STUDIES ON COMPARATIVE PERFORMANCE OF DIFFERENT ONION *(Allium cepa L.)* VARIETIES IN RESPECT OF GROWTH, YIELD, QUALITY AND STORAGE LOSSES

BY

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DEDICATED TO MY FATHER

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CERTIFICATE-I

The thesis entitled " STUDIES ON COMPARATIVE PERFORMANCE OF DIFFERENT ONION (Allium cepa L.) VARIETIES IN RESPECT OF GROWTH, YIELD, QUALITY AND STORAGE LOSSES" submitted by Ramchandra Govindrao Nilangekar, to the Marathwada Agricultural University, Parbhani, for the award of the degree of Doctor of Philosophy in Horticulture, is a record of original and bonafide research work carried out by him under my guidance and supervision. No part of the thesis has been submitted anywhere for publication or for any other degree of any University. The assistance received during the course of investigation and sources of literature have been duly acknowledged.

Parbhani
Date :31/10/1995

N.N.Shinde
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CERTIFICATE II

This is to certify that the thesis entitled "STUDIES ON COMPARATIVE PERFORMANCE OF DIFFERENT ONION (Allium cepa L.) VARIETIES IN RESPECT OF GROWTH, YIELD, QUALITY AND STORAGE LOSSES" submitted by Ramchandra Govindrao Nilangekar to the Marathwada Agricultural University, is in partial fulfillment of the requirements of the degree of Doctor of Philosophy in the subject of Horticulture has been approved by the Student Advisory Committee after oral examination in collaboration with the external examiner.

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(R . G . Nilangekar)

CONTENTS

LIST OF TABLES

CANDIDATES DECLARATION

I hereby delcare that the dessertation or part thereof has not been previously submitted by me for degree of any University

Parbhani :

Date : 31-10-95

(R.G. Nilangekar)

CHAPTER-1

INTRODUCTION

Chapter I

INTRODUCTION

The onion (Allium cepa L.) is an important crop grown on almost all continents. Of the fifteen vegetable crops listed by FAO, the onion falls second only to tomatoes in terms of tonnes per annum world production (FAO, 1983). Onion has been used as food since time immemorial. It is the most widely used vegetables due to its' flavour. It is used for flavouring or seasoning the food both at immature and mature bulb stages, besides being used as salad and pickle. The onion powder and flakes are in great demand in the world market. The crop is also valued for its medicinal values being antiseptic, bactericidal and has blood sugar, lipid and cholesterol lowering effect

The global picture of onion shows that though India excells in total area the per hectare productivity is as low as 10.55 t/ha compared to top ranking Japan which has 41.42 t/ha productivity. India is a traditional exporter of onion and 70 % of the total foreign exchange amongst vegetable is earned by exporting onions to Malasia, Dubai, USSR, Kuwait, Singapore, United Arab and Bangladesh.

In India onion is cultivated on an area of 0.27 million ha with 2.87 M.MT bulb production. Maharashtra is leading state in onion cultivation with

54 thousand ha area and 0.64 M.MT production, which accounts to 19.85 % area and 22.4 % production of the country. Marathwada region comprising of seven districts has total area of 4 thousand ha and produces 3.81 lak MT which accounts to 7.41 % and 5.92 % respectively to that of the Maharashtra State.

The average yield/ha of onion in India is 10.55 MT and that of Maharashtra 11.90 t/ha. Gujarat has highest per hectare yield of 30.94 t/ha followed by Punjab (15.81 t/ha) and Haryana (13.61 t/ha) (Anon. 1986).

Reasons for low productivity are attributed to fluctuations in climatic conditions, incidence of pests and diseases, lack of knowledge about improved technology and improved variety. Among these factors variety of onion plays an important role in increasing production.

It is estimated that 50% production of onion valued to more than 50 crorers is lost due to storage losses. In Maharashtra onion is grown in all the three seasons i.e. Kharif (Pol) Rabi (Rangda) and Summer (Unhali). Eventhough, in Maharashtra onion is grown in kharif, rabi and summer season there is interesting contrast in bulb development and maturity. In kharif season bulbs produced are of poor storage quality

probably because of lack of senescence as vegetative growth continues. While bulbs produced in summer season has good keeping quality probably because of cessation of vegetative growth which produces inhibitors which are involved in dormancy process. Hence, main season of planting onion is January in Nasik, Pune, Aurangabad, Jalna and Beed districts of Maharashtra.

This crop is conveniently taken after other kharif crops if irrigation is available. Research work on summer onion in respect of varietal selection and other package of practices appears to be scanty.

Different storage studies revealed that poor keeping quality of onion is due to different physical and chemical characteristics of the bulb (Foskett and Peterson, 1950; Patil and Kale, 1985.) besides storage conditions the variety of onion plays major role in reducing losses in storage during June to November. In a set of storage studies involving 60 onion cultivars the losses ranged from 45 to 96 per cent depending upon the cultivar (Magdum 1981 and Patil and Kale 1985).

Wide range of variation in morphological and storage characteristics of onion bulb has been observed by different workers (Patil and Kale, 1985; Singh and Singh 1974, and Bhagchandani et al 1977). Suitability of particular variety has been emphasised by most of the researchers for a given set of climate, area and season.

Nauriyal et al. (1969), in study of twelve varieties found that Punjab selection variety was best under Ludhiana condition. Hissar-2 onion variety excelled among seven varieties studied at Faizabad (U.P.), Jaiswal et al (1984). For kharif season, Baswant 780 was found to be superior over present popular variety N-53. (Pawar et al. 1987)

The cultivar to be grown should have attractive shape, colour, high yield and should be free from twins, immature bolting and have suitable duration for accommodating it in the cropping system. As the variety is available when the prices are high in the market it should also possess good storability with a long rest period without sprouting and rots.

Onion bulbs of summer season are available in the market at lower price. These bulbs are stored in rainy season in summer and to be made available in the market for sale when prices are high. Therefore, these bulbs should possess good storability with long rest period without sprouting and no rotting in the storage.

In view of the facts mentioned above and considering the need of our present investigation was initiated to select variety for summer season, which can give good yield and has good storability. The study was also aimed of observing the different characteristics

like maturity, bulb size, bulb weight, per cent twins, yield and other characteristics in the storage and their interrelationship. Such an interrelation-ship between different characters is also of considerable significance as they help in making simultaneous selection for different economic characters. Such an information may also be useful for making suitable selection for different characteristics. As Aurangabad is situated at a little higher elevation and has mild climate/therefore long day varieites were also/to be studied, and hence the study was initiated with following major objectives.

1. To identify suitable variety for the region having characteristics of high yield, high T.S.S. and high storability.
2. To study different storage losses and its association with bulb characteristics.
3. To study correlations amongst different yield contributing characteristics.
4. To study association of quality parameters to different storage lossess.
5. To study performance of long day types at Aurangabad.

CHAPTER-2

REVIEW OF LITERATURE

Chapter 2

REVIEW OF LITERATURE

Onion (Allium cepa L.) is one of the most important commercial vegetable crop of India in general and of Maharashtra State in particular.

Lack of proper information about growing suitable variety in different seasons is one of the many constraints in low productivity of onion in the country. Growers are not selective in choosing varieties as per requirements of growing season. To achieve desired production of quality onion such a study may prove useful. Varieties has to be identified for kharif and rabi season in addition to summer season. Production of bulbs in summer season is most important as bulbs of this season can be stored and made available in off season when prices are high. Research on identification of variety for this season is scanty in this region.

Attempts have been made to review the published literature on morphological, bio-chemical and storage characteristics of onion bulb, along with correlation among different characters, under suitable headings.

The biology and agronomy of onion has been reviewed by Jones and Mann (1963). Brewster (1977)

presented a detailed review of the physiology of onion. There exists lot of variability in onion. The variability within a population has significant role in breeding programme for making simul-taneous selections.

2.1 Morphological characteristics

2.1.1 Plant characteristics

Increased leaf area and chlorophyll content increases the top growth of plant (Sivtsev, 1973)› Moursi et al (1975) found that when "Giza" variety of onion was delayed for sowing time, reduction in plant height and number of tubular leaves were observed. When Red creole variety of onion was transplanted in November maximum plant height was obtained as compared to December transplanting (Huerres, 1979). Positive correlation between bulb yield to leaves per plant and plant height was reported by Pandian and Muthukrishnan (1982) and Sidhu et al. 1986. Nagre (1984) found that plant height and number of leaves per plant was maximum in December planting and decreased with delay in planting. Similar trend was also observed by Bhamburkar (1984).

Thamburaj et al (1976) reported non-significant results for correlation studies between weight of foliage and number of leaves per plant.

Maturity : Jaiswal et al. (1984) found that variety "N-53" had lowest duration when compared to "UD-102 White."

2.1.2 **Bulb characteristics :**

2.1.2.1 **Bulb weight :**

Correlation of fresh bulb weight has been reported as early as in fortees. Karmarkar and Joshi (1941) reported that the per cent loss in weight of small bulbs (60 g) was higher than that of large bulbs (125 g). Mann and Holyes (1945) found significant correlation between fresh weight of the bulb and the per cent dry matter content. Zeceva and Minkov (1965) from a study of different varieties concluded that Var. 957 A and 957 S having a bulb weight of 100 to 110 g and with 12 % dry matter content were found to have satisfactory storage capacity. Mc Collum (1968) reported low heritability value for bulb weight of a spanish "Jumbo onion" variety. Maximum phenotypic co-effecient of variability for yield (33.3 %) followed by the bulb weight (20.2%) has been reported by Randhawa et al (1974). Variation in bulb weight has been reported by many workers. Kader et al. (1979) reported that "Bellary Red" (76 g), "Udaipur 101" (70g) and "N-53" (82 g) with bulb weight were at par in yield. Jaiswal et al. (1984) did not observe significant differences in bulb weight. Lot of variability in bulb weight was reported by Patil (1984).

Simple correlation and metric traits in onion have shown that weight of bulb is an important

contributing factor in the yield of onion bulb (Thamburaj et al 1976). Ahmed and Ahmed (1976) reported that mean weight per exportable bulb and number of exportable bulbs per faddan (analysis of variance) among the entries did not vary.

Singh and Joshi (1978) observed that bulb weight was positively correlated with equatorial diameter. Buso and Costa (1979) recorded high heritability for bulb weight. They further observed that the different types of correlations between bulb weight, bulb diameter and soluble solid content in onion were negative. Sandhu et al (1976) and Singh and Joshi (1978) also recorded negative correlation between bulb weight and total soluble solids; these workers, however, concluded that bulb weight was not correlated with the loss in total weight, marketable weight and per cent rotten bulbs. Buso and Costa (1979) observed that the bulb weight was negatively correlated with the bulb diameter. Muthukrishnan et al (1978) reported that the variety "N-53" which has highest single bulb weight is also high yielding. Significantly positive correlation was observed by Netrapal (1980) in weight of bulb and yield. Magdum (1981), observed that the red onion cultivars had generally higher bulb weight compared to white one. Nagre (1984) found that average weight of bulb was maximum in produce obtained from December planting, and it decreased in later dates. Jaiswal et al. (1984)

reported that the biggest sized bulbs were obtained in the variety "VL-67" followed by Hissar-2 and "Pusa Red". However, no significant differences were observed among different varieties in this respect. Bartos (1986) found that there is a negative correlation between mean bulb weight and marketable value after storage (r=0.65)

2.1.2.2 Bulb diameter and bulb size :

The size of bulb is an important parameter contributing to yield of bulb. Literature in this regard is reviewed as under.

Binkley (1932) found that there was sgnificant positive correlation between length of onion bulb and weight, and a more significant positive correlation between the width and weight of onion bulb. Woodman and Brnall (1937) reported that there was not any difference in dry matter content of large and small bulbs. Karmarkar and Joshi (1941) observed that large sized bulbs showed marked tendency of sprouting. Similar trend was also observed by Patil (1960) and Ward (1979). However, contradictory to this Bielinka et al. (1981) found that smallest bulbs were first to sprout and produce roots, while largest bulbs were last to sprout. Ward (1979) reported that both rooted and sprouted bulbs increased with increase in bulb size. Patil (1984) revealed that selection for large bulbs is likely to result in poor storage quality. Most of the

workers reported that medium to big sized bulbs (4.5-7.0 cm) store well (Karmarkar and Joshi 1941; Patil 1960; Kapkowa and Umiecka, 1970 and Bielinka et al. 1981).

Correlation studies conducted by Thamburaj et al (1976) revealed that length and girth of the bulb is important selection index for higher bulb yield. Bulb diameter has been reported to be negatively correlated with total soluble solids, (Padda et al. 1973 and Singh and Joshi, 1978). Netrapal (1980) reported that in correlation studies the bulb yield was highly and positively correlated with horizontal and vertical diameter of the bulb.

Singh and Joshi (1978) concluded that the polar diameter was positively correlated with rotting and sprouting lossess of the bulbs. Muthukrishnan et al (1978) indicated importance of length and girth of bulb as selection index for higher yield.

Patil (1984) showed that bulb weight was positively correlated with bulb diameter (both polar and equatorial), neck thickness, diameter of root plate, number of leaves, dry matter content and sprouting percentage while it was negatively correlated with percentage of bolting, T.S.S. content and non-reducing sugar at genotypic and phenotypic levels. Shaha and Kale (1985), revealed that bulb weight was positively

correlated with diameter (equatorial and polar) and neck thickness negatively correlated with T.S.S. (Thamburaj et al. 1976).

Heritability values for bulb diameter (both polar and equatorial) have been observed to be low by Mc Collum (1977) and Magdum (1981), while Padda et al. (1973) reported that the heritability estimates were higher for bulb size with higher genetic advance. They further observed that there was a positive correlation between the bulb weight and equatorial diameter.

The big size of the bulb is also responsible for good seed yield as stated by Binkley (1932) and Arakeri and Patil (1935).

2.1.3 Neck thickness :

Neck thickness is an important character of onion bulb neck thickness indicates the quality of bulb produced.

Wayse (1967) hypothesized that thick neck of onion bulb may be due to excessive nitrogen. Kapkowa and Umiecka (1970) observed that onion with thin, well dried neck stored well than those with badly dried thick necks. Singh and Swami (1976) reported that onion with small thin neck is preferred for dehydration. The neck thickness was positively correlated with storage lossess due to rotting, sprouting and shrinkage (PLW) as

reported by Magdum (1981). Patil (1984) revealed that the thin neck trait is fairly reliable for selecting varieties with potential for extended storage life.

2.1.4 Premature bolting :

Formation of premature seed stalk in a bulb crop is important characteristic of given variety. Bolting in onion crop adversely impair the quality of bulb. This is reviewed as under.

Jones and Mann (1963) reported that yield and quality of bulb is lowered by bolting in onion. They further explained that warm temperatures in early growing season may reduce bolting by decreasing inflorescence initiation and favouring rapid bulbing.

Thompson and Smith (1938) found that cultivars grown in green house at 50^{o} to 60^{o} F temperature exhibited 100 % bolting. At 60^{o} to 70^{o} F it was 10 % and at 70^{o} to 80^{o} F no bolting was observed.

Response of cultivars vary for bolting. Davis and Jones (1944) reported that White Sweet Spanish variety produced 71 per cent bolters whereas Italian Red produced no bolters. It is evident that rapid bulb formation may supress the emergence of inflorescence which have been initiated but have not yet elongated. (Heath and Hods-worth, 1948). Yawalkar (1969) observed that 80 to 90 per cent bolting in onion plants

transplanted in later part of kharif or early Rabi (Aug-Sept), however, plantings undertaken December onwards did not show more than 10 to 14 per cent bolters. Singh and Pandey (1972) found that Poona Red, Pusa Red and Punjab Selection were having lower percentage of bolting. Singh and Singh (1974), reported that premature bolting was lowest in Poona Red, Pusa Red and Hissar-II.

Warid and EL- Shafie (1976) recorded significant difference in bolters between the direct seeding (18-19 %) and transplanting method (7.64); they further stated that the variety Tropicana which produced high percentage of bolters and its yeild was low. Jaiswal et al. (1984) observed lowest bolting in variety "VL-67" (0.15 %), "PusaRed" (0.03 %) and "Hissar-2" (0.90 %). Maximum bolting was recorded in variety "Udaipur-103" (7.9%) followed by "Udaipur 101" (2.95 %) Imam and Butt (1970) concluded that the variety Yellow Granex hybrid which gave highest yield and was lowest in bolters. Muthukrishnan et al. (1978) found that the varieties viz. Bellary Red, N-53 and Udaipur 101 which gave highest yield under Tamilnadu conditions and did not show any bolting.

Ahmed and Ahmed (1976) reported that mean percentage of bolters varied significantly among entries. Progenies of both the internal doubles and 'Giza Gmahassam' produced less bolters (1.8 and 6.2 %

respectively) than did the progenies of single centered bulb (3.45 %) and those with two contact centric growing centres (6.15 %). Brewster and Salter (1980) found that cultivars "Express Yellow" and "Shenshyu" differed markedly in their susceptibility to bolting. Bhamburkar (1984) observed that the variety N-53 followed by N-257-9-1 and local white showed maximum percentage of bolting. Nagre (1984) found that December planting had maximum bolting followed by January planting. February planting was completely free from bolting. Gaushal (1986) revealed that significantly lowest precentage of bolting was observed in January planting. Patil (1984) showed that percentage of bolting was directly related to storage loss.

2.1.5 Twins or doubles:

Production of twins and doubles in crop is a common phenomenon. It affects the quality of bulb. This character is influenced by various factors viz, variety grown, time of planting and other cultural management practices.

Doubles in onion refers to bulbs which could be so judged without horizontal sectioning. Stino et al. (1960) found higher yield and higher percentage of doubles were recorded in direct seeding method than transplanting. They further observed that early planting in September recorded more total yield and

higher percentage of doubles. Warid and El-Shafie (1976) found that "Mahassam" and "Behairy" varieties showed highest percentage of doubles and open pollinated varieties showed highest per cent of doubles than that resulting from hybrids.

Ahmed and Ahmed (1976) opined that frequent irrigation and white rot disease are contributing in doubling in onion resulting poor storage. They further observed that amongst the varieties studied no doubles were produced from the progeny of the single centered bulbs. Internal doubles which is undesirable for dehydration has also the same inheritance. Patil (1984) concluded that percentage of twin bulbs was directly related to storage lossess.

2.2 Biochemical composition of bulb:

Biochemical composition of onion bulb plays an important role in selecting a variety for dehydration, fresh consumption and long term storage. Good storage capacity in onion appeared to be associated with high content of dry matter and non-reducing sugars and low proportion of reducing sugars (Bat_uris, 1958; Towl and Pospisilova, 1969; Tronickova, 1969; Musa et al. 1974, Chang, 1979; Bajaj et al. 1980 and Magdum, 1981).

Purewal (1963) recorded that red skin colour of onion is due to presence of 'Quercetin' such cultivars

are more pungent due to the presence of catechol and protocatechnic acid in skin and hence keeps better in storage in comparison to white cultivars which are mild and good flavoured.

Dry matter content of onion bulbs varied greatly between cultivars, it ranged from 6 to 18 per cent (Jones and Mann, 1963). Bajaj et al. (1981) reported dry matter content amongst varieties in the range of 10 to 15 per cent. Padda et al. (1973) observed wide range of variability in T.S.S. (7.4 to 17.5 per cent). Bajaj et al. (1981) also observed wide range of variability in total sugar content of the bulb (41.5 to 74.00 %) and in total phenols (1.75 to 2.95 per cent) on dry weight basis.

Netra Pal (1980) found significantly positive correlation between total solids, dry matter and total soluble solids.

Studies conducted by Foskett and Peterson (1950) indicated that there was a marked tendency for varieties and hybrids having high dry matter percentage not to sprout during storage. Abdel-Hafez et al. (1976) proposed that varieties of onions like Behairy and Gizza Mahassam of which T.S.S. was as high as 13.86 and 15.90 should be selected for good storage and yield. Varieties having higher content of dry matter and

T.S.S., were less susceptible to sprouting (Foskett and Peterson, 1950; Sandhu et al. 1975 and Tronickova. 1969).

Several research workers observed that there was a close relationship between dry matter content and T.S.S. with good keeping quality, Refractive index has been used for estimating the approximate dry matter (Mann and Haylo, 1945; Foskett and Peterson, 1950; Baturis, 1958; Tronickova 1969; Nieuwhof et al. 1973; Sethi et al 1973 and Magdum, 1981).

Varietal response for T.S.S and dry matter content has been studied largely. Kapur et al. (1976) showed that Pusa Red had 14 to 14.5 per cent T.S.S while Pusa Ratnar had 13.5 per cent T.S.S. Yarchistina (1978), found that the highest content of dry matter was present in the pungent varieties and intervarietal differences were noticed in respect of both sugars and ascorbic acid content.

Muthukhrishnan et al. (1978) did not find much differeneces in T.S.S contents in different varieties of onin in Tamil Nadu. Bhagchandani et al. (1980) reported that Pusa White Flat a high yielding white veriety of onion has 11.85 per cent T.S.S. The dry matter of this variety was also high; this veriety surpassed Red varieties in storage. Patil (1983) reported that white

cultivars had fairly high content of T.S.S. and dry matter and sprouting was also significantly lower than red varieties. Bhamburkar (1984) concluded that amongst different varieties N-257-9-1 had maximum T.S.S. than N-2-4-1. Singh and Singh (1974) reported maximum T.S.S. (14 %) in variety Pusa Ratnar, whereas 13.5 % T.S.S. in Udaipur-103 was reported by Jaiswal et al. (1984).

Correlation studies have also been presented by many workers. Magdum (1981), found that dry matter and T.S.S were negatively correlated with reducing sugar, total loss in weight, shrinkage (PLW), sprouting and rotting. Patil (1983) confirmed these findings.

High heritability has been reported for dry matter (Mc Collum, 1968; Padda et al. 1973 and Magdum 1981) and also for T.S.S. (Andras-falvy, 1978; Buso and Costa, 1979; and Magdum, 1981 and Patil, 1983). Ananian (1986) in the study of varieties from 45 countries found that varieties with high disaccharide/mono-saccharide ratio recorded best storage quality. Shekib (1986), studied changes in moisture content and in total solids, T.S.S. and pyruvic acid during storage and observed that there was gradual decrease in moisture content associated with an increase in the other constituents.

Padda et al. (1973) observed that genetic coefficient of variability and genetic coefficient of

variation and genetic advance for T.S.S. was moderate and values of genotypic and phenotypic variance were very low. He further reported that heritability genetic advance and genetic coefficient of variation were hgiher for dry matter.

Bennett (1941) noticed that onion had largest percentage of reducing sugars in cold storage. He further concluded that the increase in temperature indicated that the condition for contact between enzymes and subtrate were favoured. Yamaguchi et al. (1957) showed that low temperature storage increased the ratio of reducing sugars to non-reducing sugars and concluded that in onion low temperature induced some depolymerisation of the reverse oligo saccharides.

Rutherford and Whittle (1982) observed that the soluble non-reducing sugars present in onion bulbs were oligosaccharides probably a series of fructosans. The only reducing sugars were found, fructose and glucose. They further observed that the main change in cold storage was hydrolysis of oligosaccharides to reducing sugars, increase in fructose during storage was also observed by them.

Aoyagi et al. (1977) reported that the total sugar content of the onion bulb increased from 5.6 to 7.4 per cent and refractive index of juice from 1.3348 to 1.3359 after storage at $0^{o}C$ for thirty days of storage.

Darbyshire (1978) observed higher sucrose level at high storage temperature and concluded that changing sugar levels in onion bulbs during storage may be implicated together with sucrose and fructon hybrolysis at the lowest temperatures.

2.3 Extent of storage losses :

High keeping quality of bulbs is an important quality parameter of onion. Extent of losses depends on keeping quality of bulb. It is influenced by variety, grown season, irrigation, fertilzer application and storage structure.

Storage lossess in onion have been studied as early as in 1925-26. Gaylord (1927) was the first to report the storage losses from 35 storage houses. He found that 11 to 35 per cent actual loss in weight occured. 14 to 17 per cent losses in onion bulb weight were recorded by Patil (1960).

Several workers have reported that the magnitude of storage losses were about 50 per cent which was mainly due to shrinkage i.e. PLW (about 18 %) and losses due to sprouting increased towards the end of storage when the temperatures dropped (Paterson and Wittwer, 1953; Rao et al.(1967) and Musa et al. (1973). Sandhu et al. (1975) observed that sprouting was more in red varieties than white one, while the rotting losses were the same in white and red varieties. More rotting

has been reported in small bulbs, by Patil (1960). He further found that large sized bulbs showed more tendency to sprouting.

N-2-4-1 a red onion cultivar from Maharashtra State has been reported to be superior in keeping quality (Patil, 1960; Singh and Joshi, 1975; Magdum, 1981). Patil (1983) in screening study observed that cultivars Saroli-1, Adsuli-1, Pusa Red, Udaipur-101, 102 and 103 recorded significantly lower storage losses than check var. N-2-4-1. He further reported that the per cent total loss was significantly and positively correlated both at phenotypic and genotypic levels with neck thickness and bulb diameter (both equatorial and polar), physiological loss in weight (PLW), sprouting, rotting and protein content, while it was negatively correlated with Potash, ash, dry matter, T.S.S. content and reducing sugar before storage. Moderate to high heritability values with high genetic advance were observed for the charac-ters, per cent total loss, bulb weight and per cent sprouting. He also concluded that significant differences were observed among the onion cultivars in respect of morphological and storage characters and storage characters and chemical constituents of bulb indicating high magnitude of variability in 37 genotypes studied.

Saimbhi and Randhawa (1982) reported that the total losses were highest in big bulbs, intermediate in medium bulbs and least in smaller bulbs. Contrary to above observations, several research workers have reported that the losses were least in large bulbs than smaller bulbs (Karmarkar and Joshi; 1941, Kapur et al. and Kapkowa and Umiecka,1970), Kunkel (1947) and Patil (1960) could not find any significant difference between bulb size and sprouting, rotting and total losses respectively.

The research work of several workers revealed that white varieties have poor keeping quality than red varieties (Patil, 1960; Tronickova, 1969 and Sandhu et al. 1975). Sprouting losses have been observed to be more in varieties with low percentage of dry matter and T.S.S. content (Foskett and Peterson, 1950; Tronickova, 1969; and Sandhu et al. 1975).

2.4 Effect of temperature and humidity on storage of onion.

According to Rao and Purewal (1957) Onion does not thrive well in places where the average rainfall exceeds 750 mm. It requires 70 % RH for good growth and temperature before bulbing 12.8^{o}C to 23^{o}C and for bulb development 15.5^{o}C to 21^{o}C. Effect of temperature and humidity on storage lossess have been reported by several workers. Onions stored at low temperatures (-2^{o}C to 4^{o}C and RH 70 %) resulted in the

least storage losses' (Bottcher, 1972; Udry, 1972; Berg et al. 1973; Admicki and Kepta, 1974; Strow, 1975; Ward, 1976; Iordachescu and Mihaileacu ,1979, and Huerres, 1980). Balkova (1978) found that most suitable range of temperature for onion storage were $0^{o}C$ to 4 ^{o}C. Storage at lower temperature in 5 per cent CO_2 and 3 per cent usually gave best results (Admikki and Kepta, 1974). Berg et al. (1973) and Strow (1975) reported that at 98-100 % RH neck rot was observed.

Khurana (1984) found lowest weight losses for two years in cold storage for cv. "Hissar-II"

2.5 Varieties and yield:

Yawalkar (1969) found that crop planted in South-West and North-East monsoon yields 150-200 Q/ha bulbs. The January planted crop yields about 75-100 Q/ha. He further observed that average yield of large sized varieties has been reported to be 150 Q/ha and that of local small sized varieties 75 Q/ha.

Bhagchandani et al. (1972) observed that under Delhi condition onion can be grown in rainy season but the yield was less than that of cool season.

Singh and Singh (1974) studied performance of onion varieties and showed that 'Hissar-2' exhibited higher yield and dry matter than 'Pusa Red', 'Pubjab Selection', 'Poona Red', 'Patna Red', 'Yellow Globe', 'Red Giant'

and 'Bombay Red'. Jaiswal et al. (1984) also found that Hissar-2 out yielded over other six varieties under U.P. condition.

Bhagchandani et al. (1980) reported that amongst five cultivars, Pusa White Flat and Pusa White Round recorded higher yields. Nagre (1984) obtained maximum yield from December planting. Bhamburkar (1984) concluded that Pusa White Flat excelled over other varieties, N-257-9-1 being poor yielder. Chadha and Sidhu (1986) studied performance of 13 onion varieties for green or bunching onion and found that Verma's Giant selection was highest yielder (483.43 Q/ha) and selection 2-4-1 lowest yielder (280.06 Q/ha).

Cultivators for diffferent regions have also been indentified in India. Bhagchandani et al. (1977) reported that long day cultivars like Brown Spanish, Cream Gold, White Spanish and Early Lockyer Brown were suitable for hill area than short day types viz. Pusa Red usually grown in plains. Contradictory to above Gupta and Hiralal (1985) recommended a light red colour variety 'Nasik Red' for Garhwal hills Baswant-780 a new variety has been recommended for kharif season (Pawar et al. 1987). This variety is superior in yield and quality over existing variety N-53. Netra Pal et al. (1980) found that Early Grano, Pusa White Flat and Pusa White Round are best as green onion.

CHAPTER-3

MATERIALS AND METHODS

Chapter 3

MATERIALS AND METHODS

Experimental details, materials used and methods adopted during the course of present investigations are given in this chapter under the appropriate headings.

3.1 Experimental site:

The present investigations were carried out at Fruit Research Station, Himayat Bagh, Aurangabad (M.S.) in plot No. 9 of B block during years 1986 and 1987. The soil of the experimental plot is loamy in texture, slightly alkaline in reaction and calcarious in nature. According to new classification the soil is categorised as `Inceptisol'. The soil analysis data are given in Appendix I.

Fruit Research Station, Himayat Bagh, Aurangabad is situated within municipal corporation limits of Aurangabad city which is a Divisional Head Quarter of Marathwada Division. The Research Station is situated on northern side of Aurangabad-Ajantha road. It is situated at 19° North latitude and 76° East longitude and is located at an altitude of 581 meters above mean sea level.

3.2 Climate and Weather :

The climatic conditions are rather pleasent and cool at Aurangabad. The yearly mean minimum and maximum temperatures range between $7^{o}C$ and $44^{o}C$ in this area. Annual mean precipitation of 700 mm is mostly received from south-west monsoons from June to September. On an average total rainy days are seventy. Average relative humidity ranges between 15.8 % minimum and 89.7 % maximum recorded at 8.30 and 17.30 hrs respectively.

3.3 Previous cropping:

The crop rotations followed in the experimental field for last three years is given in Table 1.

Table 1: Cropping history of the experimental plot :

Year	Season	Crop
1983	Perennial	Roses
1984	Kharif	Brinjal
1985	Rabi	Tomato
1986	Kharif	Sann hemp
1987	summer Summer	onion onion

Studies on comparative performances of different onion (Allium cepa L.) varieties in respect of growth, yield, quality and storage losses.

3.4 Experimental details:

3.4.1 Design and treatment details:

The present experiment was laid out in Randomised Block Design with three replications and sixteen treatments of different onion varieties. Seeds of following sixteen varieties from different research centres were collected.

Table 2. Treatment details :

Sr. No.	Treatment symbol	Name of the onion variety	Source
I Red varieties			
1.	V1	N-53	AADF, NASIK
2.	V2	N-2-4-1	MPKV, RAHURI
3.	V3	Pusa Red	AADF, NASIK
4.	V4	Nasik Red	AADF, NASIK
5.	V5	Pusa Ratnar	NBPGR, New Delhi
6.	V6	Ratnar Selection	NBPGR, New Delhi
7.	V7	Baswant 780	MPKV, RAHURI
8.	V8	Chikalthana Local	Chikalthana, Dist. Aurangabad.
9.	V9	V-L-1	VPKAS, Almora
II White varieties			
10	V10	U.D. 102 White	RCA, UDAIPUR.
11.	V11	N-257-9-1	MPKV,RAHURI
12.	V12	Pusa White Flat	IARI, Regional Station, KARNAL
13.	V13	PKV-White Local	PKV, AKOLA

III Long day types

14.	V14	Brown Spanish	IARI, Regional Stn. KATRAIN (H.P.)
15.	V15	Early Lockyer Brown	--- " ----
16.	V16	Cream Gold	--- " ---

The salient characteristics of different varieties are presented in Appendix-I.

3.4.2 Layout

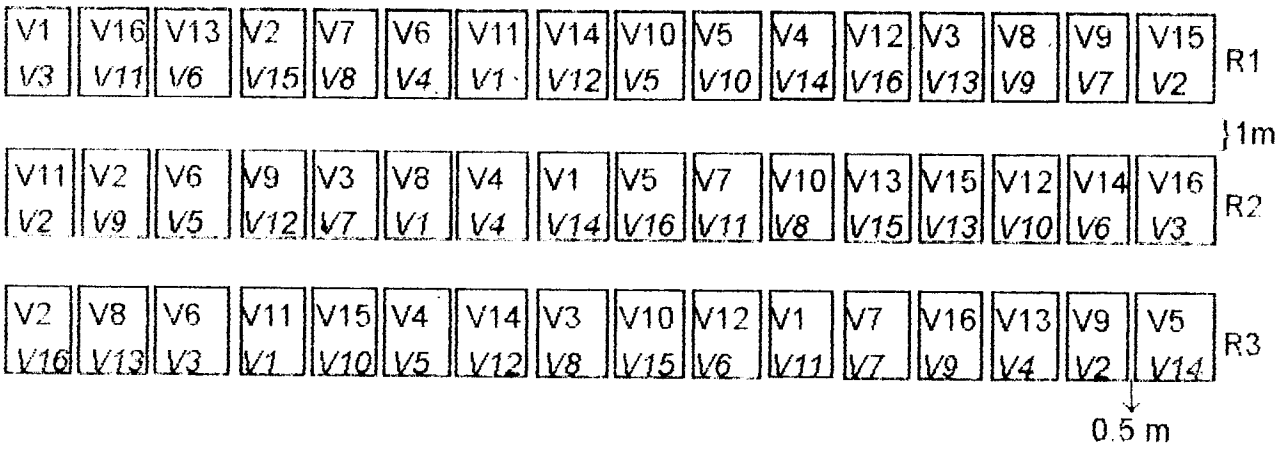
The experimental field was laid out after preparatory cultivation and before transplanting in Randomized Block Design consisting of 48 plots i.e. treatments replicated 3 times. The gross and net plot size was 2.85 x 2.40 m^2 and 2.25 x 2.00 m^2 respectively. Optimum plot size was selected as suggested by Gupta and Raghav Rao (1971). The distance between two plots was kept 0.5 m and distance between two replications was kept 1.0 m (Fig-1).

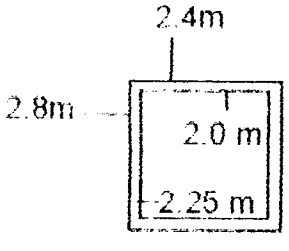
3.5 Cultivation :

3.5.1 Preparatory tillage:

The land was ploughed in October month for both the years. Two cross wise harrowings were given to obtain loose and friable soil for preparation of beds. Stubbles of previous crop were picked up to keep the plot clean. The source of variety is given in Table 2.

FIG: 1 LAY OUT PLAN OF ONION EXPERIMENT (1986 & 1987)





Treatment symbol

V1	N-53
V2	N-2-4-1.
V3	Pusa Red.
V4	Nasik Red.
V5	Pusa Ratnar.
V6	Ratnar Selection.
V7	Raswant-780.
V8	Chikhalthana Local.
V9	VL-1.
V10	U. D. 102 White.
V11	N-257-9-1.
V12	Pusa White Flat.
V13	PKV-White Local.
V14	Brown Spanish.
V15	Early Lockyer Brown.
V16	Cream Gold.

3.5.2 Application of fertilizers :

Recommended fertilizer dose of 20 t FYM, 150 kg Nitrogen, 50 kg P_2O_5 and 50 Kg K_2O/ha was applied. Basal dose of 75 kg i.e. half nitrogen and full dose of P and K in the form of mixed fertilizer was given before transplanting of onion seedlings. Remaining half dose of nitrogen was applied one month after transplanting as top dressing through urea.

3.5.3 Seedling raising :

Before sowing seed of onion varieties were treated with Captafal (2 g/kg of seed). Raised beds of 6 m x 1 m x 0.5 m size were prepared and well rotted, sieved FYM + 0.15 kg super phosphate was spread on the top. Seed sowing was done in rows placed 10 cm apart. Seed sowing was done on 20th November in 1986 and 25th November 1987. Regular hand watering and weeding was done.

3.5.4 Seedling transplanting :

Flat beds of 3 x 2.5 meters were prepared and basal fertilizer dose was applied. Plots were irrigated before transplanting. Transplanting of seedlings was done after clipping the seedling tops. Spacing of 15 cm between rows and 10 cm between two plants in a row was given.

3.5.5 Intercultivation : T 3240

Two hand weedings at 30 days interval were given and plots were kept clean. One spray of Diathane M-45 and Endosulphon was given after two months of transplanting.

3.5.6 Scheduling irrigation :

Irrigation at an interval of 10 days was scheduled. Total twelve irrigations were given. Irrigation was withheld 15 days before harvesting.

3.5.7. Harvesting and curing :

The bulbs were harvested in the month of May, when the leaves turned yellow and more than 50 % tops were fallen. The bulbs were cured for 12 days by keeping the bulbs in heaps with tops still intact. After curing tops were cut at 5 cm neck length and cured for 4-5 days. Then sample of 3 kg of each variety was kept in well ventilated laboratory at room temperature for studying storage losses at monthly interval. Gross and net plot yields were seperately recorded.

3.6 Observations :

Observations for the different morpholgical, chemical and storage characteristics were recorded as explained below.

3.6.1 Plant height (cm) :

Observation plants were marked to record plant height and number of leaves. The height of plant was recorded from ground level to the tip of tallest leaf. Plant height was recorded two weeks before harvesting.

3.6.1.1 Number of leaves per plant :

This observation was also recorded two weeks before harvesting. Dried leaves were also taken into account.

3.6.1.2 Per cent bolting:

The number of bolted plants and number of bulbs was recorded from each plot and the percentage of bolting was calculated by using following formula.

$$\text{Percentage bolting} = \frac{\text{Number of bolted plants/plot}}{\text{Number of bulbs/plot}} \times 100$$

The number of premature bolting was counted and flowering stalk was cut off.

3.6.1.3 Maturity in days:

When physiological maturity was reached and yellowing of leaves with 50 % top fall observed this observation was recorded variety wise.

3.6.1.4 Per cent twins :

The number of double (twin) bulbs and the total number of bulbs harvested per plot was recorded and the per cent of twins was worked as under.

$$\text{Per cent twin} = \frac{\text{Number of double bulbs/plot}}{\text{Number of bulbs harvested/plot}} \times 100$$

3.6.1.5 Average bulb weight (g):

The total weight of bulb in grams and number of bulbs were recorded from each plot immediately after harvesting and from this average weight of bulbs was calculated.

3.6.1.6 Number of bulbs/kg :

Replication wise 1 kg bulb sample was taken and number of bulb/kg was counted.

3.6.1.7 Ten bulb weight (kg):

Replication wise randomly ten bulbs were picked up and weighed and ten bulb weight (kg) was worked out.

3.6.1.8 Neck thickness (cm):

This was measured in cm by vernier calliper, from the five randomly selected bulbs used for calculating bulb weight (g).

3.6.1.9 Bulb diameter (Polar) in cm :

It was measured in cm by vernier calliper from the junction of root plate to the top of the bulb from the same bulbs which were used for recording neck thickness and the mean polar diameter was worked out.

3.6.1.10 Bulb diameter (Equatorial) in cm:

This was the maximum distance between opposite sides at right angles (to the polar diameter) and was measured in cm by vernier calliper. This observation was recorded from the same five randomly selected bulbs which were used for recording polar diameter and the mean equatorial diameter was worked out.

3.6.1.11 Root plate diameter (cm):

It was measured by vernier calliper in centimeter from the same random selected bulbs used for recording bulb diameter and the root plate diameter (cm) was calculated.

3.6.1.12 Yield :

The yield per plot (kg) was estimated and yield Q/ha caculated by using hectare factor.

3.6.2 Biochemical constituents:

The analysis for bio-chemical constituents such as dry matter, T.S.S., Reducing sugar, Non Reducing sugar

and total sugars were carried at harvest after bulb curing and at one month after storage.

3.6.2.1 Per cent total soluble solids (T.S.S.):

For this purpose three bulbs from each variety were randomly selected and juice was extracted with help of juicer. The mean T.S.S. was determined by hand-refractometer.

3.6.2.2 Per cent Dry matter :

Three bulbs were randomly selected and cut into small pieces with the help of stainless steel knife and weighed. The prepared sample of 100 g was then kept in hot air oven at 60^{o}C temperature till the constant weight was obtained. From this the per cent dry matter was calculated.

3.6.2.3. Per cent Reducing Sugar:

Per cent Reducing sugar content of onion bulb was estimated by the method of Lane and Eynon (1923) on fresh weight basis as juice of bulb was taken for analysis.

3.6.2.4 Per cent Total Sugars:

Per cent total sugars were estimated after acid hydrolysis by the same method as that of reducing sugars.

3.6.2.5 Per cent non-reducing sugars:

Non reducing sugars was calculated by substracting reducing sugar from the total sugars.

3.6.3 Storage characteristics:

The uniform sample of 3 kg of harvested, cleaned and cured bulbs of each variety was kept for storage studies from 1st June to 1st November for both the years.

Observations at monthly intervals were recorded for the storage losses . At each observation rotted and sprouted bulbs were dis carded after recording the weight.

3.6.3.1 Total loss in weight

The weight of only healthy bulb was recorded, which was substracted from the initial weight of sample to get total loss in weight.

3.6.3.2. Per cent Rotting

The rotted bulbs were seperated and weighed and per cent loss due to rotting was worked out.

3.6.3.3 Per cent sprouted bulbs

Sprouted bulbs were seperated and weighed and per cent loss due to sprouting was determined.

3.6.3.4 Per cent physiological loss in weight (PLW)

The per cent loss in weight both due to rotting and sprouting was substracted from total loss in weight and thus loss due to PLW (Shrinkage) was worked out.

3.6.4 Statistical analysis

The observations were recorded for morphological, bio-chemical and storage characteristics of onion bulbs. While analysing the data statistically the percentages were converted to arcsin values. The experiment was laid out in Randomised block design and appropriate standard errors were worked out. Whenever the F ratios were found to be statistically significant critical difference (CD) values at five per cent level of probability were worked out and are given whereever necessary.

The analysis of variance was worked out according to methods given by Panse and Sukhatme (1976) for Randomised Block Design. As the experiment was conducted for two years the data were pooled, analysed. Homogenity test was applied and where data were not pooled weighted average were worked out and are presented.

Genotypic co-rrelation co-efficients were calculated for the different pairs of characters involving nine and twenty characteristics for yield and

storage losses respectively. Significance of various co-rrelation co-efficient were tested from statistical table values of co-rrelation co-efficient at 1 and 5 per cent levels of significance. (Shedecor and Cochran, 1967 and Fisher and Yates, 1963).

CHAPTER-4

RESULTS

Chapter 4

RESULTS

The results of the experimental findings are presented in this chapter under appropriate headings viz. morphological character, bulb characteristics, bio-chemical studies and extent of storage losses.

4.1 Morphological characteristics :

Observations recorded on height and number of leaves at harvesting during 1986, 1987 and their weighted mean are presented in Table 3 and Table 4 respectively.

4.1.1 Plant height (cm) at harvesting:

The data regarding height of the plant during the year 1986 as presented in Table 3 indicated that there were statistical significant differences amongst varieties for plant height. The vareity N-53 recorded 69.26 cm height which was statistically significant over remaining fifteen varieties. The local selection PKV-White was next taller in recording 66.30 cm height but it was statistically similar to remaining five varieties viz. Pusa Ratnar, Pusa Red, N-2-4-1, Chikalthana Local and Nasik Red.

Perusal of the data clearly showed that all the three long day varieties recorded significantly lower

Table 3. Effect of various treatments on plant height (cm) at harvest

Treatments	Year		weighted mean
	1986	1987	
Red Varieties			
N-53	69.26	60.50	62.16
N-2-4-1	65.13	60.90	61.70
Pusa Red	65.20	60.56	61.44
Nasik Red	64.53	61.83	62.34
Pusa Ratnar	65.73	64.10	64.41
R.Selection	64.30	62.03	62.46
B-780	64.30	62.50	62.84
ChikalthanaL.	64.86	61.06	61.78
V-L-1	60.76	62.40	62.10
White Varieties			
U.D. 102 white	61.50	61.13	62.20
N-257-9-1	60.50	60.10	60.17
Pusa W.Flat	61.83	63.23	62.96
PKV-White-L	66.30	60.13	61.30
Long day type			
Brown Spanish	52.53	50.96	51.26
Early L.B.	52.50	50.53	50.90
Cream Gold	50.53	50.03	50.12
S.E. ±	0.62	0.30	0.27
C.D. at 5 %	1.79	0.86	0.78

height than rest of the thirteen varieties.

During the year 1987, however, variety Pusa Ratnar recorded maximum height of 64.10 cm, which was statistically at par to the variety Pusa White Flat. In the year 1987 too all the long day types had lower height.

Pooled result:

It is clear from the observations of weighted mean that Pusa Ratnar had maximum plant height of 64.41 cm; whereas significantly lowest height of 50.12 cm was recorded by variety Cream Gold.

4.1.2 Number of leaves/plant :

The data in respect of number of leaves per plant at harvest for the year 1986, 1987 and their weighted mean are presented in Table 4.

Perusal of the data revealed that during 1986, vareity N-257-9-1 produced highest number of leaves per plant (16.06), which was statistically significant to all the varieties except Pusa Red to which it was at par. Lowest number of leaves per plant (11.56) was produced by Brown Spanish, which were at par to Cream Gold variety. All the long day varieties produced lowest number of leaves compared to remaining thirteen varieties.

Table 4 Effect of various treatments on number of leaves /plant at harvest

Treatment	Year		Weighted mean
	1986	1987	
Red Varieties			
N-53	12.26	11.76	11.89
N-2-4-1	13.56	11.20	11.84
Pusa Red	15.56	11.86	11.78
Nasik Red	12.70	13.20	13.06
Pusa Ratnar	12.66	12.13	12.27
R.Selection	13.40	13.53	13.49
B-780	14.40	11.73	12.45
Chikalthana L.	11.80	11.80	11.80
V-L-1	15.00	15.06	15.04
White Varieties			
U.D. 102 white	13.50	12.36	12.67
N-257-9-1	16.06	11.60	11.45
Pusa W.Flat	14.63	13.03	13.46
PKV-White-L	14.30	11.16	12.01
Long day type			
Brown Spanish	11.56	10.76	10.98
Early L.B.	12.23	11.13	11.43
Cream Gold	11.86	11.06	11.28
S.E. ±	0.18	0.11	0.09
C.D. at 5 %	0.52	0.32	0.26

In the year 1987 the variety V-L-1 was found significant in production of number of leaves (12.06).

Pooled Result:

The weighted mean clearly indicated that the variety V-L-1 emerged to be superior in respect of leaf number (15.04). As it is clear from the data recorded during the years 1986 and 1987 and their weighted mean recorded by long day varieties were signficantly lower than other thirteen varieties.

4.1.3 Root Plate Diameter (cm):

The data about root plate diameter for the years 1986, 1987 and their weighted mean are presented in Table 5

For the year 1986, the variety U.D. 102 White and Baswant 780, recorded more root plate diameter (1.73 cm), which was statistically at par to the varieties N-53, Pusa White Flat, Chikalthana Local and Ratnar Selection, but significantly superior over remaining varieties.

Lowest root plate diameter of 0.86 cm was recorded by the variety Brown Spanish which was statistically at par to other two long day varieties.

During the year 1987 also, U.D. 102 White had more root plate diameter of 1.63 cm which was statistically at

Table 5 Effect of various treatments on Root plate Diameter (cm) at harvest

Treatment	Year		Weighted mean
	1986	1987	
Red Varieties			
N-53	1.66	1.60	1.64
N-2-4-1	1.60	1.60	1.60
Pusa Red	1.40	1.60	1.49
Nasik Red	1.50	1.43	1.47
Pusa Ratnar	1.60	1.46	1.54
R.Selection	1.63	1.50	1.58
B-780	1.73	1.56	1.66
Chikalthana L.	1.66	1.70	1.67
V-L-1	1.46	1.40	1.44
White Varieties			
U.D. 102 white	1.73	1.63	1.69
N-257-9-1	1.46	1.60	1.51
Pusa W.Flat	1.63	1.53	1.59
PKV-White-L	1.50	1.56	1.52
Long day type			
Brown Spanish	0.83	0.86	0.84
Early L.B.	0.93	0.93	0.93
Cream Gold	0.86	0.86	0.86
S.E. +	0.04	0.05	0.03
C.D. at 5 %	0.12	0.14	0.08

par to other eight varieties and significantly more than remainig seven varieties.

The weighted mean also had more or less similar trend of observations as of 1986 and 1987. Here also U.D. 102 White emerged superior in root plate diameter (1.69 cm) and the long day variety Brown Spanish was lowest with 0.84 cm root plate diameter.

4.1.4 Neck Thickness (cm):

Data regarding neck thickness are given in Table 6 for the years 1986, 1987 and their weighted mean.

The data revealed that the neck thickness recorded by long day cultivars was more. During the year 1986, the variety Cream Gold had maximum neck thickness of 1.40 cm which was statistically at par to Brown Spanish, Early Lockyer Brown, Nasik Red, Ratnar Selection, V-L-1 and U.D. 102 White and significantly more to rest of the varieties. The neck thickness of variety Pusa White Flat was lowest (0.73 cm), which was statistically at par to N-2-4-1, Pusa Red, Pusa Ratnar, Baswant 780 and Chikalthana Local.

During the year 1987 also, most of the varieties maintained the same trend i.e. Pusa White Flat recording lowest neck thickness (0.73 cm) and was statistically similar to N-2-4-1, Pusa Red, Pusa Ratnar and Baswant 780. The variety V-L-1 recorded high Neck thickness of

Table 6 Neck thickness (cm) as affected by various treatments

Treatment	Year		Weighted mean
	1986	1987	
Red Varieties			
N-53	0.96	1.23	1.06
N-2-4-1	0.80	0.86	0.82
Pusa Red	0.83	0.86	0.84
Nasik Red	1.20	1.10	1.16
Pusa Ratnar	0.83	0.66	0.76
R.Selection	1.23	1.20	1.22
B-780	0.90	0.96	0.92
Chikalthana.L.	0.90	1.16	1.00
V-L-1	1.20	1.40	1.23
White Varieties			
U.D. 102 white	1.16	1.30	1.21
N-257-9-1	1.13	1.23	1.17
Pusa W.Flat	0.73	0.73	0.73
PKV-White-L	1.13	1.10	1.12
Long day type			
Brown Spanish	1.20	1.23	1.21
Early L.B.	1.23	1.20	1.22
Cream Gold	1.40	1.20	1.32
S.E. +	0.08	0.10	0.06
C.D. at 5 %	0.24	0.29	0.17

1.40 cm which was statistically at par to N-53, Ratnar Selection, Chikalthana Local, U.D. 102 White, Brown Spanish and Early Lackyer Brown. All these varieties produced significantly thicker neck to remaining seven varieties.

Pooled Result:

The weighted mean data revealed that Cream Gold variety had maximum Neck thickness of 1.32 cm, while lowest one was again for Pusa White Flat i.e. 0.73 cm.

4.1.5 Duration in days for maturity:

The data regarding number of days required for maturation are presented in Table 7 for the years 1986, 1987 and along with their pooled mean.

For the year 1986, the data clearly indicated that the variety Brown Spanish took maximum days for maturity (120) which was statistically significant to all remaining varieties. Significantly lowest days were required for attaining maturity for the variety Baswant-780 (101).

However, during the year 1987, the variety Cream Gold had long duration with 125 days. In this year also, the variety Baswant 780 had lowest duration of 99 days, which was statistically at par to duration of the variety N-53, but significantly lower than remaining fourteen varieties.

Table 7 Duration in days as influenced by various treatments

Treatment	Year		Weighted mean
	1986	1987	
Red Varieties			
N-53	102.33	99.00	99.02
N-2-4-1	115.33	115.00	115.00
Pusa Red	112.67	113.00	112.99
Nasik Red	111.00	112.00	111.99
Pusa Ratnar	112.00	113.00	112.99
R.Selection	113.00	114.00	113.99
B-780	101.00	99.00	99.01
Chikalthana L.	104.33	107.33	107.31
V-L-1	117.33	121.33	121.31
White Varieties			
U.D. 102 white	116.00	118.00	117.98
N-257-9-1	114.33	114.33	114.33
Pusa W.Flat	113.00	113.00	113.00
PKV-White-L	111.00	111.00	111.00
Long day type			
Brown Spanish	120.00	120.00	120.00
Early L.B.	118.33	121.00	120.98
Cream Gold	118.00	125.00	124.95
S.E. ±	0.52	0.04	0.04
C.D. at 5 %	1.51	0.13	0.11

Weighted mean :

Data revealed that all the long day types had higher duration compared to short day types. Cream Gold took maximum duration for maturity (124.95) which was significantly highest than rest of the varieties. Next treatments were Brown Spanish and Early Lockyer Brown with 120 days duration.

Lowest duration for maturity was found in the variety Baswant-780 (99.01) and N-53 (99.02). Remaining all varieties had about 105 to 120 days duration for maturity.

4.1.6 Per cent twins :

The data regardig per cent twins for the years 1986, 1987 and pooled mean for twin bulb is presented in Table 8.

It is evident from the data presented in Table 8 that in the year 1986, the variety Ratna Selection had maximum twin bulbs (28.04 %) which was statistically at par to the variety U.D. 102 White and significantly more to other fourteen varieties. In this year Nasik Red and Chikalthana Local had no twin bulbs; whereas the variety Baswant 780 recorded lower twin percentage of 3.30 which was significantly lowest than the remainig varieties.

Table 8 Percent twin bulbs/plot as influenced by various treatments

Treatment	Year		Pooled mean	
	1986	1987		
Red Varieties				
N-53	1.86 (7.77)	2.07 (8.19)	1.90 (7.98)*	
N-2-4-1	4.26 (11.86)	6.73 (15.00)	5.40 (13.43)	
Pusa Red	9.40 (17.84)	10.93 (19.30)	10.10 (18.57)	
Nasik Red	Nil (0.56)	Nil (0.56)	Nil (0.56)	
Pusa Ratnar	20.61 (26.99)	24.30 (29.53)	27.40 (28.26)	
R.Selection	21.80 (28.04)	27.26 (31.48)	24.60 (29.76)	
B-780	0.25 (3.30)	0.72 (4.68)	0.40 (3.99)	
Chikalthana.L.	Nil (0.56)	Nil (0.56)	Nil (0.56)	
V-L-1	16.75 (24.11)	21.40 (27.55)	19.00 (25.83)	
White Varieties				
U.D. 102 W	21.23 (27.43)	20.97 (27.22)	21.10 (27.32)	
N-257-9-1	2.81 (9.56)	3.68 (11.03)	3.20 (10.29)	
Pusa W.Flat	10.50 (18.87)	13.59 (21.61)	12.00 (20.24)	
PKV-White-L	11.72 (20.00)	12.90 (21.04)	12.30 (20.52)	
Long day type				
Brown Spanish	9.97 (18.11)	10.70 (19.15)	10.20 (18.63)	
Early L.B.	14.70 (22.51)	16.60 (24.03)	15.60 (23.27)	
Cream Gold	11.00 (19.65)	13.90 (21.88)	12.60 (20.76)	
S.E. ±	-- 0.48	-- 0.39	0.31	
C.D. at 5 %	-- 1.39	-- 1.14	0.89	
			Year	TR x Y
SE ±			0.54	0.22
C.D.at 5%			1.56	N.S.

* Figures in the parenthesis are arcsin values and statistics applies to them.

In the year 1987 also, Ratnar selection produced maximum twin bulbs (27.26 %). As observed in 1986, Nasik Red and Chikalthana Local had no twins, the next low twin production was observed in Baswant-780 (4.68 %) which was significantly lower than remaining varieties.

Pooled Result:

Perusal of the data in respect of pooled mean clearly indicated that the variety Ratnar Selection produced maximum twin bulbs (29.76 %), which was statistically at par to the variety Pusa Ratnar and significantly more than rest of the fourteen varieties.

The pooled mean values for low twin bulb percentage were observed in the variety Baswant-780 with only 3.99 per cent.

Bolting:

The data regarding per cent bolted plants in each vareity have not been statistically analysed, as only four varieties bolted during both the years under study. The mean values showed that Chikalthana Local had 1.76 per cent and U.D. 102 White had 1.48 per cent bolters. Varieties Ratnar Selection and PKV-white Local produced 0.75 and 0.38 per cent bolters respectively. (Table-9A)

Table 9-A Per cent bolted bulbs at 95 days

Treatment	1986	1987	Mean
R Selection	0.50	1.00	0.75
Chikalthana Local	1.51	2.02	1.76
U.D. 102 White	1.42	1.55	1.48
PKV-White Local	0.95	0.66	1.61

4.2 Bulb Characteristics :

4.2.1 Average number of bulbs per kg :

The data for the years 1986, 1987 and pooled for average number of bulbs/kg are presented in Table 9.

It is evident from the data presented in Table that, the variety Early Lockyer Brown produced maximum number of bulbs/kg of weight (40.100); which were statistically significant to all remaining fifteen varieties. The next variety which produced smaller sized bulbs was Brown Spanish which was statistically significant to the variety Cream Gold. Thus, long day types produced smaller bulbs. Amongst, other than long day types short day variety Baswant 780 recorded more number of bulbs which were statistically similar to the variety N-53 and significantly superior over remaining varieties. Thus, among short day type Baswant-780 produced smaller bulbs.

The data further indicated that variety U.D. 102

Table 9 Average number of bulbs/kg as influenced by various treatments

Treatment	Year		Pooled mean
	1986	1987	
Red Varieties			
N-53	13.16	17.06	15.11
N-2-4-1	8.20	15.36	11.78
Pusa Red	11.90	19.66	15.78
Nasik Red	10.36	15.60	12.98
Pusa Ratnar	10.30	13.46	11.88
R.Selection	10.46	11.63	10.91
B-780	14.13	17.43	15.78
ChikalthanaL.	7.56	12.73	10.14
V-L-1	8.93	12.13	10.53
White Varieties			
U.D. 102 white	7.40	18.63	13.01
N-257-9-1	10.70	13.73	12.21
Pusa W.Flat	8.13	10.66	9.39
PKV-White-L	11.96	14.10	13.03
Long day type			
Brown Spanish	37.70	55.20	46.45
Early L.B.	40.10	47.26	43.68
Cream Gold	32.00	40.56	36.28
S.E. ±	0.60	0.90	0.54
C.D. at 5 %	1.74	2.61	1.56
		Year	TR x Y
SE±		0.94	0.38
C.D.at 5%		2.27	1.11

White had lowest number of bulbs (7.40) in one kg. This treatment was statistically at par to Chikalthana Local, N-2-4-1, Pusa White Flat and V-L-1. Thus, these varieties produced bulbs of bigger size.

In the year 1987, highest bulb number/kg was recorded by the variety Brown Spanish (52.2). The other varieties which produced more number of bulbs per kg were Early Lockyer Brown (47.26) and Cream Gold (40.56). The perusal of the data further revealed that as regards remaining varieties Pusa Red had maximum bulb number per kg; which was statistically at par to Pusa Red, U.D. 102 White and Baswant 780 and significantly superior over remaining varieties.

Pooled Result:

The pooled data showed that, Brown Spanish was significantly superior to all fifteen varieties with regards to number of bulbs per kg. The lowest number of bulbs per kilo was found in Pusa White Flat (9.39) which was statistically significant and significantly less than all other varieties under study. This indicates that the variety Pusa White Flat produced bulbs of bigger size.

4.2.2 Ten bulb weight (kg):

The data for ten bulb weight in different varieties for the years 1986 and 1987 and their weighted

mean are presented in Table 10.

The close scrutiny of the data for the year 1986 clearly indicated that highest ten bulb weight (1.35 kg) was found in the variety Chikalthana Local which was statistically at par to U.D. 102 White and V-L-1 indicating thereby that these varieties produced heavier bulbs.

Statistically lowest ten bulb weight was found in the variety Early Lockyer Brown. This variety had statistically similar values with the variety Cream Gold, Brown Spanish, PKV-White local, N-257-9-1 and N-53 indicating thereby that these varieties produced bulbs of smaller size.

For the year 1987, Pusa White Flat had highest ten bulb weight (0.95) which was statistically significant over all other varieties.

Regarding lowest ten bulb weight Cream Gold had 0.26 number which was statistically at par to Brown Spanish and significantly lowest than remaining varieties.

The weighted mean of two years indicated that the variety Pusa White Flat emerged to be superior in producing heavier bulbs as is evident from ten bulb weight/kg. Lighter bulbs were produced by long day

types as per two years data indicating thereby that these types produced smaller bulbs. Cream Gold recorded lowest ten bulb weight of 0.26 kg.

4.2.3 Average bulb weight (g) :

The data pertaining to average bulb weight during the years 1986, 1987 alongwith pooled data are presented in Table 11.

Perusal of the data presented in Table 11 for the year 1986 revealed that Chikalthana Local produced high bulb weight of 133.33 g, which was statistically similar to the varieties U.D. 102 White, V-L-1, Pusa Ratnar, Pusa White Flat and N-2-4-1 indicating thereby that these varieties produced heavier bulbs.

It is further clear from the data that the variety Early Lockyer Brown had lower average bulb weight of 30 g which was statistically similar to other two long day varieties and significantly lowest than rest of the varieties.

For the year 1987, Pusa White Flat recorded highest average bulb weight (90g). The lowest being recorded by Cream Gold (26.66 g) which was statistically similar to other two long day varieties and significantly lower than remaining varieties.

Ten

Table 10 L Bulb weight (kg) as influenced by various treatments

Treatment	Year		Weighted mean
	1986	1987	
Red Varieties			
N-53	0.79	0.58	0.60
N-2-4-1	1.19	0.56	0.58
Pusa Red	0.74	0.47	0.48
Nasik Red	1.10	0.60	0.62
Pusa Ratnar	1.18	0.76	0.78
R.Selection	1.03	0.81	0.82
B-780	0.72	0.57	0.57
Chikalthana L.	1.35	0.58	0.61
V-L-1	1.23	0.79	0.81
White Varieties			
U.D. 102 white	1.31	0.48	0.51
N-257-9-1	0.91	0.68	0.69
Pusa W.Flat	1.18	0.95	0.96
PKV-White-L	0.90	0.71	0.72
Long day type			
Brown Spanish	0.39	0.29	0.30
Early L.B.	0.30	0.28	0.28
Cream Gold	0.37	0.26	0.26
S.E. ±	0.05	0.01	0.01
C.D. at 5 %	0.14	0.04	0.03

Table 11 Average bulb weight (g) as influenced by various treatments

Treatment	Year		Pooled mean
	1986	1987	
Red Varieties			
N-53	76.66	60.00	68.33
N-2-4-1	116.67	56.66	86.66
Pusa Red	73.33	46.66	59.99
Nasik Red	110.00	60.00	85.00
Pusa Ratnar	116.67	73.33	95.00
R.Selection	103.33	80.00	91.66
B-780	73.33	56.66	64.99
Chikalthana.L.	133.33	60.00	96.66
V-L-1	123.33	76.66	99.99
White Varieties			
U.D. 102 white	130.00	50.00	90.00
N-257-9-1	90.00	66.66	78.33
Pusa W.Flat	116.67	90.00	103.33
PKV-White-L	90.00	76.66	83.33
Long day type			
Brown Spanish	40.00	30.00	35.00
Early L.B.	30.00	30.00	30.00
Cream Gold	40.00	26.66	33.33
S.E. +	5.18	2.83	2.95
C.D. at 5 %	14.95	8.15	8.53
		Year	TR x Y
SE ±		5.11	2.08
C.D.at 5%		14.77	6.01

Pooled Result:

The data for pooled mean indicated that Pusa White Flat was topping with 103.33 g bulb weight being statistically at par to V-L-1, Chikalthana Local and Pusa Ratnar.

The lowest bulb weight was again by Early Lockyer Brown, which was statistically at par to Brown Spanish Cream Gold and significantly lower than rest of the varieties.

4.2.4 Bulb size :

4.2.4.1 Bulb diameter (Equatorial and Polar) (cm):

The data regarding bulb size including bulb diameter (Equatorial and Polar) for the years 1986, 1987 and their mean have been given in Table 12.

It is evident from the data for the year 1986 that the variety Chikalthana Local had maximum equatorial bulb diameter of 6.93 cm which was statistically similar to the varieties N-53, N-2-4-1, Pusa Red, U.D. 102 White, N-257-9-1 and all these varieties were significantly superior for equatorial bulb diameter over rest of the varieties.

The data also indicated that lowest bulb diameter (E.) was recorded by Cream Gold which was statistically at par to Brown Spanish and Early Lockyer Brown and

Table 12 Effect of various treatments on Bulb size (cm)

Treatment	Year				Weighted mean	
	1986		1987			
	Eq.	Pol	Eq.	Pol	Eq.	Pol
Red Varieties						
N-53	5.99	4.36	5.63	3.90	5.81	4.13
N-2-4-1	6.81	5.10	6.53	4.90	6.67	5.00
Pusa Red	6.71	4.76	6.40	4.70	6.55	4.73
Nasik Red	6.35	5.04	6.26	5.03	6.30	5.03
Pusa Ratnar	6.29	5.60	6.23	5.30	6.26	5.45
R.Selection	6.44	5.23	6.30	4.83	6.37	5.03
B-780	6.04	4.56	5.90	4.36	5.97	4.46
Chikalthana,L.	6.93	6.40	6.80	6.33	6.86	6.36
V-L-1	6.45	5.43	6.30	5.13	6.37	5.28
White Varieties						
U.D. 102 white	6.85	5.30	6.80	5.06	6.82	5.18
N-257-9-1	6.32	4.63	6.16	4.40	6.24	4.51
Pusa W.Flat	6.77	5.23	6.53	5.10	6.65	5.16
PKV-White-L	6.27	4.76	6.10	4.74	6.18	4.75
Long day type						
Brown Spanish	3.74	6.76	3.60	6.43	3.67	6.59
Early L.B.	3.79	5.73	3.50	5.66	3.64	5.69
Cream Gold	3.67	7.00	3.43	7.03	3.55	7.01
S.E. ±	0.07	0.09	0.07	0.09	--	--
C.D. at 5 %	0.22	0.28	0.21	0.27	--	--

significantly superior to remaining varieties.

As regards polar diameter, Cream Gold recorded the highest polar diameter which was statistically similar to Brown Spanish and significantly superior to remaining varieties.

Lowest polar diameter was observed in the variety N-53 which was statistically similar to Pusa Red and Baswant 780 and significantly lower to rest of the treatments.

The data in the year 1987 indicated that Chikalthana Local and U.D. 102 White had maximum (6.80 cm) equatorial diameter which was significantly superior over remaining varieties.

Regarding lowest bulb diameter (equatorial), Cream Gold with 3.43 cm was lowest, being at par to other two short day type and significantly superior over rest of the varieties.

The data for polar diameter indicated that the variety Cream Gold recorded higher polar diameter of 7.03 cm which was statistically significant to remaining fifteen treatments.

Lowest polar diameter was recorded in the variety N-53 (3.90 cm) which was significantly lowest than all other fifteen varieties.

Weighted mean :

The weighted mean indicated that the variety Chikalthana Local had highest equatorial and polar diammeter suggesting that the bulbs were of big size. Next to this the veriety N-2-4-1 and Pusa white Flat had big size bulbs. Polar diameter of long day type was more than their equatorial diameter indicating their globose shape.

4.3 Yield per plot and quintol/ha :

The data for the yield per plot (kg) and per hectare yield in quintol for the year 1986, 1987 and pooled mean are presented in table 13.

The data cleraly indicated that there were significant differences in the yield kg. per plot and yield quintol per hectare for the year 1986. The veriety N-2-4-1 and PKV-White Local recorded highest yield of 9.76 kg/plot and 216.88 q/ha. However, these two verietys were statistically at par with the varieties Pusa White Flat and Chikalthana Local, all these four verieties had significantly higher yield than remaning twelve varieties.

All the short day types produced significantly lowest yields, the variety Cream Gold produced significantly lowest bulb yield of 1.50 kg/plot and

Table 13 Yield of onion bulbs (kg/plot) and total yield (Q/ha) as influenced by various treatments.

Treatment	Year				ighted mean	
	1986		1987			
	kg/ plot	q/ha	kg/ plot	q/ha	kg/ plot	q/ha
Red Varieties						
N-53	6.26	139.11	4.86	107.99	5.56	123.55
N-2-4-1	9.76	216.88	9.40	208.88	9.58	212.88
Pusa Red	5.56	123.55	4.96	110.22	5.26	116.88
Nasik Red	7.93	176.22	7.43	165.11	7.68	170.66
Pusa Ratnar	8.16	181.33	7.26	161.33	7.81	173.55
R.Selection	6.63	147.33	6.60	146.66	6.61	146.88
B-780	6.76	150.22	6.80	151.11	6.78	150.66
Chikalthana L.	9.23	205.11	7.46	165.77	8.34	185.33
V-L-1	7.03	156.22	6.63	147.33	6.83	155.77
White Varieties						
U.D. 102 white	8.63	191.77	5.13	113.99	6.88	152.88
N-257-9-1	7.60	168.88	5.66	125.77	6.63	147.33
Pusa W.Flat	8.36	185.77	9.16	203.55	8.66	192.44
PKV-White-L	9.76	216.88	9.30	206.66	9.53	211.77
Long day type						
Brown Spanish	2.13	47.33	2.06	45.77	2.08	46.222
Early L.B.	1.60	35.55	1.50	33.33	1.55	34.44
Cream Gold	1.50	33.33	1.56	34.66	1.53	33.99
S.E. ±	0.53	11.77	0.30	6.66	0.21	6.88
C.D. at 5 %	1.53	33.99	0.88	19.55	0.89	20.45
	Year	TR x Y	Year	TR x Y		
SE±	0.53	0.22	11.77	4.88		
C.D.at 5%	1.53	N.S.	33.99	N.S.		

33.33 q/ha yield, it was however, statistically at par to Early Lockyer Brown and Brown Spanish. Persual of the yield data for the year 1987 revealed that the variety N-2-4-1 produced significant higher yield over other varieties remaining statistically similar to the varieties PKV-White Local and Pusa White Flat. The variety N-2-4-1 produced 9.40 kg/plot 208.88 q/ha yield while PKV-White Local(206.66 q/ha)and Pusa White Flat (192.44 q/ha) were at par to it.

In the year 1987 also long day varieties produced significantly lowest yield. Early Lockyer Brown recorded 1.5 kg/plot and 33.33 Q/ha yield and was at par to Cream Gold and Brown Spanish.

Pooled Result :

The pooled data clearly indicated that variety N-2-4-1 had highest yield of 9.58 kg/plot and 212.88 Q/ha. It was statistically similar to the yields of the variety PKV-Wlhite Local with 9.53 kg/plot and 211.77 Q/ha and Pusa White Flat with 8.69 kg/plot and 192.44 q/ha yield, these three vareities produced significantly superior yield over thirteen varieties.

Significantly lowest yield was recorded by long day type namely Cream Gold (1.53 kg/plot and 33.99 Q/ha) which was at par to Early Lockyer Brown and Brown Spanish. It can be thus concluded that amongst different

groups in red type the veriety N-2-4-1 ranked top as it recorded significantly highest yield in red types. In white varieties PKV-White Local recorded highest yield but it was statistically similar to Pusa White Flat and these two were further significantly superior over remaning two white varieties. For long day types all the varieties were statistically at par in yield however Brown Spanish was numerically at the top.

Interaction effects for treatment x year were found to be non-significant.

4.4 Bio-chemical composition :

4.4.1 Per cent dry matter at harvest and one month after storage :

The data for the years 1986, 1987 and their weighted mean in respect of dry matter content of bulbs before harvest and one month after storage are given in Table-14. In the year 1986, N-257-9-1 was having highest dry matter content of 22.08 per cent which was at par to the variety Pusa White Flat (22.7 %) and significantly more than rest of the fourteen varieties. During the year 1987 bulbs of the variety Pusa white Flat variety had highest dry matter content (23.1%). The lowest dry matter content of 18 % was recorded by the bulbs of the variety Brown Spanish. For both the years dry matter content had narrow range.

Table 14 Per cent dry matter at harvest and one month after storage as influenced by various treatments

Treatments	% dry matter at harvest		Weighted mean	% dry matter one month after harvest		Weighted mean
	1986	1987		1986	1987	
N-53	12.70 (20.9)	11.90 (20.2)	12.30 (20.36)	13.10 (20.7)	12.70 (20.8)	12.30 (20.59)*
N-2-4-1	14.40 (22.4)	14.10 (22.1)	14.20 (22.17)	15.10 (22.9)	14.60 (22.4)	14.60 (22.43)
Pusa Red	11.90 (20.2)	11.90 (20.2)	11.90 (20.20)	12.60 (20.7)	12.90 (21.1)	12.90 (21.08)
Nasik Red	11.90 (20.2)	12.00 (20.50)	11.90 (20.20)	12.20 (20.50)	13.00 (21.10)	12.80 (20.95)
Pusa Ratnar	14.00 (21.9)	14.10 (22.1)	14.10 (22.05)	15.00 (22.8)	14.90 (22.7)	14.90 (22.70)
R.Selection	13.00 (21.1)	13.70 (21.7)	13.50 (21.55)	14.00 (21.8)	14.20 (22.2)	14.10 (22.18)
B-780	13.10 (21.2)	12.90 (21.1)	13.00 (21.12)	13.90 (21.9)	13.60 (21.7)	13.70 (21.71)
Chikalthana L.	13.70 (21.7)	13.40 (21.5)	13.50 (21.54)	14.10 (22.0)	14.00 (21.9)	13.90 (21.90)
V-L-1	12.70 (20.8)	12.80 (21.0)	12.80 (20.95)	13.00 (21.1)	13.20 (21.3)	13.20 (21.29)
U.D. 102 white	12.20 (20.5)	13.40 (21.5)	13.10 (21.26)	13.00 (21.1)	14.10 (22.0)	14.10 (21.94)
N-257-9-1	15.00 (22.8)	15.20 (22.9)	15.10 (22.87)	15.90 (23.5)	16.00 (23.6)	16.00 (23.59)
Pusa W.Flat	15.00 (22.7)	15.50 (23.1)	15.50 (23.02)	15.90 (23.5)	16.40 (23.9)	16.40 (23.88)
PKV-White-1	14.50 (22.4)	14.20 (22.1)	13.10 (22.17)	15.20 (22.8)	16.00 (22.8)	15.00 (22.80)
Brown Spanish	9.50 (18.5)	9.50 (18.0)	9.60 (18.11)	10.20 (19.3)	10.20 (18.6)	10.20 (18.64)
Early L.B.	9.80 (18.4)	10.00 (18.4)	10.00 (18.47)	10.70 (19.1)	10.90 (19.3)	10.90 (19.29)
Cream Gold	9.70 (18.4)	9.70 (18.5)	10.00 (18.47)	10.40 (19.5)	10.60 (19.5)	11.10 (19.50)
S.E. ±	0.09	0.05	0.04	-- 0.20	-- 0.05	-- 0.04
C.D. at 5 %	0.29	0.17	0.12	-- 0.60	-- 0.16	-- 0.14

* Figures in the parenthesis are arcsin values and statistics applies to them.

Data of weighted mean revealed that significantly highest dry matter content of bulbs was recorded by the varieties Pusa White Flat (23 %) and N-257-9-1 (22.8 %) over all other fourteen verities. These two varities were statistically similar to each other.

Among long day type the variety Brown Spanish recorded low dry matter content of 18.11 % which was statistically at par to Early Lockyer Brown and Cream Gold and significantly lower than other verities. For verities other than long day types, variety Pusa Red, Nasik Red and N-53 had low dry matter content.

The data for dry matter percentage one month after storage for the years 1986 and 1987 and their weighted mean recorded following observations.

Data for the year 1986 showed that the bulbs of the varieties Pusa White Flat and N-257-9-1 had 23.5 % dry matter content which was significantly superior over rest of the verities. The bulbs of the veriety Early Lockyer Brown with 19.1 % dry matter being lowest was at par to Brown Spanish and Cream Gold. All these long day type varieties exhibited significantly lower values.

In the year 1987 also the bulbs of the variety Pusa White Flat recorded highest dry matter content of 23.6 per cent which was statistically significant over rest of the varieties. Significantly lowest dry matter

Percentage was found in the bulbs of the variety Brown Spanish (18.6 %). During both the years varieties Pusa Red and N-53 amongst short day types recorded low dry matter.

For Weighted mean bulbs of the variety Pusa white Flat produced significantly more (23.88 %) dry matter over all other varieties. Significantly lowest dry matter was recorded by Brown Spanish (18.64). For varieties other than long day types varieties N-53 and Nasik Red continued to be low in dry matter content after one month of storage.

4.4.2. Per cent soluble solids at harvest and one month after storage :

The data pertaining to per cent total soluble solids during the years 1986, 1987 and their weighted mean for observations fo T.S.S. (at harvest and one month after storage) are persented in Table-15.

The data in respect of T.S.S. for the year 1986 clearly indicated that bulbs of the variety PKV-White Local with 23.5% showed highest T.S.S. content which was statistically similar to the carieties N-2-4-1, V-L-1, Pusa Red and Chikalthana Local, all being statistically sigificant to rest of the varieties. Bulbs of the long day varieties were statistically at par and significantly lower in T.S.S. content of other varieties.

Table 15 Per cent T.S.S. at harvest and one month after storage as influenced by various treatments

Treatments	% T.S.S. at harvest		Weighted mean	% T.S.S. one month after harvest		Weighted mean
	1986	1987		1986	1987	
N-53	14.10 (21.8)	13.90 (21.7)	13.70 (21.79)	15.00 (22.8)	14.40 (22.1)	13.20 (22.95)*
N-2-4-1	15.80 (23.3)	15.00 (22.8)	15.60 (23.29)	16.50 (24.7)	15.90 (23.4)	16.60 (24.05)
Pusa Red	14.40 (22.9)	14.00 (21.9)	15.10 (22.88)	15.40 (23.0)	15.10 (22.9)	15.20 (22.95)
Nasik Red	15.70 (23.2)	15.90 (23.5)	15.80 (23.00)	16.40 (23.6)	16.30 (23.6)	16.30 (23.40)
Pusa Ratnar	14.90 (22.8)	15.00 (22.5)	15.00 (22.79)	16.10 (23.5)	16.00 (23.5)	15.90 (23.50)
R.Selection	15.20 (22.9)	14.70 (22.3)	15.10 (22.89)	15.50 (23.3)	15.30 (22.9)	15.40 (23.10)
B-780	14.10 (22.1)	14.00 (21.9)	14.10 (22.09)	15.10 (22.3)	15.00 (22.5)	14.90 (22.70)
Chikalthana L.	15.60 (23.2)	15.00 (22.7)	15.40 (23.19)	16.10 (23.6)	16.10 (23.8)	16.20 (23.70)
V-L-1	15.90 (23.4)	15.50 (23.3)	15.70 (23.39)	16.3) (23.8)	16.30 (23.7)	16.20 (23.75)
U.D. 102 white	14.90 (22.7)	14.10 (21.1)	14.80 (22.69)	15.10 (22.8)	15.00 (23.4)	15.40 (23.10)
N-257-9-1	14.90 (22.7)	14.90 (22.2)	14.80 (22.69)	16.00 (22.9)	16.10 (22.7)	15.00 (22.80)
Pusa W. Flat	15.00 (22.9)	15.20 (22.4)	15.20 (22.95)	16.00 (23.6)	16.00 (23.4)	15.90 (23.50)
PKV-White-L	16.00 (23.5)	15.50 (23.7)	15.90 (23.49)	16.80 (24.0)	15.90 (23.4)	16.20 (23.70)
Brown Spanish	10.80 (19.0)	10.20 (18.5)	10.60 (18.99)	10.90 (19.3)	10.80 (19.2)	10.90 (19.25)
Early L.B.	10.20 (18.7)	10.10 (18.5)	10.20 (18.69)	10.90 (19.3)	10.80 (19.1)	10.80 (19.20)
Cream Gold	10.00 (18.8)	10.00 (18.5)	10.30 (18.79)	10.40 (19.3)	10.70 (19.3)	10.90 (19.55)
S.E. ±	-- 0.11	-- 0.87	-- 0.11	-- 0.15	-- 0.15	0.10
C.D. at 5 %	-- 0.34	-- 2.65	-- 0.31	-- 0.46	-- 0.45	0.31

* Figures in the parenthesis are arcsin values and statistics applied to them.

During the year 1987, the T.S.S. content of bulbs at harvest was in a much narrow range. Bulbs of the variety PKV-White Local recorded high T.S.S. of 23.7 % but it was statistically similar to many other varieties. All the varieties belonging to long day types had lowest T.S.S. i.e. around 18.5 per cent.

The weighted mean data for T.S.S. at harvest revealed that the variety PKV-White Local had highest T.S.S. (23.49 %) before harvest. This variety exhibited at par values with the varieties V-L-1, Chikalthana Local and N-2-4-1. Significantly lowest T.S.S. has again been recorded in long day types. These entries being at par to each other had significantly lower T.S.S. than remaining varieties. The variety N-53 recorded low T.S.S. after long day types.

The data regarding T.S.S. percentage after harvest during the year 1986, clearly indicated that amongst sixteen varieties the variety N-2-4-1 had highest T.S.S. of 24.7 per cent, which was statistically significant to all other varieties.

Low T.S.S. percentage was observed in the bulbs of long day types with 19.3 per cent. These three varieties were statistically similar to each other.

The content of T.S.S. after one month of storage during the year 1987 revealed that bulbs of Chikalthana

Local recorded highest T.S.S. percentage of 23.8 which was statistically similar to other seven varieties and significantly superior to remaining eight varieties.

The T.S.S. percentage of long Day type varieties being statistically at par to each other had significantly low T.S.S. (19.2 %) percentage than remaining thirteen types.

The data pertaining to weighted mean showed that the variety N-2-4-1 emerged out to be significantly superior variety over other varieties in respect of T.S.S. percentage, recording 24.05 per cent total soluble solids.

Long day types being at par with each other recorded lowest T.S.S. (19.20 %) than other short day varieties ; among short day varieties Baswant-780 had low T.S.S. percentage of 22.7.

4.4.3 Percent sugars at harvest and one month after storage :

The data showing percentage of sugars in the onion bulb for the years 1986 and 1987 have been presented in Table 16 and 17.

Table 16 Per cent sugars at havest and one month after storage as influenced by various treatments (1986)

Treatments	% Reducing sugars		% Non-reducing sugar		% Total sugar	
	At harvest	One month after harvest	At harvest	One month after harvest	At harvest	One month after harvest
N-53	2.70 (9.4)	2.40 (9.6)	3.40 (10.6)	4.20 (11.8)	6.40 (14.4)	6.60 (14.8)*
N-2-4-1	1.90 (8.0)	1.80 (8.9)	3.00 (10.0)	4.70 (12.2)	5.00 (12.9)	6.40 (14.1)
Pusa Red	2.50 (9.2)	2.00 (9.7)	3.70 (11.1)	4.00 (11.6)	6.20 (13.8)	6.20 (13.9)
Nasik Red	2.10 (8.5)	1.90 (8.8)	2.90 (10.8)	3.70 (11.1)	5.00 (13.3)	5.20 (13.6)
Pusa Ratnar	2.50 (9.2)	1.90 (9.1)	3.00 (10.0)	4.60 (12.4)	5.40 (13.5)	6.50 (14.8)
R.Selection	2.60 (8.2)	2.00 (9.3)	3.30 (10.5)	4.10 (11.2)	5.80 (14.0)	6.00 (14.3)
B-780	2.50 (9.2)	2.00 (9.5)	3.40 (10.6)	4.00 (11.6)	6.00 (14.2)	6.00 (14.3)
Chikalthana L.	2.40 (9.0)	1.90 (9.2)	3.20 (10.2)	4.20 (11.9)	5.50 (13.6)	6.10 (14.4)
V-L-1	3.00 (10.0)	2.70 (10.0)	3.50 (10.8)	4.20 (11.9)	6.50 (14.8)	6.90 (15.3)
U.D. 102 white	2.30 (8.7)	2.00 (8.9)	2.80 (9.7)	3.60 (10.9)	5.00 (12.9)	5.60 (13.7)
N-257-9-1	2.40 (8.9)	1.40 (9.8)	3.80 (11.2)	4.80 (12.7)	6.00 (14.2)	6.90 (15.3)
Pusa W.Flat	2.30 (8.7)	1.90 (9.3)	3.40 (10.7)	4.0 (11.4)	5.80 (13.7)	6.30 (14.2)
PKV-White-L	2.40 (9.0)	2.00 (8.1)	3.10 (10.2)	4.20 (11.9)	5.50 (13.6)	6.30 (14.5)
Brown Spanish	4.10 (11.7)	3.70 (11.1)	4.90 (12.2)	5.80 (13.9)	8.60 (17.1)	9.40 (17.9)
Early L.B.	4.50 (12.3)	3.20 (10.4)	4.40 (12.2)	5.70 (13.5)	8.40 (16.5)	9.00 (16.9)
Cream Gold	4.10 (11.0)	3.00 (10.5)	4.40 (12.3)	5.70 (13.4)	8.40 (16.5)	9.00 (16.9)
S.E. ±	-- 0.24	-- 0.54	-- 0.11	-- 0.13	-- 0.18	-- 0.18
C.D. at 5 %	-- 0.74	-- 1.66	-- 0.34	-- 0.41	-- 0.55	-- 0.56

* Figures in the parenthesis are arcsin values and statistics applies to them.

Table 17 Per cent sugars at harvest and one month after storage as influenced by various treatments (1987)

Treatments	% Reducing sugars				% Non-reducing sugar				% Total sugar			
	At harvest		One month after harvest		At harvest		One month after harvest		At harvest		One month after harvest	
N-53	2.50	(9.2)	2.20	(8.5)	2.90	(9.8)	3.70	(11.0)	5.40	(13.4)	5.90	(14.1)*
N-2-4-1	2.00	(8.3)	1.70	(7.6)	3.10	(10.1)	4.10	(11.6)	5.00	(12.9)	5.80	(14.0)
Pusa Red	2.40	(9.0)	1.90	(8.0)	3.70	(11.1)	4.40	(12.1)	6.10	(14.3)	6.20	(14.4)
Nasik Red	2.20	(8.6)	1.80	(7.8)	3.00	(9.9)	4.10	(11.7)	5.20	(13.2)	5.90	(14.1)
Pusa Ratnar	2.60	(9.3)	2.00	(8.1)	2.90	(9.9)	3.90	(11.3)	5.40	(13.5)	5.90	(14.1)
R.Selection	2.80	(9.7)	2.10	(8.3)	3.50	(10.7)	4.30	(12.0)	6.20	(14.4)	6.30	(16.5)
B-780	2.30	(8.8)	1.90	(7.9)	3.10	(10.2)	4.10	(11.6)	5.40	(13.5)	6.00	(14.2)
Chikalthana L.	2.50	(9.2)	1.90	(8.0)	2.90	(9.7)	2.90	(11.3)	5.40	(13.4)	5.60	(13.6)
V-L-1	2.90	(9.9)	2.30	(8.8)	3.60	(11.0)	4.50	(12.3)	6.50	(14.7)	6.70	(15.0)
U.D. 102 white	2.30	(8.8)	2.00	(8.1)	2.90	(9.8)	3.80	(11.3)	5.30	(13.3)	5.80	(14.0)
N-257-9-1	2.40	(9.0)	2.00	(8.1)	3.40	(10.7)	3.90	(11.4)	6.00	(14.2)	5.90	(14.1)
Pusa W.Flat	2.40	(9.0)	1.90	(8.0)	3.20	(10.3)	4.00	(11.5)	5.70	(13.8)	5.90	(14.1)
PKV-White-L	2.50	(9.2)	2.10	(8.3)	3.00	(9.9)	4.10	(11.8)	5.40	(13.5)	6.30	(14.5)
Brown Spanish	4.00	(11.6)	3.80	(11.3)	4.50	(12.3)	5.70	(13.8)	8.60	(17.0)	9.50	(18.0)
Early L.B.	4.20	(11.9)	3.50	(10.7)	4.60	(12.4)	6.10	(14.3)	8.80	(17.2)	9.60	(18.0)
Cream Gold	4.00	(11.1)	3.20	(10.3)	4.90	(12.5)	5.90	(14.5)	8.60	(16.7)	9.40	(18.0)
S.E. ±	--	0.07	--	0.05	--	0.07	--	0.08	--	0.06	--	0.06
C.D. at 5 %	--	0.22	--	0.15	--	0.22	--	0.26	--	0.20	--	0.19

* Figures in the parenthesis are arcsin values and statistics applies to them.

4.4.3.1 Per cent sugar content during the year 1986 :

4.4.3.1.1 Per cent reducig sugars :

As evident the data in Table 16 for the year 1986, in respect of per cent Reducing Sugars clearly showed that bulbs of all long types had high reducing sugar percentage. The variety Early Lockyer Brown with 12.3 % was at par to other two varieties and was significantly superior than rest of the thirteen short day varieties. For reducing sugar content in the varieties other than long day types the variety V-L-1 had highest value of 10 % which was statistically similar to the varieties N-53, Pusa Red, Pusa Ratnar and Baswant 780. These varieties were significant over remaining eight varieties.

The vareity Ratnar Selection recorded lowest reducing sugar percentage (8.2) which was statistically at par to other four varieties viz. N-2-4-1, Nasik Red, U.D. 102 White and Pusa White Flat and significantly lower than remaining eleven varieties.

One month after storage the reducing sugar percentage in different varieties clearly indicated that Brown Spanish had highest reducing sugar (11.1 %), which was statistically at par to other six varieties viz. Early Lockyer Brown, N-257-9-1, V-L-1, Baswant 780, Pusa Red and N-53, these being significantly superior over remaining nine varieties.

Significantly lowest reducing sugar percentage was found in the variety PKV-White Local after one month of storage, which was statistically similar to other eight varieties viz. N-2-4-1, Nasik Red, Pusa Ratnar, Ratnar Selection, Baswant 780, Chikalthana Local, U.D. 102 White and Pusa White Flat, these being significantly superior over remaining seven varieties.

4.4.3.1.2 Non Reducing Sugar (%) :

The non-reducing sugar percentage at harvest during the year 1986, indicated that the variety Cream Gold had hgihest non-reducing sugar (12.7%) which was significantly superior than all remainig varieties. Significantly lowest non-reducing sugar was recorded by the variety U.D. 102 White (9.7 %), which was statistically similar to those found in the varieties N-2-4-1 and Pusa Ratnar.

One month after storage the non-reducing sugar percentage at harvest was highest in the variety Early Lockyer Brown, having at par observations to Brown Spanish and Cream Gold. For varieties belonging to short day type, reducing sugar percentage in the bulbs of the varieties Pusa Ratnar and Pusa Red were significantly superior over remaining ten varieties, both being statistically similar to each other.

The bulbs of the vareity U.D. 102 White recorded lowest (10.9 %) non-reducing sugar which was statistically similar to the varieties Pusa Red, Ratnar Selection, Baswant-780 and Pusa White Flat and significantly lower than rest of the eleven varieties.

4.4.3.1.3 Per cent total sugars :

It is evident from the data presented in Table 16 that, all the three long day type varieties recorded higher total sugar percentage (around 17 %) at harvest during the year 1986. These varieties were statistically similar to each other and significantly superior over remaining thirteen varieties. The varieties viz, N-53, Baswant 780, V-L-1 and N-257-9-1 were having significantly lower percentage of total sugar than above varieties. However, all these varieties were at par to each other and significantly superior over rest of the eight varieties.

Low sugar percentage (12.9 %) was found in the varieties N-2-4-1 and U.D. 102 White. These two varieties were at par to other six varieties and had significantly lower total sugar percentage than rest of the six varieties.

The data about total sugar percentage one month after storage in the year 1986 clearly indicated that all the three long day type varieties had significantly

higher sugar percentage (16.9 to 17.9 %). These three varieties were at par to each other. The varieties N-53, Pusa Ratnar, V-L-1 and N-257-9-1 were next best to above mentioned varieties. All these four varieties had at parmsugar percentage. They were statistically higher in total sugar percentage than remaining nine varieties.

Lowest total sugar percentage was found in the variety U.D. 102 White (13.7 %) which was statistically similar to the varieties N-2-4-1, Pusa Red and Nasik Red. These varieties had significantly low total sugars than other twelve varieties.

4.4.3.2 Per cent sugar content during the year 1987

The data in respect of total sugars have been presented in the Table 17.

4.4.3.2.1 Per cent reducing sugar

The data in respect of reducing sugar at harvest for the year 1987 has similar trend as that observed for the year 1986. It is clear from the data that all three long day type varieties were at par and recorded highest reducing sugar per cent than remaining thirteen varieties. Early Lockyer Brown topping with 11.9 per cent. The reducing sugar content for other than above varieties was in a narrow range; V-L-1 having 9.9 % reducing sugar which was statistically similar to the varieties N-53, Pusa Red, Ratnar Selection, Chikalthana

Local, V-L-1, N-257-9-1, Pusa White Flat and PKV-White Local. The remaining five varieties had significantly low reducing sugar percentage. The variety N-2-4-1 recorded lowest (8.3 %) reducing sugar values.

The data regarding per cent reducing sugar one month after storage during the year 1987, showed that the variety Brown Spanish had highest reducing sugar, which was significantly superior over rest of the varieties. The variety N-2-4-1 recorded statistically lowest reducing sugar percentage (7.6 per cent). For the varieties other than long day types the reducing sugar was in much narrow range.

4.4.3.2.2 Per cent non-reducing sugars

Non-reducing sugar percentage observations also revealed that all the long day type had high non-reducing sugar percentage (12.3 %). These varieties behaved statistically similar to each other and recorded significantly higher non-reducing percentage over the remaining thirteen varieties.

Lowest reducing percentage of 9.7 was found in the variety Chikalthana Local, which was statistically at par to other six varieties.

The observations for non-reducing sugar one month of storage indicated that the varity Brown Spanish had

the highest i.e. 14.3 % non-reducing sugars. The lowest non-reducing sugars was found in the variety N-53.

4.4.3.2.3 Per cent total sugars

The data for total sugars at harvest showed that the variety Early Lockyer Brown had significantly highest total sugar (17.2 %). It was statistically similar to the Brown Spanish and significantly more than remaining fourteen varieties. The variety V-L-1 with 14.7 % total sugars was at the top amongst varieties other than long day types.

The vareity N-2-4-1 had lowest total sugars (12.9 %) which had statistically lowest position amongst remaining fifteen varieties.

Perusal of the data in respect of total sugars after one month of storage clearly indicated that all the long day types had high total sugar content (18 %). These three varieties being at par to each other recorded significantly higher total sugars over the rest of the thirteen varieties. The variety Ratnar Selection was at the top with 16.5 % total sugars in the group of short day varieties.

The lowest total sugar percentage of 13.6 was observed in Chikalthana Local which was significantly lowest than all other varieties.

4.5 Per cent storage losses

Results of the losses recorded at 30 days interval due to rotting, sprouting, physiological loss in weight and total losses for 1986 and 1987 have been presented here under suitable sub headings.

4.5.1 Percentage Bulb rotting

Data in respect of per cent bulb rotting loss during the years 1986 and 1987 are presented in the Table 18 . The data regarding per cent bulb rotting recorded at 30 days interval for the year 1986 clearly indicated that for the first 30 and 60 days, the variety Cream Gold recorded maximum losses of 1.36 and 3.55 per cent respectively, which were significantly more than all the remaining varieties.

The lowest losses for the first 30 days were found in the variety N-2-4-1 and for 60 days in variety V-L-1. The magnitude of losses being 0·15 and 0·47 per cent respectively. These losses were significantly lowest compared to remaining fourteen varieties.

At 90 days however, the variety Early Lockyer Brown registered highest rotting losses (13.10%) and the lowest by the vareity Pusa White Flat (5.80%), both these varieties recorded significantly the highest and the lowest rotting losses.

Table 18 Percent bulb rotting as affected by different treatments (1986/1987)

Treatment	Percent rotting (Days after storage)					Percent rotting (Days after storage)					Pooled mean (end of storage)
	30	60	90	120	150	30	60	90	120	150	
			(1986)					(1987)			
Red Varieties											
S-53	00.63(4.6)	0.83(5.10)	2.58(9.1)	1.50(7.1)	0.86(5.2)	0.48(3.8)	0.85(5.2)	2.75 (9.5)	1.25(6.4)	1.05(5.88)	1.00 (5.58)*
N-2-4-1	00.15(1.8)	0.95(5.5)	0.95(5.5)	1.05(5.8)	0.45(3.8)	0.10(1.88)	0.88(5.2)	1.95 (8.08)	0.95(5.5)	0.65(4.60)	0.40 (4.23)
Pusa Red	00.45(3.8)	0.76(4.9)	0.90(5.4)	0.81(5.1)	0.50(4.0)	0.40(3.60)	0.85(4.9)	1.27 (6.40)	0.75(4.9)	0.85(5.20)	0.70 (4.66)
Nasik Red	00.49(4.0)	0.63(4.4)	1.18(6.1)	0.68(4.6)	0.58(4.4)	0.45(3.80)	0.55(4.2)	1.45 (6.90)	0.55(4.2)	0.75(4.90)	0.70 (4.71)
Pusa Ratnar	01.05(5.8)	1.36(6.6)	1.41(7.0)	1.55(7.1)	1.25(6.4)	0.95(5.50)	1.25(6.4)	1.85 (7.80)	1.30(6.5)	1.45(6.90)	1.40 (6.66)
K.Selection	00.31(3.1)	0.81(5.1)	1.00(5.6)	0.81(5.17)	0.63(4.4)	0.21(2.50)	0.85(5.2)	1.95 (8.00)	0.70(4.9)	0.79(5.10)	0.70 (4.78)
B-780	00.47(3.8)	0.63(4.4)	2.95(9.0)	1.55(7.1)	1.20(6.1)	0.40(3.60)	0.55(4.2)	3.10 (10.10)	1.10(6.0)	2.05(8.20)	1.60 (7.19)
Chikalthana L.	00.62(4.4)	1.31(6.5)	1.31(6.5)	1.30(6.5)	1.10(6.0)	0.45(3.80)	1.25(6.4)	2.00 (8.20)	1.25(6.4)	1.45(6.90)	1.30 (6.46)
V-L-1	00.47(3.8)	0.49(4.0)	1.18(6.1)	1.05(5.0)	0.49(4.0)	0.35(3.80)	0.50(4.0)	1.85 (7.80)	0.85(5.2)	0.85(5.20)	0.70 (4.66)
White Varieties											
U.D. 102 white	00.63(4.4)	1.05(7.1)	2.33(8.7)	1.55(7.1)	1.31(6.5)	0.45(3.80)	1.25(6.4)	1.40 (3.03)	1.40(6.7)	1.05(7.10)	1.40 (6.85)
N-257-9-1	00.95(5.5)	1.36(7.8)	2.70(9.4)	1.10(16.0)	0.85(5.2)	0.45(3.80)	1.65(7.0)	2.95 (9.80)	0.85(5.2)	1.00(5.70)	0.90 (5.51)
Pusa W. Flat	00.32(3.1)	0.82(5.1)	1.05(5.0)	0.81(5.1)	0.15(1.8)	0.27(2.81)	0.76(4.9)	1.00 (5.80)	0.71(4.9)	0.45(3.80)	0.40 (2.92)
PKV W. Local	00.31(3.1)	0.81(5.1)	1.45(6.9)	0.63(4.4)	0.15(1.8)	0.20(2.50)	0.85(5.2)	2.10 (8.30)	0.55(4.2)	0.45(3.80)	0.40 (2.82)
Long day type											
Brown Spanish	01.55(7.1)	2.65(9.3)	5.13(10.0)	--- (0.56)	--- (0.56)	1.45(6.90)	2.40(9.0)	6.05 (14.20)	--- (0.56)	--- (0.56)	Nil (0.56)
Early L.B.	01.49(7.0)	2.16(8.4)	5.16(13.1)	--- (0.56)	--- (0.56)	1.35(6.60)	2.00(8.2)	6.05 (14.20)	--- (0.56)	--- (0.56)	Nil (0.56)
Cream Gold	01.36(7.9)	3.55(10.8)	4.85(12.7)	--- (0.56)	--- (0.56)	1.50(7.10)	3.40(10.7)	5.50 (13.60)	--- (0.56)	--- (0.56)	Nil (0.56)
S.E. ±	0.13	0.10	0.12	0.09	0.10	0.16	0.14	0.14	0.15	0.13	0.07
C.D. at 5 %	0.39	0.32	0.37	0.29	0.33	0.49	0.43	0.42	0.46	0.40	0.20

* Figures in the parenthesis are arcsin values and statistics applies to them.

During the year 1987, the rotting losses recorded by Cream Gold (7.1 %) were highest at first 30 days, but they were statistically similar to Early Lockyer Brown and Brown Spanish.

The lowest intensity of rotting loss in this period by the variety N-2-4-1 to the extent of 1.8 % was found .

At 60 days the variety Cream Gold had highest rotting losses of 10.7 %, the lowest being in the variety V-L-1 (4 %), which was statistically similar to the varieties Chikalthana Local and Nasik Red . Both the losses were significantly lowest .

The rotting losses at 90 days of storage had more or less similar trend as that of earlier period. The varieties Brown Spanish and Early Lockyer Brown recorded the highest losses of 14.2 per cent. The lowest rotting were observed in Pusa White Flat (5.8 %). Both these losses were statistically significant.

At 90 days all the long day type varieties recorded 100 % losses and hence for 120 and 150 days only comparison of remaining thirteen varieties have been done.

Rotting losses at 120 days in the year 1986 clearly indicated that the variety Baswant 780, U.D. 102

White, Pusa Ratnar and N-53 recorded the highest losses of 7.1 per cent which were significantly more than remaining nine varieties. The lowest losses during this period were observed in Nasik Red (4.4 %) and PKV-White Local (4.6 %).

At 150 days of storage rotting losses were highest (7.6 %) in the varieties Pusa Ratnar , U.D. 102 White and Baswant 780. Lowest rotting losses for this period were in PKV-White Local and Pusa White Flat (1.8 %).

During the year 1987, highest rotting losses at 120 days were found in the varieties N-53, Chikalthana Local, U.D. 102 White and Pusa Ratnar (7.6 %). The varieties PKV-White Local and Nasik Red had lowest rotting losses (4.2 %). Both these highest and lowest losses were statistically significant.

At 150 days of storage the rotting losses for the year 1987 were highest in variety Baswant 780 (8.2 %). The lowest losses for rotting were observed in PKV-White Local and Pusa White Flat (3.8 %).

When the data for the years 1986 and 1987 were pooled for losses at the end of storage (i.e. 150 days after storage), maximum 7.19 per cent rotting was observed in the bulbs of the variety Baswant-780. The lowest loss was observed in the varieties Pusa White Flat and PKV White local (2.82 %) as is evident from the pooled mean. The

varieties Pusa Ratnar, U.D. 102 White, Chikalthana Local and N-53 also recorded higher rotting loss above 6 per cent. Lowest rotting loss of 4.25 per cent was found in the bulbs of variety N-2-4-1 .

Monthwise rotting percentage showed that there was linear increase in rotting losses upto 90 days, but later on there was gradual decrease. This trend was more or less similar for all the varieties.

4.5.2 Percentage Bulb sprouting

Per cent bulb sprouting during the years 1986 and 1987 has been tabulated in the Table 19.

Careful obsrevation of the data for the year 1986 showed that at 30 days of storage there were no sprouting losses in any variety. At 60 days of storage varieties Cream Gold amd Early Lockyer Brown had maximum sprouting loss of 10.5 per cent which was significantly higher than other fourteen varieties. Significantly lowest loss of one per cent was found in the variety Chikalthana Local.

At 90 days of storage the variety Cream Gold recorded significantly highest loss of 13.6 per cent due to sprouting of bulbs over all the varieties. Significantly lowest sprouting was recorded in the varieties PKV-White Local and Chikalthana Local (2.5 %).

Table 19 Per cent bulb sprouting as affected by various treatments (1986/1987)

Treatment	Percent sprouting (Days after storage)				Percent sprouting (Days after storage)				Pooled mean (end of storage)
	60	90	120	150	60	90	120	150	
		(1986)				(1987)			
Red Varieties									
N-53	0.27(2.0)	0.45(3.8)	0.58(4.2)	2.18(8.4)	0.27(2.85)	0.37(3.38)	0.51(4.05)	2.90(9.88)	2.50(9.15)*
N-2-4-1	0.30(3.1)	0.50(4.0)	0.63(4.4)	1.36(6.6)	0.29(3.[illegible])	0.47(3.68)	0.57(4.27)	1.15(7.88)	1.50(7.02)
Pusa Red	0.40(3.6)	0.65(4.6)	0.86(5.2)	2.00(8.1)	0.33(3.14)	0.51(4.05)	0.59(4.96)	2.70(9.54)	2.40(8.83)
Nasik Red	0.20(2.5)	0.40(3.5)	0.41(3.5)	2.59(9.1)	0.19(2.56)	0.21(2.56)	0.28(2.85)	2.90(9.88)	2.80(9.53)
Pusa Ratnar	0.55(4.2)	1.05(5.8)	1.68(7.3)	2.13(8.4)	0.47(3.84)	0.85(5.20)	1.59(7.15)	2.90(9.88)	2.60(9.15)
R.Selection	0.20(2.5)	0.30(3.1)	0.50(4.0)	2.55(9.1)	0.22(2.56)	0.22(2.56)	0.46(3.84)	3.00(9.97)	2.60(9.18)
B-780	0.20(2.5)	0.30(3.1)	0.63(4.4)	1.63(7.2)	0.24(2.56)	0.27(2.85)	0.70(4.78)	1.70(7.47)	1.70(7.37)
Chikaltham.L.	0.05(1.0)	0.20(2.5)	0.31(3.1)	2.86(9.7)	0.16(2.18)	0.16(1.01)	0.31(3.14)	3.10(10.13)	3.00(9.92)
V-L-1	0.35(3.3)	0.65(4.6)	0.86(5.2)	2.46(8.8)	0.39(3.63)	0.59(4.24)	0.79(4.96)	3.00(10.05)	2.70(9.45)
White Varieties									
U.D. 102 white	0.40(3.6)	0.50(4.0)	0.82(512)	2.55(9.1)	0.43(3.63)	0.47(3.04)	0.80(5.10)	3.00(9.97)	2.60(9.58)
N-257-9-1	0.45(3.8)	1.05(5.8)	1.68(7.3)	2.18(8.4)	0.53(4.05)	0.75(4.96)	1.45(6.91)	2.90(9.93)	2.60(9.18)
Pusa W.Flat	0.15(3.1)	0.45(3.8)	0.63(4.4)	1.68(7.3)	0.27(2.85)	0.48(3.84)	0.65(4.62)	1.90(8.02)	1.80(7.70)
PKV W.Local	0.20(2.5)	0.20(2.5)	0.45(3.8)	2.36(8.8)	0.24(2.56)	0.17(1.81)	0.49(3.84)	2.70(9.45)	2.50(9.13)
Long day type									
Brown Spanish	2.30(8.7)	4.45(12.1)	- (0.56)	-(0.56)	2.40(8.91)	4.00(11.61)	- (0.56)	- (0.56)	- (0.56)
Early L.B.	3.35(10.5)	4.45(12.2)	- (0.56)	-(0.56)	3.40(10.70)	4.00(11.54)	- (0.56)	- (0.56)	- (0.56)
Cream Gold	3.30(10.4)	5.55(13.6)	- (0.56)	-(0.56)	3.50(10.86)	4.40(12.18)	- (0.56)	- (0.56)	- (0.56)
S.E. ±	0.13	0.16	0.15	0.06	0.16	0.14	0.12	0.13	0.062
C.D. at 5 %	0.40	0.48	0.45	0.18	0.48	0.44	0.39	0.42	0.18

* Figures in the parenthesis are arcsin values and statistics applies to them.

At 120 days, in long day types no bulbs were available for observations as cent per cent bulbs were spoiled at 90 days of storage. The varieties N-257-9-1 and Pusa Ratnar registered the highest losses of 7.30 per cent. The lowest sprouting losses were recorded in the varieties Chikalthana Local (3.17 %), PKV-White Local (3.8 %) and Nasik Red (3.8 %).

At 150 days of storage Chikalthana Local recorded the highest loss of 9.7 % which was significantly more than rest of the varieties. Significantly lowest loss of sprouting was observed in the variety N-2-4-1 compared to rest of the varieties.

In the year 1987 also no variety had recorded losses due to sprouting for first thirty days of storage. At 60 days of storage the varieties Early Lockyer Brown and Cream Gold recorded 10.7 and 10.86 per cent sprouting losses which were significantly higher as compared to the losses in other varieties. These two varieties were at par with each other. The lowest sprouting of 2.18 % was found in the variety Chikalthana Local next lowest being in the varieties Ratnar Selection and Baswant-780 with 2.5 % loss.

For sprouting loss at 90 days again Cream Gold had higher value of 12.18 % which was statistically significant to remaining varieties. Significantly lowest

loss of 1.01 % was observed in the ublbs of the variety Chikalthana Local.

At 120 days of storage bulbs of long day types were totally spoiled. However the varieties Pusa Ratnar and N-257-9-1 had highest sprouting loss of 7.15 and 6.19 per cent respectively. The lowest spourting loss was observed in the variety Pusa Ratnar (2.85 %). Both these varieties had significantly lower losses over other varieties.

At 150 days of storage many varieties recorded highest spouting loss, remaining at par to each other with very narrow range. The highest loss was in the variety Chikalthana Local (10.13 %) which was at par to other seven varieties. Baswant 780 and N-2-4-1 had the lowest sprouting loss of 7.47 and 7.88 per cent respectively in red types. Among white varieties, Pusa White Flat with 8.02 % sprouting had lower values. These two varieties remaining statistically at per to each other recorded significantly lowest losses over other varieties.

Pooled Result :

The pooled data indicated that at the end of storage the variety Chikalthana Local with 9.92 % sprouting loss was at the top. This was significantly higher that the sprouting loss in other varieties. The lowest loss of 7.02 % was observed in the variety N-2-4-1, which was significantly lower than other fifteen

varieties. The pooled data mean indicated that other varieties with low sprouting loss were Pusa White Flat (7.70 %) Baswant 780 (7.37 %) and Pusa Red (8.83 %). The rest of the varieties had sprouting losses to the tune of nine per cent or more.

The monthly sprouting data indicated that in none of the variety there was sprouting upto 30 days but when once sprouting started it went on increasing as storage period advanced. This was more or less similar for all the varieties.

4.5.3 Percentage physiological loss in weight (PLW)

The physiological loss in weight during the years 1986 and 1987 are given in Table 20.

Perusal of the data for PLW loss in the year 1986 clearly indicated that at 30 days of storage the variety Cream Gold with 26.20 per cent PLW had significantly highest loss in the weight. Significantly lowest was recorded by the variety N-2-4-1 (15.8 %).

At 60 days of storage highest PLW was recorded by the vareity Brown Spanish (35.7 %), here again the variety N-2-4-1 had the lowest PLW loss (8.60 %). Both the varieties recorded significantly more and less PLW loss over other varieties.

Table 20 Per cent physiological loss in weight (PLW) as affected by different treatments (1986/1987)

Treatment	Percent PLW (Days after storage)					(Days after storage) Percent PLW					Pooled mean (end of storage)
	30	60	90	120	150	30	60	90	120	150	
			(1986)					(1987)			
Red Varieties											
N-53	11.53(19.8)	6.22(14.5)	8.55(17.0)	23.58(29.0)	32.08(34.4)	12.2(20.4)	7.80(16.1)	9.40(17.9)	24.1(29.4)	30.1(33.3)	31.00(33.84)*
N-2-4-1	08.45(15.8)	2.25(8.6)	3.13(10.1)	21.25(27.4)	31.85(34.8)	08.6(17.0)	3.20(10.3)	4.00(11.6)	23.3(28.8)	26.1(32.0)	30.00(33.18)
Pusa Red	08.68(17.1)	5.95(14.1)	6.08(14.2)	24.33(29.5)	31.18(33.9)	09.2(17.5)	7.60(16.0)	7.70(16.2)	26.0(20.6)	29.2(32.7)	30.20(33.33)
Nasik Red	08.91(17.1)	6.50(14.7)	7.63(16.0)	23.30(28.6)	31.00(33.8)	10.3(18.7)	8.00(16.4)	9.00(16.8)	24.5(29.6)	28.0(31.9)	29.40(32.88)
Pusa Ratnar	10.90(19.2)	6.58(14.8)	7.26(15.6)	22.55(28.3)	36.30(37.0)	11.9(20.2)	8.00(16.3)	8.20(16.5)	24.5(29.7)	32.6(34.8)	34.40(35.93)
R.Selection	09.76(18.1)	5.90(14.0)	7.08(15.3)	23.90(29.2)	30.40(33.4)	11.1(19.4)	6.90(15.2)	8.10(16.5)	26.0(30.6)	29.7(33.0)	30.10(33.24)
B-780	09.73(18.1)	6.45(14.7)	6.76(15.0)	22.95(28.6)	35.31(36.4)	11.0(19.4)	7.50(15.9)	7.70(15.9)	25.4(30.2)	31.6(34.2)	33.50(35.34)
Chika.thanol	09.95(18.3)	6.08(14.2)	7.75(16.1)	26.30(30.8)	30.40(33.4)	11.9(20.2)	7.50(15.9)	9.50(07.5)	28.1(32.0)	29.2(32.7)	29.90(33.11)
V-L-1	10.63(19.0)	5.63(13.7)	8.86(16.7)	23.63(29.0)	30.20(33.3)	12.0(20.2)	7.90(16.3)	9.50(17.5)	25.4(30.2)	28.6(32.6)	29.60(32.97)
White Varieties											
V.S. 1/2 white	10.75(19.1)	5.32(13.3)	7.16(16.0)	25.53(30.3)	35.18(36.3)	10.9(19.8)	7.00(15.3)	8.00(15.8)	27.6(31.6)	32.5(34.7)	33.80(35.50)
N-257-9-1	10.64(18.4)	6.68(14.9)	7.10(15.4)	23.40(28.7)	36.05(36.9)	11.5(19.8)	7.90(16.3)	8.00(16.4)	25.5(30.3)	34.0(35.7)	35.10(36.30)
Pusa W.Flat	09.06(17.5)	4.55(12.3)	7.95(16.3)	23.85(28.7)	30.08(33.2)	10.6(19.1)	5.05(13.4)	7.40(15.7)	25.1(20.0)	28.1(32.0)	29.10(32.62)
PKV-White L.	08.55(17.1)	5.31(13.3)	5.45(13.5)	24.40(29.6)	31.05(33.8)	10.4(18.4)	6.30(14.5)	6.40(14.6)	25.3(30.1)	30.3(33.2)	30.50(33.53)
Long day type											
Brown Spanish	17.55(24.7)	34.15(35.7)	33.45(35.3)	00.00(0.56)	00.00(0.56)	19.8(26.4)	31.0(34.2)	31.4(34.11)	00.0(0.56)	00.0(0.56)	Nil (00.56)
Early L.B.	17.59(24.7)	31.50(34.1)	35.08(36.3)	00.00(0.56)	00.00(0.56)	19.0(25.8)	30.6(33.5)	31.9(34.40)	00.0(0.56)	00.0(0.56)	Nil (00.56)
Cream Gold	19.59(26.2)	32.88(34.9)	30.08(33.2)	00.00(0.56)	00.00(0.56)	20.0(26.6)	30.0(33.2)	30.8(33.80)	00.0(0.56)	00.0(0.56)	Nil (00.56)
S.E. ±	0.10	0.09	0.16	0.07	0.11	0.11	0.08	0.19	0.05	0.09	0.06
C.D. at 5 %	0.33	0.27	0.50	0.21	0.33	0.34	0.26	0.60	0.15	0.29	0.17

* Figures in the parenthesis are arcsin values and statistics applies to them.

With 36.3 per cent PLW at 90 days of storage the vareity Early L. brown recorded significantly highest loss over other fifteen varieties. The variety N-2-4-1 with 10.1 percentage PLW was again at the lowest level.

As it is evident from earlier results long day types went out of race by recording cent per cent losses at 90 days only. The variety V L - 1 Local recorded the highest loss of 30.8 per cent and the variety N-2-4-1 again registered lowest PLW of 27.40 per cent which was significantly lowest over rest of the varieties.

At 150 days of storage the PLW observations indicated that the varieties Pusa Ratnar (37%) and N-257-9-1 remained statistically similar and recorded significantly higher PLW over remaining varieties.

At 150 days, however, the variety N-2-4-1 was not in picture for lowest PLW, but the varieties Pusa White Flat (33.2 %), Ratnar Selection (33.4 %), Chikalthana Local (33.4 %) and V-L-1 (33.33 %) registered significantly lowest PLW.

Data regarding PLW for the year 1987 clearly indicated that at 30 days of storage the variety Cream Gold had highest loss of 26.60 per cent which was statistically at par to the variety Brown Spanish with 26.4 % PLW. Both these varieties recorded significantly higher PLW over rest of the varieties.

Lowest PLW loss was observed in the variety N-2-4-1 (17.00%) being significantly lowest compared to other varieties.

Observations regarding PLW loss at 60 days indicated that all long day type varieties had high PLW, the highest being in the variety Brown spanish (34.20 %). The other two varieties were statistically at par to this one. Lowest PLW was again recorded by the variety N-2-4-1 (10.3 %) which was significantly lowest values for PLW loss over other varieties.

At 120 days, as seen in the year 1986, during the year 1987 also long day type varieties were no more as they had already recorded 100 % losses at 90 days only. The variety Chikalthana Local with 32.00 per cent PLW recorded highest loss and for lowest loss of PLW again the variety N-2-4-1 with 28.80 per cent was there. Both these losses were significantly superior or low over other varieties.

The data in respect of 150 days showed that the variety N-257-9-1 had highest PLW (35.70%) than remaining varieties. The variety N-2-4-1 was consistantly having lowest loss as observed here also with 32.60 per cent PLW.

Pooled Result:

The pooled data mean for losses at the end of storage indicated that the variety N-257-9-1 had highest loss of 36.30 per cent which was significantly higher than rest of the varieties.

The pooled mean for losses at the end of storage revealed that the variety Pusa White Flat had lowest loss of 32.62 per cent at the end of storage, this being significantly lower than remaining varieties. Other varieties with low PLW were VL-1, Nasik Red and Chikalthana local.

The trend of monthly PLW losses clearly showed that, PLW (%) increased upto 30 days, then decreased at 60 days and reamined constant upto 90 days of storage. Per cent PLW again increased at 120 days and it was highest at 150 days, this was more or less similar for all the varieties.

4.5.4 Per cent total loss in weight

The data for the total loss of weight due to rotting, sprouting and PLW for the years 1986 and 1987 are given in Table 21.

The data for the year 1986 as regards to total loss indicated that at 30 days of storage the variety Cream Gold with 26.80 per cent losses and the variety

Table 21 Per cent total loss weight in storage(1986/1987)

Treatment	Percent Total loss (Days after storage)					Percent Total loss (Days after storage)					Pooled mean (end of storage)
	30	60	90	120	150	30	60	90	120	150	
			(1986)				(1987)				
Red Varieties											
N-53	12.26(20.4)	7.35(15.7)	11.68(19.9)	25.71(30.4)	35.17(36.3)	12.88(21.0)	8.70(17.2)	12.75(20.92)	26.0(30.66)	34.0(35.07)	34.60(36.00)*
N-2-4-1	07.53(15.9)	7.15(15.5)	6.31(14.5)	22.63(28.3)	33.56(36.4)	08.75(17.2)	4.28(11.9)	6.33(14.58)	24.5(29.55)	30.10(33.3)	31.80(34.30)
Pusa Red	09.13(17.5)	7.11(15.4)	7.58(15.9)	25.91(30.5)	33.58(35.4)	09.55(18.0)	8.77(17.2)	8.75(17.20)	27.5(31.66)	32.90(35.0)	33.20(35.20)
Nasik Red	09.31(17.7)	7.33(15.6)	9.11(17.5)	24.00(29.3)	24.15(35.6)	10.90(20.16)	8.90(17.41)	10.60(19.00)	25.4(30.30)	32.0(34.45)	33.10(35.10)
Pusa Ratnar	11.90(20.1)	8.86(17.3)	10.00(18.4)	25.68(30.8)	39.58(35.9)	12.90(21.04)	9.90(18.29)	11.10(19.46)	27.5(31.56)	37.8(37.49)	38.30(38.23)
R.Selection	10.13(18.5)	6.81(15.1)	8.48(16.9)	25.31(30.2)	34.08(35.7)	11.31(19.64)	7.95(16.31)	10.37(18.76)	27.1(31.40)	33.8(35.12)	33.60(35.47)
S-780	10.28(18.6)	7.38(15.7)	10.26(18.5)	25.23(30.1)	38.05(38.0)	11.45(19.77)	8.37(16.79)	10.97(19.82)	27.1(31.40)	35.4(36.54)	36.70(37.31)
Th.Kaithamalli	10.53(18.9)	7.59(16.0)	9.36(17.8)	27.98(31.8)	33.86(35.5)	12.30(20.53)	8.79(17.41)	11.23(19.55)	29.3(33.80)	33.9(35.6)	34.10(35.59)
V-1-1	11.18(19.5)	6.28(14.4)	10.38(17.2)	24.95(30.2)	38.16(35.1)	12.35(20.57)	8.79(17.30)	12.28(20.48)	26.9(32.24)	32.6(34.67)	33.30(34.91)
White Varieties											
S.B. 132 white	11.31(19.6)	7.12(15.4)	10.58(18.9)	28.00(31.9)	39.10(38.7)	11.45(19.77)	8.90(17.36)	10.47(18.86)	29.9(33.15)	36.6(37.28)	37.30(37.96)
S-257-3-1	11.19(19.4)	8.95(17.4)	11.40(19.7)	26.08(30.6)	39.73(39.0)	12.05(20.31)	9.60(17.51)	11.91(20.22)	28.1(32.04)	38.6(38.11)	38.80(38.54)
Pusa W.Flat	10.49(17.9)	8.61(13.6)	9.45(17.3)	24.62(29.7)	31.59(34.4)	10.97(19.32)	6.45(14.17)	9.98(18.30)	26.[illegible]	34.6(36.5)	[illegible]
PKV-W.Local	08.96(17.4)	6.39(14.5)	7.15(15.5)	25.48(30.3)	33.59(35.4)	10.65(19.04)	7.63(15.99)	[illegible]	26.2(30.32)	33.3(35.27)	33.60(35.35)
Long day type											
Brown Spanish	19.30(25.9)	38.[illegible]	38.4[illegible]	42.98(40.9)	-- - [illegible]	---- [illegible]	31.[illegible]	36.0(36.90)	42.10(40.45)	----(0.56)	----(0.56)	Nil (00.56)
Co.2 S.B.	[illegible]	38.71(39.4)	41.45(39.7)	---- (0.56)	---- (0.56)	20.20(26.74)	36.0(36.90)	42.10(40.48)	----(0.56)	----(0.56)	Nil (00.56)
T.1.1 S.B.	20.41(26.9)	38.50(39.55	39.73(39.0)	---- (0.56)	---- (0.56)	21.50(27.65)	37.3(37.64)	40.10(39.32)	----(0.56)	----(0.56)	Nil [illegible]
S.E. ±	0.11	0.12	0.39	0.76	.5	0.20	0.11	0.06	0.25	0.04	0.023
C.D. at 5 %	0.3-	0.36	1.19	1.13	0.16	0.62	0.35	0.20	0.78	0.13	0.80

* Figures in the parenth.s.s are arcsin values and statistics applies to them.

N-2-4-1 with 15.90 per cent losses recorded highest and lowest loss respectively. Thus the veriety N-2-4-1 recorded significantly lowest losses.

For total loss at 60 days the varieties Early Lockyer Brown and Cream Gold had highest total loss of about 39.50 per cent. On the other hand, significantly lowest loss was observed in the variety V-L-1 (14.4%). The data had statistical significance over other varieties.

At 90 days all the long day type varieties registered significantly highest total loss (39 to 40%). Significantly lowest loss of 14.50 per cent was observed in the bulbs of the variety N-2-4-1, followed by 15.50% total loss in the bulbs of the variety PKV-White Local.

It is evident from the data that long day varieties had 100% losses up to 90 days only. At 120 days the variety U.D.102 White recorded significantly highest loss of 31.90% which was statistically at par to 31.8% loss observed in the variety Chikalthana Local. These two varities were statistically superior over remaining varieties.

Among all varieties significantly lowest loss of 28.3% was observed in the variety N-4-2-1 followed by Nasik Red (29.3%), both these varieties were statistically at par to each other.

During the year 1987, data for 30 day observations clearly showed that the variety Cream Gold recorded significantly highest total loss of 27.65 per cent. However, the losses in this variety were at par to the variety Brown Spanish and was significantly superior over other varieties. Significantly lowest total loss was found in the variety N-2-4-1 (17.20 %).

At 60 days the variety Cream Gold recorded the highest total loss of 37.64 per cent. However the lowest loss was again recorded in the variety N-2-4-1 (11.90 %). This was significantly lowest amongst remaining varieties.

The perusal of the data for 90 days indicated that the varieties Brown Spanish and Early Lockyer Brown had recorded 40.45 and 40.48 total loss over all other varieties. The lowest loss was again recorded by the varieties N-2-4-1 (14.58 %) which was statistically lower than remaining varieties.

As it is evident from the data at 120 days of storage long day type varieties were totally lost , having recorded 100 % loss earlier. Here highest and lowest loss in weight was recorded by the variety Chikalthana Local and N-2-4-1 with 33.80 and 29.55 respectively. The data had statistical significance.

The data for 150 days of storage revealed that the variety N-257-91 had significantly highest total loss at this stage with 38.41 per cent loss. Significantly lowest loss (33.30 %) was observed in the bulbs of the variety N-2-4-1.

Pooled Result :

The pooled data chearly indicated that the variety Pusa Ratnar had significantly highest (38.23 %) total loss at the end of storage over rest of the varieties. Lowest total loss of bulbs i.e. 34.30 per cent was found in the variety N-2-4-1. which was statistically at par to the total loss recored by varieties Pusa white flat (34.47 %), N-257-9-1 V-L-1 (34.58 %) -1(34.91 %) and Nasik Red (35.10 %).

The monthwise total loss depicted that high total loss at 30 days decreased at 60 days but there after had a linear increase upto 150 days. This was more or less similar to all varieties.

4.6 Correlation studies

4.6.1 Gentoypic correlation co-efficients for different characteristics of onion to bulb yield (kg).

The genotypic correlation co-efficient between different pairs of characters are presented in Table 22.

Persual of the data revealed that there existed correlation between five characterists studied to bulb yield. Eqatorial diameter, average bulb weight, plant height and root plate diameter had positive genotypic correlation with yield. The Polar diameter and number of bulbs in one kg, however, had highly negative correlation to yield.

For correlation amongst differenct characteristics also had highly positive and negative correlations. Positive correlations were found between bulb diameter (equatorial) and root plate diameter; plant height and average bulb weight. Number of bulbs/kg exhibited negative correlation with root plate diameter. Polar diameter was negatively correlated to root plate and plant height. The bulb neck also showed negative co-rrelation with, plant height and root plate diameter.

Number of bulbs in one kilo had negative correlation between average bulb weight, plant height and root plate diameter.

Table 23 : Correlation of different morphological characteristics to different storage losses

	Maturity (Days)	Bulb dia (E)	Bulb dia (P)	Neck thick.	Av.bulb wt	% Twin	% Rotting	% Sprouting	% PLW	% Total loss
Maturity(days)	1.000	-0.382*	0.495**	0.404*	-0.223	0.618**	0.191	0.544**	0.025	0.293
Bulb dia (E)		1.000	-0.628**	-0.439*	0.706**	-0.159	-0.730**	-0.768**	-0.141	-0.665**
Bulb dia (P)			1.000	0.295	-0.303	0.180	0.495**	0.517**	0.293	0.497**
Neck thick.				1.000	-0.308	0.126	0.355	0.479**	0.082	0.482**
Av.bulb wt.					1.000	-0.065	-0.528**	-0.502**	-0.110	-0.518**
% Twin						1.000	-0.010	0.282	0.132	0.101

Average bulb weight has positive correlation with root plate diameter, suggesting that higher the root plate diameter higher is bulb weight. Plant height was positively co-rrelated to root plate diameter.

4.6.2 Genotypic correlation co-efficient for different characteristics of onion to different storage losses.

4.6.2.1 Correlations of morphological characters to storage losses

Different characteristics were correlated to different types of losses• by utilizing pooled data. The data presented in Table 23 showed that a good correlation exists in between morophological/ biochemical characteristics and different storage losses in onion.

Morophological characteristics:

Rotting losses had a positive correlation with polar bulb diameter and negative correlation between equatorial diameter and average bulb weight.

As regards sprouting lossess all the characters under study except per cent twins snowed either positive or negative correlation. Polar diameter, duration in days and neck thickness exhibited positive co-rrelation to sprouting losses . However, there was negative correlation between sprouting losses to equatorial bulb

Table 22 : Genotypic correlation co-efficients for different characters of onion

	No.of leaves	Bulb dia (E)	Bulb dia (P)	No.of bulbs per kg.	Av.bulb wt.	Plant ht.	% Twins	Root plate	Yield
No.of leaves/plant	1.000	0.559	-0.657*	-0.531	0.314	0.327	0.067	0.402	0.431*
Bulb dia (E)		1.000	-0.602*	-0.982**	0.894**	0.838**	-0.185	0.929**	0.926**
Bulb dia(P)			1.000	0.601*	-0.305	-0.729**	0.207	-0.680**	-0.569
No.of bulbs/kg				1.000	-0.907**	-0.837**	0.199	-0.938**	-0.938**
Av. bulb wt.					1.000	0.621*	-0.039	0.823**	0.899**
Plant ht.						1.000	-0.370	0.886**	0.823**
% Twins							1.000	-0.283	-0.208
Root plate dia								1.000	0.898**
Yield									1.000

Table 24 : Correlation of biochemical constituents to different storage losses

	% DM (harvest)	% DM (after)	% TSS (harvest)	% TSS (after)	% Red sug (harvest)	%Red sug (after)	%Non Red (after)	%Non R sug(after)	%Tot sug (harvest)	%(Tot sug) (after)	% Rott	% Spro	% PLW	% Total
% DM(harvest)	1.000	0.350**	0.708**	0.736**	-0.042	-0.821**	-0.772**	-0.514**	-0.759**	-0.792**	-0.483**	-0.531**	-0.241	-0.428**
% DM(after)		1.000	0.741**	0.752**	0.070	-0.833**	-0.644**	-0.532**	-0.763**	-0.713**	-0.554**	-0.579**	-0.324	-0.486**
% TSS(harvest)			1.000	0.952**	-0.038	-0.872**	-0.822**	-0.658**	-0.864**	-0.855**	-0.849**	-0.782**	-0.225	-0.773**
% TSS(after)				1.000	0.033	-0.898**	-0.806**	-0.660**	-0.892**	-0.888**	-0.824**	-0.788**	-0.178	-0.744**
% Red Sug(har)					1.000	0.017	0.002	-0.081	-0.036	-0.045	-0.161	-0.077	-0.032	-0.115
% Red Sug(after)						1.000	0.827**	0.660**	0.942**	0.935**	0.694**	0.776**	0.242	0.671**
% Non Reds(after)							1.000	0.636**	0.801**	0.826**	0.651**	0.734**	0.187	0.641**
% Non R.sug(after)								1.000	0.707**	0.717**	0.476**	0.498**	0.169	0.384*
% Tot sug(harvest)									1.000	0.937**	0.704**	0.830**	0.233	0.709**
% Tot sug(after)										1.000	0.692**	0.773**	0.244	0.643**
% Rotting											1.000	0.749**	0.311	0.885**
% strutting												1.000	0.209	0.880**
% PLW													1.000	0.290
% Total														

diameter and average bulb weight. There was no correlation of different morphological characters to physiological loss in weight. The polar diameter and neck thickness were positively correlated to total losses in storage. The total lossess in storage were negatively correlated to equatorial bulb diameter and average bulb weight.

4.6.2.2 Correlations of biochemical constituents to storage losses

High magnitude of different bio-chemical constituents and different storage losses were found. For rotting, sprouting and total losses following constituents of bulb showed correlations. The reducing sugar only after harvest, non-reducing sugar and total sugars both at harvest and one month after storage showed positive correlations to rotting, sprouting and total losses. Dry matter and T.S.S. both at and one month after harvest were negatively correlated to rotting, sprouting and total losses during storage. None of the bio-chemical constituents exhibited any correlation to losses due to physiological means.

CHAPTER-5

DISCUSSION

Chapter-5

DISCUSSION

Data collected in respect of various charactrastics of onion for yield, quality and storability studies during present investigation are presented in the previous chapter of the result and disscussed in this chapter.

In this investigation, 16 varities of different groups were studied for their performance in respect of growth, yield, bulb characters and storage losses. On the basis of the data collected co-relation between various characters contributing yield and storage losses were worked out and presented in the previous chapter.

In present study among sixteen varities there were two groups of onion types viz. short day and long day types. There were thirteen short day type and three long day type varieties. Among short day group there were nine varieties producing red bulbs and four varities producing white bulbs.

The genetic constitution of the varieties differed markedly as the origin of these varieties is from different sources. Therefore, in this chapter the results obtained are disscussed taking into consideration group of variety belonging to either short day or long day and varieties with red and white bulbs. Disscussion is presented under suitable heads as per the nature of the observation.

5.1 Vegetative growth

In onion vegetative growth comprises of height of plant and number of leaves. In present investigation, the data in respect of height of plant for the years 1986, 1987 and pooled results showed significant differences among various varieties.

In the year 1986 the variety N-53 recorded significantly more height over all varieties, while the variety Pusa Ratnar recorded more height in the year 1987 and in the pooled results as well. Pusa Ratnar had significantly more height than rest of the varieties. While comparison is made between short day and long day types it is clear that long day type had significantly less height than short day types.

With regard to the number of leaves per plant in the year 1986, the variety N-257-9-1 produced significantly more number of leaves over rest of the varieties, while the variety V-L-1 produced significantly more number of leaves in the year 1987 and in pooled result too. These results are similar to the findings reported by Gaushal (1986), where he observed more number of leaves in the variety N-257-9-1. It is clear that the short day types are vigorous in growth in term of height of plant and number of leaves compared to long day type. It is apparent since onion growth is greatly influenced by day length and temperature.

Requirement of long day types can not be fulfilled under Aurangabad conditions, affecting adversely the vegetative growth of long day type . Hence all short day type varieties produced significantly more height and number of leaves than long day types.

In onion before bulbing is initiated there should be sufficient vegetative growth to support proper bulb development. In initial stage for proper vegetative growth low temperatures (13 to 21^{o}C) with short day condition are favourable while for bulb initiation and during it's development long day conditions with higher temperatures are required. In present investigation short day types had favourable day length and temperature conditions for vegetative growth, therefore had optimum vegetative growth, while long day types did not receive optimum requirements of day length and temperature. At Aurangabad temperature during February and March ranged between 14^{o} to 21^{o}C were favourable for vegetative growth (Appendix IV).

Height of plant and number of leaves produced by variety found obviously differed as genetic make-up of varieties also varies. Varieties studied in present investigation are evolved from different places. Among red varieties, the variety Pusa Ratnar and Ratnar Selection had significantly more height, while significantly more number of leaves were produced in

Ratnar selection. Among white onion varieties the variety PKV-White Local and N-257-9-1 were superior in number of leaves.

These results are in agreement to the findings reported by Singh and Singh (1974). However, Lalan Singh (1986) reported that the variety VL-1 produced superior vegetative growth at Nasik.

Differences due to time of planting and variety are reported by various research workers. Moursi et al (1975) reported reduced plant height in Gaize variety. Huerres (1979) achieved greatest plant height in red Creole variety transplanted in November. Nagre (1984) and Bhamburkar (1984) reported more number of leaves in onions when transplanted in December. Gaushal (1986) observed maximum number of leaves when transplanted in December for the variety N-257-9-1.

This variation in vegetative growth due to varietal differences having different genetic make up is also seen amongst the short and long day group.

Thamburaj and Chaugule (1984) observed high vegetative growth of Spanish Brown variety under Nilgiri conditions in contrast to those observed in present investigation. This might be due to differences in climatic conditions of Aurangabad and Nilgiri. Pandian and Muthukrishnan (1982) and Sidhu et al (1986) observed

positive correlation between plant height and number of leaves to bulb yield, thereby, emphasising their importance. Similar trend was observed in present investigation also.

5.2 Root Plate Diameter :

Observations regarding rootplate diameter clearly indicated that the varieties U.D. 102 White, Baswant-780, N-53, Pusa White Flat, Chikalthana Local and Ratnar Selection had significantly higher root plate diameter.

All Long day types had smaller root plate diameter compared to short day types. It is obvious that difference in root plate diameter due to varieties belonging to different group is apparent.

5.3 Per cent Twins and Bolters :

In onion quality of bulb is affected by production of twins and bolters. Production of twins and boltes is affected by various factors viz time of planting, cultural practices and the variety grown.

Pooled results in respect of twins indicated that the variety Ratnar Selection produced maximum twin bulbs (29.76%) which was at par to Pusa Ratnar. However, significantly lowest twin bulbs were observed in the variety Baswant-780. While U.D.-102 White among white

types recorded significantly more number of twins. The variety N-257-9-1 recorded significantly lowest twin bulbs. Amongst long day types medium percentage of twin bulbs were observed.

Bolting is premature seed stalk formation in a bulb crop. Jones and Mann (1963) reported that yield and quality of bulb is impaired by bolting in onion. Pawar et al (1987) found 3.5 and 11.5 per cent bolting in Baswanth-780 and N-53 varieties respectively. Data regarding bolting percentage revealed that negligible bolting was observed in four varieties, while there was no bolting in the remaining twelve. All the long day types did not record any bolting. The variety Chikalthana Local had 1.76 per cent and U.D. 102 White had 1.48 per cent bolters. Varietal differences in production of twin bulbs is obvious as they are derived from different genetic sources (Ahmed and Ahmed, 1976; Warid and El-Shafie, 1976; Stino et al 1960).

Low number of bolters have been observed in late planting i.e. December onward (Nagre, 1984). The bolting was very low in general in this experiment which is in agreement to the findings of Yawalkar (1969), who reported that very low temperatures at the begining of the growth favours bolting and such temperatures were not existing at Aurangabad for both the years under study.

5.4 Duration in days for maturity :

There were significant differences in days required for attaining maturity of the crop. In general, long day types required more number of days for attaining maturity, while significantly lowest days for maturity were required for the variety Baswant-780.

It might be due to the requirement of long day types in respect of photoperiod and temperature. Long day type needs more photoperiod and temperature than short day types for attaining maturity. Hence, long day type took 125 days while short day types required 99 days to 117 days for attaining maturity due to differences in genetic make-up of the varieties. Zeceva and Minkovi (1965) observed that varieties with long day requirement grew vigorously with attaining bulb maturity. In this study also duration of long day types extended but bulbs were very small.

Duration of 140 to 145 days was observed by Kadar et al (1979) in Udaipur 101, Bellary Red and N-53 varieties. Jaiswal et al (1984) reported that the variety N-53 required lower days for maturity compared to U.D.-102 White thereby , recording variations in days for maturity. As per Thomposon and Smith (1938) onion grown as summer crop has early maturity due to extremely high temperature adversely affecting yield. Yawalkar

(1969) reported that January planted crop yields between 75-100 q/ha. The findings are similar for all short day types, the yields being lower than rabi season.

5.5 Yield :

In onion, bulbs are commercial products. The data in respect of yield per plot and per hectare revealed that the variety N-2-4-1 produced significantly higher yield which was statistically similar to Pusa White Flat and PKV-White Local and significantly more than rest of the varieties. However, all long day types produced significantly lowest yield. Among red types the variety N-2-4-1 produced significantly more yield, while among white types, Pusa White Flat produced higher yield. Variation in performance of onion is obvious since all varieties are bred by different research institute on the basis of their performance in respective places of origin.

It is obvious that the yield of the long day type varieties was significantly lowest on account of unfavorable climatic condition in which they were grown. The varieties require long photoperiod and higher temperature. Requirement with regard to day length and temperature was not satisfied because of which the vegetative growth, was low resulting in poor nourishment of bulbs and thereby yield reduction. In favourable

agro-climatic conditions long day variety Spanish Brown recorded yield as high as 27 MT/ha. as against 3 MT for Brown Spanish variety at Aurangabad.

The bulb size in terms of weight and size of the variety N-2-4-1 was more thereby resulting into higher yield.

Yield of the variety depends on climatic factors in which they are grown, besides cultural practices. For kharif season Baswant-780 (390 q/ha.) and N-53 (361 q/ha.) yield was recorded by Pawar et al (1987) . It is also dependent on the genetic purity of the seed. This variation in performance of a particular variety in region differs. It is supported by the findings of various workers. Shinde (1986) highlighted the varietal characteristics of different varieties in detail. The performance of the variety at a given location reported by various researchers is different. Singh and Singh (1974) reported that the variety Hissar-2 exhibited higher yield in Hariyana. Same variety performed well under U.P. condition as reported by jaiswal et al (1984). Under Delhi condition Bhagchandani et al (1980) found that the cultivars Pusa White Flat and Pusa White Round recorded higher yield. Bhambukar (1984) concluded that the variety Pusa White Flat recorded higher yield. While in Maharashtra the variety N-2-4-1 has been identified as superior variety among

red and N-257-9-1 among white one. The varieties N-53 and Baswant-780 were found suitable for kharif season in Maharashtra (Pawar et al 1987.) Bhagchandani et al (1977) reported that longday cultivars like Brown Spanish, Cream Gold and Early Lockyer Brown were suitable for hilly region.

The difference in varietal production of onion bulb yield may be due to differences in genetic make-up of the varieties. Since all the varieties are developed by various research organizations, the original source for development and methods of breeding may differ, therefore, at respective places these varieties may have performed well and emerged superior and on the basis of performance these varieties were released. However, all these varieties were grown in different soil and climatic condition at respective places and therefore at Aurangabad, the differences in yield were observed in present investigations. On the basis of two years studies it can be said that among red variety, the variety N-2-4-1 and amongst White Pusa White Flat were high yielding varieties in rabi season of Aurangabad condition.

Correlation studies for yield contributing characters have been reported by many workers. Thamburaj et al (1976), Netrapal (1980), Patil (1960) and Patil (1984) found positive correlation between average bulb

weight, bulbs size and lower number of per kg to yield. The findings of present investigation are in agreement with the findings of the earlier research workers.

5.6. Bulb Characteristics :

5.6.1 Weight of the bulb :

Average weight of bulb indicate the ability of the onion to produce the yield. Data clearly indicated that the variety Pusa White Flat emerged superior in production of heavier bulbs. The long day types produced significantly lighter onion bulbs.

It is apparent since long day type varieties did not receive optimum day length and temperature requirement for vegetative growth and bulb development. Contrary to the findings by present investigation results reported by Jaiswal et al (1984), showed that no significant differences were observed among different varieties with regard to bulb weight. Kadar and Rangaswami (1979) found that Bellary Red (76 g), Udaipur 101 (70 g) and N-53 (82 g) with different bulb weight produced 20.84, 20.57 and 20.55 t/ha yield respectively. Pawar (1987) reported average bulb weight of 122 g for Baswant-780 a new kharif variety as compared to 98 g in N-53.

5.6.2 Bulb size :

With regard to size of bulb as indicated by equatorial and polar diameter, in present investigation it was observed that the varieties U.D.-102 White, Chikalthana Local, N-2-4-1 and Pusa White Flat had higher equatorial and polar diameter. Among red variety the variety N-2-4-1 produced bigger bulbs while among white varieties U.D.-102 White and Pusa White Flat had more equatorial diameter. Most of the varieties mentioned are stable in yield at many places.

Positive correlation of bulbs size to storage losses due to sprouting has been found by different workers (Patil, 1960; Karmarkar and Joshi, 1947; Singh and Joshi, 1978). Big size bulb keep well in storage (Patil, 1960; Bielenka et al. 1981). Size of bulb for high yield has been found to be contributing character (Thamburaj et al 1976; Muthukrishnan, 1978). In present study also varieties with big sized bulbs had higher yield. The finding for both bulb weight and size revealed that, long day types which had poor vegetative growth were poor yielder. Kato (1966) concluded that scale leaf formation and thickening of basal part of leaf sheath were prerequisites for bulb formation and development. As poor vegetative growth was recorded, the varieties had low bulb weight and size in the present study.

5.6.3 Neck thickness :

Neck thickness is an important parameter indicating the bulb quality. Amongst short day type Pusa White Flat had significantly lowest neck thickness for the year 1986, 1987 and in pooled result as well. More neck thickness was recorded in long day type variety i.e. Cream Gold. In present investigation long day type recorded higher neck thickness and had highest rotting percentage of bulbs, while the variety Pusa Ratnar and Pusa White Flat had lowest rotting loss.

Kapkowa and Umiecka (1970) reported that onion with thin, well dried neck stored well, than those badly dried thick neck. Singh and Swami (1976) reported that onion with small thin neck is preferred in dehydration. Magdum (1981) and Patil (1984) revealed that thin neck trait is fairly reliable for selecting varieties with potential for extended storage life. The results of present study are supported by the findings reported by various research workers.

5.7 Quality Parameters :

Quality of the bulb is indicated by total soluble solids, dry matter content and sugars present in the bulb. In present investigations observations of these parameters were taken.

5.7.1 Per cent Dry Matter and T.S.S. :

Significantly higher dry matter (23.88 %) was observed in the bulbs of the variety Pusa White Flat. Significantly lowest dry matter was observed in the bulbs of long day type and among short day type in the bulbs of the variety N-53. Variability in the dry matter content has been reported by Bajaj et al. (1981) and Padda et al. (1973). In the present investigation also the dry matter content in different varieties varied greatly. However, Muthukhrishnan et al (1973) did not find much difference in dry matter content in different varieties of onion in Tamil Nadu.

Highest T.S.S. at harvest was observed in the bulbs of the varieties PKV-White Local. It was at par with varieties V-L-1, Chikalthana Local and Nasik Red. Significantly lowest T.S.S. was recorded in the long day onion, which was contrary to findings of Thamburaj and Chougule (1984) who observed 14-15 % T.S.S. in long day variety Spanish Brown in Nilgiri hills. The adverse climatic conditions at Aurangabad seems to be one of the contributing factor in reduction of T.S.S. of all long day types.

Varieties with high T.S.S. and more dry matter have been reported to be less susceptible to sprouting (Foskett and Peterson, 1950; Sandhu et al 1975 and Tronickova, 1969). Correlation studies by many

workers revealed that dry matter and T.S.S. were negatively correlated to rotting, sprouting, PLW and total loss in storage.

The data in respect of weighted mean about the content of T.S.S. one month after storage indicated that the variety N-2-4-1 emerged superior over all other varieties under study. The T.S.S. and dry matter content was in general high in storage for almost all varieties. Shekib et al (1986) recorded similar observations, he found that T.S.S. and pyruvic acid content increased in storage of onion bulb.

5.7.2 Per cent Sugars :

Bulbs of the long day type had high reducing sugar percentage, among short day type significantly lowest reducing sugar was observed in the bulbs of the variety PKV-White Local. It was statistically similar to the varieties N-2-4-1, Nasik Red, Pusa Ratnar , Chikalthana Local, UD-102-White and Pusa White Flat, there by exhibiting narrow range in reducing sugar content.

The data for non-reducing sugar showed that bulbs of long day types onion varieties had highest non-reducing sugars (12.7%). Significantly lowest non-reducing sugars were recorded by the variety U.D.102-White (9.7%), which was statistically at par with

varieties N-2-4-1 and Pusa Ratnar. One month after storage long day varieties recorded higher non-reducing sugars. The lowest non-reducing sugars were observed in the bulbs of varieties viz. UD-102-White, Pusa Red, Ratnar Selection, Baswant-780 and Pusa White Flat.

All long day type varieties recorded higher total sugars. Low total sugar percentage was recorded in the bulbs of the varieties N-2-4-1 amongst red and U.D.102 White amongst white one.

Bio-chemical composition of onion bulb plays an important role in selecting a variety for dehydration, fresh consumption and long term storage. Good storage capacity in onion appeared to be associated with high content of T.S.S., dry matter and non-reducing sugars and low proportion of reducing sugars. (Baturin, 1958; Towl and Pospisilova, 1979; Bajaj et al ,1980 and Magdum, 1981). Khurana (1984) found that varieties with high ratio of disaccharides and monosaccharides had good storability Purewal (1954) reported that red cultivars keeps better in storage in comparison with white varieties, this has been found true in the present investigation also for the variety N-2-4-1.

Variation in biochemical composition viz, dry matter content, T.S.S. and sugars is supported by the findings of Purewal (1954) who reported that dry matter

content varied greatly betweer cultivars. Bajaj et al (1981) also reported variation .n dry matter and T.S.S. in various cultivars. Padda et al (1973) reported wide range of variability in T.S.S. percentage. In the present study also there were differences in dry matter, T.S.S. and sugars.

In general all long day types recorded significantly lowest dry matter and T.S.S. Amongst short day type the variety N-53 recorded lowest dry matter, while the variety N-2-4-1 emerged superior in respect of T.S.S. content. The association of the chemical parameters of the bulbs with storage losses has been discussed in succeeding text.

5.8 Storage Losses and correlation studies :

The results for storage losses and correlation studies have been clubbed for discussion of results. In Maharashtra late rabi onion crop, which is harvested in April-May is stored in summer and rainy season for selling in off season when fresh bulbs are not available in the market.

In Maharashtra onion is grown in three well defined seasons, kharif (August-December), early rabi (Rangda) in November-March and rabi during January-May. Maharashtra commands a large area in kharif and rabi season. The kharif production is characterised by

somewhat short day length with moderate temperature. In rabi season the days are comparatively longer and bulb development takes place at a higher temperature. In kharif season full maturity of bulb is probably reached, but due to lack of senescence the vegetative growth continues affecting storage quality. However, in rabi season, full maturity of the bulb is reached and due to senescence and sheath fall (in most cultivars) the storage of bulb is improved. While in kharif crop there is no cessation of growth and senescence does not occur. Further continuous vegetative growth impairs the storage qualities of bulbs possibly because of non-production of growth inhibitor which has been reported primary factor involved in the dormancy process. Kato (1966) suggested that the growth inhibitor is produced in the leaves during bulbing and then translocated in the bulbs during senescence.

In present investigation varietal differences in respect of losses due to rotting, sprouting and physiological weight loss and total losses were observed So far as bulb rotting is concerned it was observed that significantly more rotting losses were observed in the bulbs of the long day types compared to short day types. Cent per cent bulbs were lost due to rotting at 120 days of storage. Lowest rotting was observed in the varieties N-2-4-1 and V-L-1 at 60 days. While at 120 days Nasik Red and PKV-White Local had lowest losses.

Highest losses during this period were found in the varieties Pusa Ratnar, U.D.102 White and Baswant-780.

Pooled result indicated that lowest rotting was observed in the varieties , Pusa White Flat, PKV-White Local and N-2-4-1. Maximun rotting was observed in the variety Baswant-780.

Data with respect to sprouting also indicated that maximum sprouting was observed in Chikalthana Local lowest being in the variety N-2-4-1. Varieties Baswant-780 and Pusa White Flat also had lower sprouting percentage.

In case of PLW highest loss was observed in the variety N-257-9-1, Pusa Ratnar and U.D.102 White. The lowest being in Pusa White Flat, Chikalthana Local and V-L-1. Medium PLW loss was found in the varieties N-2-4-1 and Nasik Red.

Pooled results of total loss indicated that lowest total loss was observed in the variety N-2-4-1. While highest amongst short day types was recorded in the variety Pusa Ratnar followed by U.D.102 white and Baswant-780. Medium losses were observed in bulbs of Pusa Ratnar, V-L-1 and N-257-9-1.

It is clear from above results that in general bulbs of all long day type varieties were lost

during storage compared to short day types, indicating their unsuitability for storage. Amongst red types the variety N-2-4-1 emerged superior for extended storage life. Total losses due to rotting, sprouting and PLW were lowest in this variety followed by Pusa White Flat V-L-1 and N-257-9-1. Amongst white onion varieties medium losses were observed in the variety PKV-White Local and highest in the variety U.D.102 White.

Keeping quality of onion bulb depends upon various factors viz, genetic make of the variety, acclimatization of variety in the region where in continuous selection pressure is applied for desirable characters, season, cultural practices and chemical constitutes mainly T.S.S. and dry matter. The variety N-2-4-1 is recommended for rabi season in Maharashtra since long and is maintained genetically pure. These results are in conformity to those reported by (Patil, 1960; Singh and Joshi, 1975 and Magdum, 1987). Next good keepers were Pusa White Flat and V-L-1.

Patil (1983) in screening studies observed that per cent total loss was significantly and positively correlated both at phenotypic and genotypic levels with neck thickness and bulb diameter (equatorial and polar), physiological loss in weight, sprouting and rotting, while it was negatively correlated with dry matter.

So far as colour of bulb is concerned various research workers revealed that white varieties have poor keeping quality than red varieties this holds good for findings of this experiment, where N-2-4-1 was at the top with lowest losses followed by Pusa White Flat and N-257-9-1 (Patil, 1960; Tronickor,1969 and Sandhu et al 1975). Sprouting losses observed to be more in varieties with low percentage of dry matter and T.S.S. content (Foskatt and Peterson, 1980; Tronickova 1969 and Sandhu et al 1975). Correlation studies conduced by Magdum (1981) revealed that dry matter and T.S.S percentage has negative correlation with total loss in weight, shrinkage (PLW), sprouting and rotting. These results were confirmed by Patil (1983).

Correlation studies showed that there was positive correlation of polar diameter to rotting while equatorial diameter and bulb weight was negatively correlated with rotting. For sprouting positive correlation between polar diameter, duration in days and neck thickness was observed. The total loss was positively correlated to polar diameter and neck thickness, where as equatorial diameter and average weight had negative correlation with total loss.

In present investigation significant differences in storage losses, due to rotting, sprouting and total losses were observed in different varieties of

onion. The variety N-2-4-1 emerged significantly superior with significantly less losses in storage due to rotting and sprouting. It was superior over all red and white varieties. In general red onion types stored well compared to the white onion types. The long day types performed badly as these varieties started rotting and sprouting to such a high tune that there were cent per cent losses up to 120 days only.

As per the research findings of the various workers it is established that there is positive correlation between polar diameter with rooting, sprouting and total loss. Another bulb character positive correlated with storage losses are neck thickness and duration of the variety (Patil 1983, Magdum, 1981; Patil, 1960; Singh and Joshi, 1978). The bulb characters which are negatively correlated storage losses reported are equatorial diameter average bulb weight to rotting, sprouting and totai loss (Karmarkar and Joshi, 1941; Kapur et al 1953).

The chemical composition of bulb i.e. dry matter, T.S.S. and sugars has definite correlation with losses of bulb in storage. Higher content of T.S.S. and dry matter have been reported to be positively correlated with storage life of onion as reported by various research workers (Mann and Hoyle, 1945; Foskett and Petson, 1950; Baturin, 1958; Tronickova, 1969;

Sethi. et al 1973 and Magdum, 1981). Similar results have been obtained in present study also.

As the storage of onion bulb was done at room temperature and bulbs were not graded some of the findings in present investigations may not corroborate the observations recorded by some of the earlier research workers.

CHAPTER-6

SUMMARY

Chapter-6

SUMMARY

The present investigation entitled, "Studies on copmarative performance of onion (*Allium cepa L.*) varieties in respect of growth, yield, quality and storage losses"; was carried out at Fruit Research Station, Himayat Bagh., Aurangabad, during the years 1986 and 1987.

The present study was initiated with major objectives of selecting suitable variety for summer season of onion cultivation and to study association for different morphological and bio-chemical constituents to storage losses. Sixteen different varieties, nine in red type, four in white type and three in long day types were planted and evaluated, data was pooled and findings of the investigation are summerized below.

The vegetative growth parameters included plant height and number of leaves per plant. The variety Pusa Ratnar recorded significantly more height (64.41) and lowest was found in long day type varieties (7.50.) The number of leaves were found to be more in the variety V-L-1 (15), here also long day plants had lowest number of leaves (11). Root plate diameter of U.D. 102 White, Baswant 780, N-53, Pusa White Flat and Chikalthana Local was more than 1.6 cm, for this character also long day types had lower values <1cm.

The variety Ratnar Selection produced significantly higher number of twin bulbs (29.76). There were significant defferences amongst varieties for this character. Long day types did not produce twins. Bolting has been recorded only by four varieties and that too it was very low. (0.30 to 1.7%).

The duration for maturity varied for different varieties. Varieties N-53 and Baswant 780 had short duration of 99 days. All long day types had longer duration of about 125 days.

There were significant differences in yield of different varieties. All long day types were found low yielder. Amongst red type the variety N-2-4-1 (212.88 q/ha) and in the white group Pusa White Flat and PKV-White Local were high yielder (211.77 and 192.44 q/ha respectively).

The studies in respect of bulb characteristics showed that for average number of bulbs / kg. Pusa White Flat with 9.39 bulbs/kg was at the bottom. Highest number of bulbs/kg was for Cream Gold (36.28). Ten bulb weight was also highest in Pusa White Flat (00.96 kg) where as cream Gold with 0.26 kg was lowest. Significantly highest bulb weight (103.33 g) was also recorded by Pusa White Flat. The bulb weight fo Early Lockyer Brown was only 30g. The bulb size was significantly more in the variety U.D. 102 White, Chikalthana Local and Pusa white Flat. The polar diameter was, however, more in long day types.

The observation of bulb characteristics revealed that Pusa White Flat had bigger bulb size.

The result of the bio-chmical constituents which determine bulv quality in onion showed that T.S.S. of more than 16 was recorded by the varieties N-2-4-1, Nasik Red, PKV-White Local, Chicalthana Local and VL-1. The per cent T.S.S. in long day types was low (10 to 11 per cent).

The dry matter content was also in the narrow range as that of per cent. T.S.S. Pusa White Flat and N-257-9-1 recorded highest T.S.S. of 16 per cent. In red group the varieties Pusa Ratnar and N-2-4-1 were at the top with (14.90 and 14.60 %) T.S.S. Dry matter for long day types was again low. (10 to 11%)

Different sugar percintage which has bearing on storage life showed that all the long day types had comparatively high reducing sugars and total sugars (4%), but non reducing sugars were low. In N-2-4-1 non reducing sugar was high (4.7%) which was statistically at par to variety N-257-9-1.

The monthly storage loss study revealed that lowest rotting losses were found in variety N-2-4-1. Pusa White Flat and Pusa Ratnar. (0.40 %) in all the varities there were no sprouting losses for first thirty days. Maximum sprouting was found in Chikalthana Local (3%). Highest physiological loss in weight was recorded by the varities N-257-9-1 and Pusa Ratnar. (34 to 35 %). The total loss was lowest in N-2-4-1 (31.80%) and highest in Pusa White Flat, Baswant - 780 (36.70%) and U.D. 102 White (37.80%).

All the long day types had highest losses and cent per cent losses took place at 90 days only.

The correlation studies revealed posiive correlation of average bulb weight and equatorial bulb diameter to yield. The different types of losses had nagative correlation with dry matter. T.S.S. and nonreducing sugar percentage.

In conclusion it can be said that among red varieties N-2-4-1 and in white groups Pusa White Flat and PKV-White Local were high yielding varieties, with big size bulbs. The storage losses were minimum in N-2-4-1. The T.S.S. and dry matter percentage was high in Pusa White Flat and PKV-White Local indicating their suitability for growing in the region. For summer season the cariety N-2-4-1 is found to be superior considering its yield, quality parameters and storability.

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Appendix - I.

Characterstics of different varieties under study

1. Pusa White Flat : Keeps healthly in storage suitable for dehydration, b bread at IARI, New Delhi. Identified in 1975. For zones IV, VI and VII. The attractive white bulbs are flatish and medium to large in size, T.S.S. 12-14 per cent. Duration 120-130 days after transplanting, yield 335-350 q/ha.

2. N-2-4-1 : Developed at Rahuri and identified in 1985. Pungent to test T.S.S. 11-13 per cent high yield potential with good keeping quality. Tolerance to Alternaria blight and trips.

3. N-257-9-1 : Develolped at Rahuri and identified in 1985 for zones. Bulbs globose shaped, white, high yield protential with good keeping quality, suitable for rabi season.

4. N-53 : Duration 150-165 days bulbs of bright scarlet red colour, round shaped and less pungent, Average bulb weight 70-100 cm. Suitable for kharif. Released by Department of Agriculture Maharashtra.

5. Baswant - 780 :Developed at Pimpalgaon, superior in bulb yield, imrovement over N-53. Bulbs are attractive globose with medium size, red colour, better keeping quality low bolting and twins.

6. P.K.V. White Local : Attractive white colour. hight yielding and good keeper, Released by P.K.V. Akola.

7. Pusa Red : Developed at IARI, New Delhi. This had been built up by selection from local red cultivars commonly grown in India.It produces medium sized bulbs, flatish round and purple red bulbs. It is less pungent than common onion.

8. Pusa Ratnar : It is selected from hybrid cultivars introduced from U.S.A. bulbs are large, slightly oblate with attractive deep Red colour. Early, high yielding with good keeping quality.

9. U.D.102 White : Developed by RCA, Udaipur. This variety has big bulbs with high T.S.S. and good keeping quality. Bulbs are flatish round.

10. V-L-1 : Red variety developed by VPKAS, ALMORA. Bulbs medium sized with 10-13 per cent T.S.S. and good keeping quality.

11. Chikalthana Local : A Local Red variety grown around Aurangabad city. Bulbs are big in size with light red colour and good keeping quality.

12. Nasik Red. : A traditionally grown deep red coloured variety of Maharashtra. Grown for Kharif and Rabi. Bulbs are big in size with keeping quality and high yielder.

13. Ratnar Selection : Selection from hybrids indtroduced from U.S.A. Slightly oblate bulbs with deep red colour and keeping quality.

14. Brown Spanish 15. Early Lockyer Brown 16. Cream Gold:

Above three verieties are long day types. Bhagchandani (1997), reported their suitability for hills over present short day types. The leaves are waxy, bulbs are globulouse with less pungent and medium keeping quality.

Appendix - II

Physico-chemical characteristics of the soil in plot 9/B of fruit Research station, Himayat Bagh, Aurangabad.

Properties	Content in soil
1) Soil pH	8.00.
2) Electrical conductivity	00.34 mm hos/cm.
3) Coarse sand	09.13 per cent.
4) Fine sand	29.58 per cent.
5) Silt	40.4 per cent.
6) Clay	19.6 per cent.
7) Texotural	Loamy.
8) Calcium carbonate	06.5 per cent.
9) Organic carbon	0.48 per cent.
10) Cation Exchange capacity	14.6 me/100g of soil.
11) Available P_2O_5	22.8 kg/ha.

Appendix - III

KRISHI UTPANNA BAZAR SAMITI, AURANGABAD

Whole sale selling rates of onion from June to October (1986/1987)

Year/ Month	Minimum Rate Rs/Q	Maximum Rate Rs/Q	Mean
1986			
June	45	120	82.50
July	70	90	80.00
August	60	100	80.00
September	80	200	140.00
October	100	200	150.00
1987			
June	60	235	147.50
July	125	400	262.50
August	250	400	325.00
September	160	400	280.00
October	75	245	160.00

Courstesy : Krishi Utpanna Bazar Samati, Aurangabad.

APENDIX IV

Table - 1 : Climatic data, NARP, Aurangabad (1987-88)

Week No.	D A T E	Temperature MAX.	Temperature MIN.	RH% MAX.	RH% MIN.	Evaporation mm/day	Sun shine hrs.	Wind velocity km/hrs Day	Wind velocity km/hrs Night	Wind velocity km/hrs 24 hrs.	Rain fall mm/ days	Rainy days
1	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
22	28-03 June	38.91	24.05	63	31	8.12	11.20	5.14	4.78	4.60	-	-
23	04-10	38.51	26.17	67	40	9.17	10.31	5.35	7.71	6.44	22.50	1
24	11-17	33.71	22.94	81	67	6.37	6.92	5.60	4.82	5.34	42.50	2
25	18-24	34.08	22.17	84	44	6.14	9.77	6.07	4.62	5.26	-	-
26	25-01 July	34.28	21.71	89	56	6.28	6.26	5.86	5.32	5.82	82.75	4
27	02-08	29.14	22.02	92	69	3.60	1.22	6.31	6.05	6.20	24.50	4
28	09-15	30.31	19.73	89	58	4.40	6.68	5.94	5.98	6.28	12.00	3
29	16-22	32.04	21.58	89	76	5.83	6.28	5.82	6.09	5.76	24.25	1
30	23-29	31.08	21.40	88	72	8.72	5.68	5.14	4.86	5.33	15.00	2
31	30-05Aug	32.74	21.68	84	62	5.12	7.51	5.86	4.28	5.49	26.00	1
32	06-12	29.17	21.15	93	76	3.08	3.28	3.98	2.41	3.22	94.25	4
33	13-19	30.06	23.00	93	75	2.42	5.68	3.68	1.92	2.84	68.50	2
34	20-26	28.01	20.61	91	85	2.44	1.94	6.17	3.10	4.05	76.75	6
35	27.02 Sept.	27.62	20.74	92	75	2.65	1.21	6.22	3.09	4.02	19.00	5
36	03-09	30.87	19.85	91	65	4.27	9.38	5.05	1.58	3.31	-	-
37	10-16	32.17	19.77	88	50	5.07	10.00	5.15	2.05	3.15	-	-

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
38	17-23	35.17	21.05	79	36	6.42	9.99	3.22	8.83	2.04	-	-
39	24-30	32.57	22.51	77	52	4.68	6.51	2.28	1.61	1.92	50.25	2
40	01-07 Oct.	30.88	20.94	87	65	3.72	5.82	2.80	2.05	2.41	77.75	3
41	08-14	32.85	19.08	77	48	5.31	10.32	2.02	2.02	2.00	-	-
42	15-21	31.10	20.14	79	54	4.54	6.43	3.02	5.55	3.55	58.25	1
43	22-28	31.84	19.50	76	37	4.91	10.24	2.74	1.52	2.12	-	-
44	29-04 Nov.	31.18	15.50	68	35	3.92	9.11	2.12	2.54	2.13	-	-
45	05-11	29.84	16.25	70	53	4.71	10.22	2.80	2.08	2.42	-	-
46	12-18	28.65	20.04	76	58	4.83	9.18	3.03	3.02	2.48	--	-
47	19-25	29.91	16.82	78	42	4.92	10.21	2.84	2.98	2.53	4.25	1
48	26-02 Dec	30.80	15.05	67	39	4.80	9.28	3.02	3.04	2.58	-	-
49	03-09	29.25	14.22	61	43	4.65	10.20	2.94	2.96	2.64	-	-
50	10-16	26.34	14.68	90	64	4.91	9.86	3.04	2.98	2.84	22.00	2
51	17-23	25.37	10.31	70	39	3.62	9.85	2.98	2.67	2.04	-	-
52	24-31	28.15	14.02	63	46	4.71	10.03	2.97	2.58	2.68	-	-
									TOTAL		720.50	45

Table-1 : Meteorological data, 1986

Met. week	Period	AURANGABAD			VALIJAPUR			MEAN TEMP*		RELATIVE* HUMIDITY	
		Average rainfall (mm)		Rainy days	Average rainfall (mm)		Rainy days	MAX.	MIN.	AM	PM
		1974-85	1986		1974-85	1986					
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
22	28-03 June	-	-	-	5.21	7.5	1	38.10	24.30	71	35
23	04-10	22.29	3.00	1	16.34	40.00	2	37.7	21.8	74	54
24	11-17	26.07	59.25	4	29.90	52.00	4	35.50	19.30	86	46
25	18-24	25.25	8.50	1	18.32	0.00	-	30.50	22.60	83	64
26	25-01 July	16.36	-	-	24.01	2.00	2	29.90	19.00	80	56
27	02-08	22.96	3.25	1	18.85	-	-	32.80	22.30	83	41
28	09-15	32.50	9.00	1	33.12	31.50	1	30.10	21.60	82	58
29	16-22	31.13	90.00	4	21.41	28.00	3	25.80	20.70	91	83
30	23-29	36.63	-	-	31.29	-	-	26.60	20.60	90	72
31	30-05 Aug.	39.10	14.00	2	19.77	-	-	30.10	20.80	90	69
32	06-12	30.76	118.00	5	14.87	22.50	3	26.10	20.90	96	77
33	13-19	20.28	4.25	2	14.26	4.50	2	22.90	19.70	91	77
34	20-26	19.02	-	-	27196	-	-	27.20	19.60	89	61
35	27-02 Sept.	43.15	5.0	2	20.24	-	-	29.80	19.00	88	45
36	03-09	21.55	6.75	1	18.25	3.00	1	30.04	19.30	87	52

(11)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
37	10-16 Sept.	35.23	7.50	2	30.69	30.50	1	30.50	20.20	84	43
38	17-23	43.40	00.75	3	31.34	52.00	3	29.70	21.10	93	63
39	24-30	41.49	4.0	2	29.86	-	-	32.50	20.40	87	39
40	01-07 Oct.	14.09	6.25	1	8.86	-	-	31.90	20.60	76	39
41	08-14	8.18	-	-	5.56	-	-	33.90	19.20	67	33
42	15-21	17.13	-	-	2.36	-	-	34.60	20.00	64	29
43	22-28	7.30	-	-	9.32	-	-	32.60	17.50	43	22
44	29-04 Nov.	7.11	-	-	4.35	-	-	32.70	20.00	50	29
45	05-11	-	4.00	1	1.23	35.00	1	31.80	20.60	72	48
46	12-18	-	-	-	-	-	-	32.50	16.80	57	25
47	19-25	-	-	-	-	-	-	31.10	15.80	45	27
48	26-02 Dec.	-	-	-	-	-	-	26.40	16.50	55	30
49	03-09	-	-	-	-	-	-	30.40	14.00	44	23
50	10-16	-	-	-	-	-	-	29.60	14.00	64	27
51	17-23	-	-	-	-	-	-	28.80	15.0	64	34
52	24-31	-	25.50	2	-	-	-	23.60	14.30	80	65
	Total	562.84	449.00	35	437.04	357.50	27				

* Data collected from met. observatory, WALMI.

VITA

R. G. Nilangekar born in 1945, graduated in 1966 and M. Sc. (Agri) Horticulture (First class with distinction) in 1977 from Marathwada Agricul tural University, Parbhani. He is Senior Fellowship holder of I. C. A. R., New Dehli and compeleted his Ph. D. Course work from I. A. R. I., New Dehli. He has served the University in different capacities like Demostrator, Agril. Officer, Asstt. Prof. and Assoc. Professor.

Presently working as Assoc. Professor in P. G. scheme at College of Agri., Parbhani. He is associated in the release of Fruit crop varieties viz. Niranjan mango, Pratishthan tamarind, Ellora Wood-Apple and Mukta Ber. He has published eight research articles and guided three M. Sc. (Agri). students.

Married to Sow. Mangal Nilangekar, he has three sons: chi. Ajay, Umesh and Sagar.