kirthiman, Suvarna, Flare and Arka Bheem were found moderately resistant for thrips infestation. Hence these cultivars were found suitable and recommended for commercial cultivation of onion in thrips and purple blotch disease prone areas with economical yield.

In onion,  $F_1$  hybrids were found to be superior for high bulb yield (Super Flare and Flare) and synthetics (Arka Bheem) for storage qualities besides both were moderate in tolerance to disease like purple blotch and pest like thrips. Hence it is concluded that in onion  $F_1$  hybrids needs to be popularised for enhancement of productivity.

## **6.1 Future line of work**

- The best performing genotypes needs to be evaluated across the locations to test their stability and confirm their performance.
- The genotypes with high TSS, dry matter, pungency and best storage parameters are needed to be utilized for processing and dehydration studies.
- There is need for evaluation onion genotypes for nutritional composition.
- There is need for popularization of onion F<sub>1</sub> hybrids for enhancement of productivity.

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# *Appendices*

## APPENDIX - I

**Mean monthly meteorological data recorded during the period of experimentation June-2015 to June 2016)**

| Month                     | Temperature (°C) |              | Relative Humidity (%) |                 | Rainfall (mm) | Rainy days  |
|---------------------------|------------------|--------------|-----------------------|-----------------|---------------|-------------|
|                           | Max              | Min          | Morning<br>8 AM       | Evening<br>4 PM |               |             |
| <b><i>Kharif crop</i></b> |                  |              |                       |                 |               |             |
| <b>June 2015</b>          | 20.00            | 32.40        | 80.90                 | 61.50           | 87.10         | 5.00        |
| <b>July, 2015</b>         | 32.40            | 20.70        | 82.64                 | 59.16           | 57.10         | 5.00        |
| <b>August, 2015</b>       | 31.90            | 20.40        | 82.93                 | 59.25           | 71.40         | 7.00        |
| <b>September, 2015</b>    | 32.20            | 19.40        | 84.20                 | 64.40           | 86.90         | 8.00        |
| <b>October, 2015</b>      | 30.40            | 17.00        | 86.25                 | 59.38           | 23.40         | 5.00        |
| <b>November, 2015</b>     | 28.20            | 15.40        | 91.33                 | 83.43           | 358.60        | 18.00       |
| <b>December. 2015</b>     | 29.00            | 12.50        | 88.45                 | 65.90           | 7.60          | -           |
| <b>Mean</b>               | <b>30.68</b>     | <b>17.56</b> | <b>85.96</b>          | <b>65.25</b>    | <b>100.83</b> | <b>6.85</b> |
| <b><i>Rabi crop</i></b>   |                  |              |                       |                 |               |             |
| <b>November, 2015</b>     | 28.20            | 15.40        | 91.33                 | 83.43           | 358.60        | 18.00       |
| <b>December. 2015</b>     | 29.00            | 12.50        | 88.45                 | 65.90           | 7.60          | -           |
| <b>January, 2016</b>      | 29.40            | 12.60        | 88.45                 | 51.30           | 13.20         | 1.00        |
| <b>February, 2016</b>     | 33.60            | 13.40        | 76.79                 | 41.65           | 0.30          | ---         |
| <b>March, 2016</b>        | 35.80            | 14.90        | 79.70                 | 36.80           | 72.6          | 1.00        |
| <b>Mean</b>               | <b>31.20</b>     | <b>13.76</b> | <b>84.94</b>          | <b>55.81</b>    | <b>90.46</b>  | <b>4.00</b> |

## APPENDIX - II

### Lists of abbreviations and symbols

|                |                              |
|----------------|------------------------------|
| <b>%</b>       | Per cent                     |
| <b>°C</b>      | Degree centigrade            |
| <b>CD</b>      | Critical difference          |
| <b>Viz.</b>    | As follows                   |
| <b>DAT</b>     | Days After Transplanting     |
| <b>PLW</b>     | Physiological loss in weight |
| <b>TSL</b>     | Total storage loss           |
| <b>FW</b>      | Fresh weight                 |
| <b>DAS</b>     | Days after storage           |
| <b>TSS</b>     | Total soluble solids         |
| <b>et al.</b>  | Et all (and others)          |
| <b>g</b>       | Gram                         |
| <b>o Brix</b>  | Degree brix                  |
| <b>i.e.</b>    | That is                      |
| <b>mg</b>      | milligram                    |
| <b>mm</b>      | Millimeter                   |
| <b>S. Em ±</b> | Standard error of mean       |
| <b>µMol.</b>   | Micro moles                  |
| <b>CV</b>      | Coefficient of variance      |
| <b>CD</b>      | Critical difference          |