SEED MATURITY AND SEED LONGEVITY STUDIES IN SNAKE GOURD (*Trichosanthes anguina* L.) VARIETIES

By
ROHIT KUMAR DHOBI
(2010-12-117)

Department of Olericulture
COLLEGE OF HORTICULTURE
VELLANIKKARA, THRISSUR - 680 656
KERALA, INDIA
2012

SEED MATURITY AND SEED LONGEVITY STUDIES IN SNAKE GOURD (*Trichosanthes anguina* L.) VARIETIES

By

ROHIT KUMAR DHOBI
(2010-12-117)

THESIS

Submitted in partial fulfillment of the requirement for the degree of

Master of Science in Horticulture

Faculty of Agriculture
Kerala Agricultural University, Thrissur

Department of Olericulture
COLLEGE OF HORTICULTURE
VELLANIKKARA, THRISSUR - 680 656
KERALA, INDIA

2012

DECLARATION

I hereby declare that this thesis entitled **"Seed maturity and seed longevity studies in snake gourd (*Trichosanthes anguina* L.) varieties"** is a bonafide record of research work done by me during the course of research and that it has not been previously formed the basis for the award to me of any degree, diploma, fellowship or other similar title, of any other University or Society.

Place: Vellanikkara **Rohit Kumar Dhobi**

Date: 18-08-2012 **(2010-12-117)**

CERTIFICATE

Certified that this thesis entitled **"Seed maturity and seed longevity studies in snake gourd (*Trichosanthes anguina* L.) varieties"** is a record of research work done independently by **Mr. Rohit Kumar Dhobi** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma or fellowship to him.

Place: Vellanikkara
Date: 18-08-12

Dr. K. Krishnakumary
Professor
(Major advisor, Advisory Committee)
Department of Olericulture
College of Horticulture
Vellanikkara

CERTIFICATE

We, the undersigned members of the Advisory Committee of **Mr. Rohit Kumar Dhobi,** a candidate for the degree of **Master of Science in Horticulture**, with major field in **Olericulture**, agree that the thesis entitled **"Seed maturity and seed longevity studies in snake gourd (*Trichosanthes anguina* L.) varieties"** may be submitted by **Mr. Rohit Kumar Dhobi** in partial fulfillment of the requirement for the degree.

Dr. K. Krishnakumary
Professor
Dept. of Olericulture
College of Horticulture
Vellanikkra
(Major advisor, Advisory Committee)

Prof. (Dr.) T.E. George
Associate Director of Research,
(Vegetable Mission) & Head
Dept. of Olericulture, COH,
Kerala Agricultural University,
Vellanikkara
(Member, Advisory Committee)

Dr. V.S. Devadas
Professor (Horti.) & ADR (Seeds)
Kerala Agricultural University,
Vellanikkara
(Member, Advisory Committee)

Dr. Rose Mary Francies
Associate Professor
Department of Plant Breeding and Genetics
College of Horticulture
Vellanikkara
(Member, Advisory Committee)

ACKNOWLEDGEMENT

First and foremost I bow my head before ***ALMIGHTY*** *whose blessings enabled me to undertake this venture successfully.I avail this opportunity to express my deep sense of reverence, gratitude and indebtedness to my major advisor* ***Dr. K. Krishnakumary,*** *Professor, Dept. of Olericulture and chairperson of my Advisory Committee for his sustained and valuable guidance, constructive suggestions, unfailing patience, friendly approach, constant support and encouragement during the conduct of this research work and preparation of the thesis. I gratefully remember his knowledge and wisdom, which nurtured this research project in right direction without which fulfillment of this endeavor would not have been possible.*

I place a deep sense of obligation to ***Prof. (Dr.) T.E. George,*** *Associate Director of Research, (Vegetable Mission) and Head, Department of Olericulture, College of Horticulture and member of my Advisory Committee for his unwavering encouragement, unflagging perseverance, well timed support and help rendered which made the successful completion of this thesis.*

I am deeply indebted to ***Dr. V.S. Devadas****, Professor (Horti.) & ADR (Seeds), Kerala Agricultural University, Vellanikkara and member of my Advisory Committee for her unbounded support, critical comments and valuable suggestions during the preparation of this manuscript.*

I am very thankful to ***Dr. Rose Mary Francies****, Associate Professor, Department of Plant Breeding and Genetics, College of Horticulture and member of my advisory committee for her whole-hearted-co-operation, candid suggestions, encouragement and valuable help rendered during this period of investigation.*

I am especially indebted to my teachers of the Department of Olericulture for their unrivalled teaching, kind concern, sincere advices, timely help and support rendered during the investigation and throughout my study period.

My heartfelt thanks are expressed to ***Shri. S. Krishnan****, Professor and Head, Department of Agricultural Statistics, College of Horticulture. For his whole hearted co-operation and immense help extended for the statistical analysis of the data.*

Words cannot really express the true friendship that I relished from ***Narender Negi, Pawan, Amar, Ashok, Pramod, Priya, Smitha, Yamuna, Archana, Aisha*** *and* ***Swati*** *for the heartfelt help, timely suggestions and back-up which gave me enough strength to get through all mind numbing circumstances.*

I am extremely thankful to my juniors ***Naveen, Parimal, Ravindra, Airina*** *and also to* ***all my batchmates*** *for their moral support and encouragement.*

I am deeply indebted to my ***Parents (Bhagwati Bai & Radhey Shyam Khatwa), grand parents (Narayani Bai & Puri Lal Khatwa) and family members (Deepak, Ritu & Asha)*** *without whose moral support, blessings and affection this would not have been a success. It would be impossible to list out all those who have helped me in one way or another in the successful completion of this work. I once again express my heartful thanks to all those who helped me in completing this venture in time.*

I am extremely thankful to ICAR for providing me Junior Research Fellowship for M.Sc. Horticulture programme.

Rohit Kumar Dhobi

Dedicated to my Parents (Bhagwati Bai & Radhey Shyam Khatwa), my advisor Dr. K. Krishnakumary and Friends

CONTENTS

LIST OF TABLES

LIST OF TABLES

LIST OF PLATES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

1. INTRODUCTION

Cucurbits form an important group of vegetable crops cultivated extensively in the country as well as in the State of Kerala. Snake gourd (*Tricosanthes anguina* L) occupies a place of pride among cucurbitaceous vegetables grown in south India and in Kerala it is cultivated in garden lands and rice fallows. This crop is a native of Indian Archipelago.

Snake gourd is an annual climber which is also called as viper gourd, snake tomato or long tomato. The fruit is usually consumed as a vegetable due to its good nutritional value. The plant is rich in chemical constituents like flavonoids, carotenoids, phenolic acids which makes the plant pharmacologically and therapeutically active. The active ingredient compound-Q is known to have therapeutic effect against the human immuno deficiency virus (HIV) (Robinson and Decker, 1997). Every 100 g edible portion of fruit contains 94.6 g moisture, 0.5 g protein, 0.3 g fat, 0.5 g minerals, 0.8 g fibre, 3.3 g carbohydrates and 160 IU vitamin- A (Gopalan *et al*., 1982). It has a prominent place in alternative systems of medicine like Ayurveda and Siddha due to its various pharmacological activities like antidiabetic, hepatoprotective, cytotoxic, anti inflammatory and larvicidal effects (Longman, 2002).

Quality seed is a prerequisite for obtaining high productivity. The demand for quality seed of snake gourd is on the rise. Seed quality is influenced by the maturity of fruit and general studies pointed out that seeds attain maximum quality when fruits are harvested at the optimum physiological maturity. Early or delayed harvesting of fruits result in low seed vigour. Harvesting at optimum maturity stage, not only minimizes the loss of viability and vigour of seeds, but also prevents the seeds from damage due to insect pests, diseases and adverse environmental conditions.

Fruit size is a major trait associated with seed quality and variability in fruit size and shape is observed in cucurbitaceous vegetables even under good management practices. In vegetables, fruit grading is very important for obtaining quality seeds. Reports reveal a close correlation between fruit size and seed quality (Thamburaj, 1973; Abbasov, 1974). Several studies pointed out that quantity and quality of seed decreases concomitantly as the fruit size or weight decreases (Roopa, 2006; Rana *et al*., 2006). In addition, the position of seed within the fruit is also said to influence seed germination and vigour.

Growth and development of fruit and seed varies with variety and storability of the seeds is affected by both storage environment and genotype. Scientific information on fruit and seed development, optimum stage of fruit maturity for seed harvest, influence of fruit size and seed position on seed quality and storability of seeds is limited in snake gourd varieties under Kerala conditions and hence the present study was proposed with the following objectives.

1. To standardise the optimum stage of harvest in snake gourd varieties to obtain maximum quality seed.

2. To study the influence of fruit size and position of seeds within the fruit on seed quality,

3. To assess the effect of storage conditions on seed quality and longevity and standardise the optimum conditions for storage.

.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Snake gourd is a cucurbitaceous vegetable grown (in garden lands and rice fallows of Kerala) for its fleshy fruits. As in other crops, use of quality seeds is one of the most important factor contributing to yield of this crop also. The stage at which fruits are harvested has great influence on seed quality. Seed quality is also associated with seed position within the fruit. Reduced germinability and low vigour of seeds during storage affect the seedling emergence and subsequent performance in the field. The literature related to the physiological maturity studies, influence of fruit size, seed position within the fruit and storability on seed quality are reviewed here under.

2.1 PHYSIOLOGICAL MATURITY STUDIES IN VEGETABLES

The physiological parameters viz., germinability and vigour play a very important role in judging the quality of a seed. The seed harvested at the physiological maturity will possess maximum germination and vigour. Thereafter, it will decline due to senescence, ageing and eventually no longer able to germinate (Harrington, 1972). Hence, fruits harvested at physiological maturity stage will have maximum dry matter accumulation and seeds attain maximum vigour at this stage and can be stored well for longer period (Harrington, 1973).

Odland (1937) revealed that if the fruits of cucurbits were allowed to remain on the vine until ‘overripe’, the seed will germinate promptly, but if fruits were picked at ripe stage, the germination will be delayed for several weeks.

Seaton (1938) studied the relation of number of seeds to fruit size and reported that weight of fruits and number of good seeds had correlated significantly.

Seed quality is at its maximum at the physiological maturity stage and depend on environment conditions. Prolonged field exposure after the stage of maturity would result in losses in germinability, longevity and vigour of seedling produced (Mc Alister, 1943 and Garris and Hoffmann, 1946).

Increase in fresh weight during the development of fertilized ovules into seeds was noticed by Young (1949) in squash.

The term 'physiological maturity' has been most frequently used to describe the point where the seed reaches its maximum dry seed weight (Shaw and Loomis, 1950)

Mann and Robinson (1950) reported that in *Cucumis melo*, the rate of growth in fruit length was maximum between five and twelve days after anthesis and fruit reached maximum length on the 16^{th} day.

Sakar and Farouk (1953) reported that in chilli, the highest fruit weight (114.85 g) was obtained when fruits were harvested at 52 days after anthesis, whereas seed weight was highest (2.05 g) in fruits harvested at 56 days after anthesis. Fruit weight (25.50 g) and seed weight (0.20 g) were found to be lowest in fruits harvested at six days after anthesis.

The seeds harvested at physiological maturity gave maximum seed germination in vegetables than immature and mature seeds (Eguchi *et al*., 1958).

Harrington (1959) studied the effect of days from anthesis to harvest in germination of muskmelon seeds. The 100 seed weight increased upto 37 DAA and beyond that there was a slight decrease in 100 seed weight. The number of seeds per fruit did not change with time from anthesis.

Showalter (1961) had confirmed that in watermelon, the fruits after reaching the maximum weight started losing weight accompanied by loss in moisture content and this dehydration was an inherent phase of development.

According to Nath and Vashistha (1969), watermelon took 32 to 35 days for maturity. There was an appreciable increase in rate of growth during earlier period of fruit development. It was maximum at mid stage, but subsequently slowed down to almost constant at maturity.

In cucumber, Hammet and Malethong (1971) reported that linear fruit growth was relatively slow for the first four days and rapid for the next eight days after anthesis (DAA), reaching the maximum on 18^{th} day of development.

According to Chauhan and Bhandari (1971), the age of the fruits significantly affected germination in bhendi. Seeds collected 27 days after flower opening recorded 89.2%, while those harvested at 30 days recorded 85.8% germination.

Good germination per cent (85.6%) was recorded in seeds of fruits harvested at 30 days after anthesis at fully matured, dry and cracking stage in okra cv. Pusa Sawani (Chauhan and Bhandari, 1971).

Potapova (1972) reported that the dry weight of cucumber seed increased with increased maturity. The quality of the seed is basically dependent on its filling and on the metabolic and synthetic efficiency during seed development and maturation.

Seed development and maturation refers to the morphological, physiological and functional changes that occur from the time of fertilization until the mature seeds are ready for harvest (Delouche, 1973).

Delouche (1973) opined that the seed weight can be considered as the maturity index and the time required for seed to decrease in moisture content from 80 per cent at fertilization to 14 to 20 per cent at harvest varied with genotypes.

Abdul- Baki and Baker (1973) used the fresh weight of seed for differentiating between 'seed development' and 'seed maturation'. According to them, the seed development is a period between fertilization and maximum fresh weight of seeds, and maturation begins at the end of seed development and continues up to harvest.

Yureva and Polumordvinova (1974) noticed intensive growth and development of tomato seeds when fruits were 30 to 45 days old and during this phase, the seeds and embryos were morphologically developed, but were unable to germinate. Only seeds obtained from 40 to 45 days old fruits were capable of germinating.

Worku *et al.* (1975) reported that capsicum fruits harvested at fully wrinkled stage gave good quality seeds with high germination, seedling length and vigour index.

In egg plant, an increase in 1000 seed weight and germination was noticed with the increase in fruit ripening period and the seeds from green fruit were also capable of germination (Alekseev, 1976).

The rate of respiration and imbibition was decreased in the seeds extracted from the fruits after ripening stage in tomato. The growth of normally developed seedling was directly correlated with degrees of ripeness of the seeds, but over ripening had adverse effect on seed quality (Prokhorov and Dikareva, 1976).

Quagliotti (1977) recorded higher seed yield in chilli with better quality from the fruits turning to yellow or red and 1000-seed weight was highest in the fruits at physiological ripe stage while it was lowest in green fruit stage.

Shanmugaraj (1978) reported that in lablab (*Lablab purpureus* (L) Sweet), seeds attained the maximum dry weight and physiological maturity on the 27th DAA.

Studies conducted at the Tamil Nadu Agricultural University have shown that physiological maturity of seeds was obtained at 60 DAA in ribbed gourd and 27 DAA in bitter gourd (Varatharaj, 1979).

Pratt *et al.* (1977) stated that in musk melon, the rate of growth was maximum between 10 and 20 DAA, and on 35th day the fruit reached maximum length.

Chandrasekaran (1979) observed maximum increase in weight of bottle gourd between 10 and 25 DAA and maximum weight was recorded on 40th DAA, whereas in fruit length, maximum rate of increase was between 10th and 30th DAA and the recorded maximum fruit length on 35th DAA. He reported that seeds attain maximum dry weight at 65 DAA in bottlegourd.

Nowsielska (1979) observed poor seed germination in capsicum fruits harvested at under ripen stage compared to the seeds from well ripened stage. The seed quality was dependent on the extent of fruit maturity and reddening of the fruits, which occurred about 50 days after flowering, indicating the beginning of fruit maturation.

Krishnaprasad (1980) reported that in ash gourd (Co- 1) fruits reached maximum fresh weight and length by 60 DAA. Seeds became germinable at 50

DAA and seeds reached maximum physiological maturity and vigour potential at 80 DAA.

Velumani and Ramasamy (1980) noticed higher values for fruit weight, number and weight of seeds per fruit with first four pickings and these values decreased with subsequent pickings in egg plant.

Chin (1981) observed that in yard long bean (*Vigna sesquipedalis*) seeds subjected to storage, the germination per cent was lower in immature seeds and highest for fully matured seeds.

Domain (1982) reported that 1000 seed weight and germination was maximum in the seeds obtained from ripened fruits of eggplant. Similarly, 1000 seed weight, seed germination per cent and field emergence were the highest when the brinjal fruits were harvested at 75, 80 and 85 DAA.

Godi (1982) reported that chilli seeds harvested at 42 days after flowering were capable of germination whereas, seeds harvested within 42 days were not capable to germinate.

Metha (1983) reported that in chilli, physiological maturity of seeds was attained at 48 DAA and seeds from fruits harvested before attaining physiological maturity did not store well. The seeds from fruits harvested before attaining physiological maturity after storage for 12 months possessed relatively low germination and field emergence potential and produced seedlings with poor growth and vigour.

Novikov (1983) reported that increased seed yield was noticed in tomato when fruits were harvested at 10, 20 or 30 days after physiological maturity.

Vadivelu (1983) reported that germination was the highest (93%) when the fruits were harvested in red skin stage whereas, it was lowest (68%) in yellow coloured fruits in tomato cvs. Co-1 and Co-2.

In watermelon, physiological seed maturation occurred at 55 DAA and the best quality seeds were obtained from fruits harvested at 35 and 45 DAA and stored for four days (Alvarenga *et al*., 1984).

Singh and Sidhu (1985) reported the highest germination (92%) in full and half ripe fruits, whereas, lowest germination (2:2%) was observed in seeds extracted from purple colour fruits in brinjal.

Singh *et al.* (1985) recorded highest germination per cent (80) in tomato fruits harvested at the stage of turning towards red and red ripe stage, whereas, only 64 per cent germination was recorded in the seeds obtained from matured green fruits.

Singh *et al*. (1985) revealed that harvesting of muskmelon fruit at full slip stage ensured the highest germination in Punjab Sunhri variety (90.29%) compared to half slip (84.83%) and full mature stage (74.54%).

Dharmatti (1986) studied the effect of different pickings on seed quality in bell pepper and concluded that the seeds of second picking gave the highest 1000 seed weight and germination compared to first and third picking.

Kanwar and Saimbhi (1987) reported that in okra, seed weight per pod and germination per cent were maximum from pods harvested at 35 DAA. Further delay in harvesting the pods increased the number of damaged seeds and reduced the seed weight and germination per cent.

Hedayat (1987) reported that watermelon seeds attained maximum 100 seed weight and germination at 42nd DAA.

Maximum germination (80%) was recorded in Tabasco pepper (*Capsicum fruitescens* L.) seeds extracted from red coloured fruits compared to seeds extracted from orange colour (52%) fruits (Edwards and Sundstrom, 1987).

In muskmelon, seed quality was the best when harvested at 'full slip' stage (Harisingh *et al*., 1988).

Nerson and Paris (1988) observed that seeds from immature fruits of cucumber (26 and 33 days past anthesis) had low germination and storability when compared to mature fruits (40 and 54 days past anthesis).

Doijode (1988) reported that chilli seeds obtained from ripe fruits had higher 1000 seed weight, germination capacity and seedling vigour. Similarly, chilli seeds extracted from fruits harvested at later stage i.e. 45 DAA recorded higher germination, vigour index and field emergence (Metha and Ramakrishnan, 1986).

Dharmalingam and Basu (1989) observed that in *Vigna radiata* (cv. Co 3) pod development preceded seed development. The developmental process was marked by an increase in length, breadth, weight and volume of pods and seeds with a corresponding decrease in moisture content. The seed attained maximum fresh weight and dry weight together with high germination and vigour at 25 DAA. Physiological maturity was indicated by a colour change in the pod from green to greenish yellow from 15 DAA to 25 DAA.

Diaz (1990) reported that in *Phaseolus vulgaris,* maximum pod weight and pod length was recorded at 20- 25 and 15- 20 days respectively after flowering.

Jayabharathi *et al*. (1990) reported that brinjal fruits should be harvested at full yellow stage for maximum seed yield, germination and vigour parameters. Highest seed germination (90.20%) and vigour index (1507) were recorded in brinjal seeds cv. PKM-1 extracted from the fruits harvested at complete yellow colour stage, while the lowest germination and vigour index (29.85% and 449, respectively) were observed in half yellow colour fruits.

Chaudhary *et al.* (1992) reported that in tomato, per cent germination, 100 seed weight, seedling height and vigour index increased with fruit maturity and were highest for seeds extracted from fruits at the red ripe stage. They observed highest germination (94.62%), seedling length (6.37 cm) and vigour index (1164) in tomato seeds harvested from full mature red skined fruits.

Barbedo *et al*. (1993) reported that in cucumber, physiological maturity of the seeds was reached at 40-45 days after anthesis. The highest values for dry matter content, per cent germination, vigour, fruit weight and fruit size were observed at this stage and the fruits were completely yellow in colour at this stage.

In brinjal, maximum fresh seed weight (1.85 g) and dry seed weight (1.54 g) were noticed in fruits harvested at 74 DAA compared to fruits harvested at 42 DAA (Biradar, 1994). He observed highest germination per cent (92.21%), shoot length (5.21 cm), root length (4.89 cm) and seedling vigour index (924.47) when fruits were harvested at 74 DAA as against earlier and later stages of harvesting.

Goncalves and Nascimento (1994) determined physiological maturity in pea (cv. Dileta) seeds as 40-47 days after flowering by assessing seed moisture content, germination, field emergence and 1000-seed weight.

Suryawanshi *et al*. (1994) observed pod length and width, pod and seed fresh weight, seed moisture content and seed germination in pigeonpeas (cv. ICPL-87) at 5 days intervals from 5 to 55 days after flowering. Physiological maturity

was reached at 50 days after flowering when seed moisture content was lowest, seed DM content was highest and seed germination was 92.3%.

Demir (1995) reported that in okra cv. 'Akkoy', maximum seed quality was recorded at 52 DAA. At this stage, seeds were mature with a moisture of 12 per cent. Delaying harvest to 59 DAA resulted in seed loss due to shattering.

Nandeesh *et al.* (1995) observed highest laboratory germination (98.22%), field emergence (94.12%) and vigour index (1289) in the fruits harvested at 40 days after anthesis in cucumber than the fruits of 30 and 50 days after anthesis.

According to Gontia *et al.* (1995), ten soyabean cultivars (Punjab 1, Ankur, JS 75-46, JS 78-80, JS 79-81, JS 81-303, JS 81-607, JS 81-335, JS 81-1625 and PK 472) reached physiological maturity by 56 days after anthesis, and seed dry matter content (83.05%), 100-seed weight (10.39 g), germination per cent (88.4%) and seedling vigour (7.06 cm seedling length and 0.081 g DW) peaked at this growth stage whereas seeds collected at 35 days after anthesis did not germinate..

According to Krishnamurthy (1995), germination, root length, shoot length, vigour index and field emergence were higher in chilli fruits harvested at 100 per cent red colour stage than those harvested at earlier stages.

Kannath (1996) studied physiological maturity of seeds which is indicated that maximum fruit size i.e., weight, length and diameter of fruits was attained by 30 DAA and 40 DAA in rainy and summer season respectively. The dry weight of seeds, seed germination and vigour were attained maximum by about 70 DAA in both the seasons in ash gourd cv. BH- 21.

Radheshyam *et al*. (1996) reported higher moisture content and electrical conductivity of seeds and lower test weight and germination per cent in seeds harvested from fruits at turning red stage compared to red ripe stage in chilli.

Baruah *et al*. (1996) observed highest 100 seed weight (299 mg) and speed of germination (16.0) in fruits harvested at red ripe stage in tomato over mature green end colour break stage.

Naik *et al.* (1996) studied the effect of fruit maturity on seed quality in capsicum. The results revealed that seed weight per fruit (1.67 g), 1000-seed weight (5.93 g), germination (88%), shoot length (2.40 cm), root length (3.17 cm), seedling dry weight (3.00 mg) and vigour index (490) were maximum in the fruits harvested at mature stage (shrunken fruits) compared to full yellow, half yellow, just turning yellow and mature green fruits.

Biradar (1999) reported that chilli fruits harvested at full red colour stage recorded significantly the highest fruit weight (0.73 g) followed by over ripen stage (0.72 g) and the lowest fruit weight (0.51 g) was obtained when fruits were harvested at green coloured stage in chilli. He reported maximum 1000 seed weight (5.31g), germination (87.33%), seedling length (17.54 cm), vigour index (1541), seedling dry weight (0.244g) and field emergence (85.39%) and lowest electrical conductivity (1.117 dSm-1) in chilli fruits harvested at full red colour stages.

Pokojska (1999) conducted physiological maturity studies in faba bean (*Vicia faba*) varieties and observed variations in number of days for attainment of physiological maturity which varied from 103- 108 days after sowing. Maximum germination potential (95-100%) was recorded for seeds harvested at 105-108 days after sowing and it was maintained until the last harvesting date.

Seth *et al.* (1999) studied the effect of seed maturity on seed quality in two cowpea genotypes. Both the genotypes attained the ability to germinate (16-20%) at 8 days after anthesis, but maximum mean germinability (81.66%) of both the genotypes occurred at 17 DAA and coincided with the maximum dry weight (7.03 g) of the seeds.

Aroonrungsikul *et al.* (2000) studied seed development of two cucumber cultivars namely Jed Bai and Puang. Seeds reached physiological maturity at 35 and 30 days after flowering (DAA) in Jed Bai and Puang respectively. Maximum viability was detected at 40 DAA in Jed Bai (100%) and at 35 DAA in Puang (96%).

Reddy *et al*. (2001) revealed that chilli fruits attained maximum length, physiological maturity and dry matter accumulation at 35 days after anthesis (DAA) and then decreased. Pods harvested at 35 to 41 DAA possessed good seed storability and up to 65% germination after 6 and 9 months of storage. Early and delay in harvest led to a decline in seed quality.

The chilli fruit harvested at full red ripe stage observed higher germination (96%)), seedling fresh weight (22.5 mg), vigour index (622) and field emergence (84%) compared to fruits harvested at mature green and half red colour stage (Pandita and Nagarajan, 2001).

Studies of Rao (2001) revealed that in pigeon pea, maximum pod length and width was attained at 35-40 DAA. Significant difference was noticed between dry matter accumulation in pedicel, pod wall and seed at different stages of pod development. Initially, the contribution of dry matter from pod wall was higher compared to pedicel and seed. At 15-21 DAA, the dry matter contribution by seed was higher to pod compared to pod wall and pedicel. The pod parts attained constant weight and physiological maturity at 41-43 DAA. Translocation of photosynthates into seed was slow up to 8-14 DAA and reached a peak level at 36-40 DAA. The complete loss of green colour of pods along with the development of seed coat colour were the visible indicators associated with physiological maturity.

Simpson *et al*. (2001) studied the effect of harvest period on the germination of Dolichos bean [*Lablab purpureus*] (cv. Rongai) seeds during storage. The

physiological maturity was obtained between 37 and 44 days after anthesis and the parameters that best characterized the physiological maturity and the time for harvesting were moisture content and dry matter weight.

Seth *et al.* (2002) monitored seed quality during seed development and maturation in three genotypes of fodder clusterbeans (Bundel Guar 1, Bundel Guar 2 and Bundel Guar 3). The occurrence of initial hardseededness was observed in all the three genotypes at or near harvest maturity. A significant increase in hard seed per cent was noticed beyond harvest maturity in Bundel Guar 2.

Vinodkumar *et al*. (2002) reported that paprika chilli seeds extracted from the fruits harvested at 60 days after flowering showed the highest 1000-seed weight (8.29 g), germination (96.50%), field emergence (90.50%), shoot length (7.67 cm), root length (5.67 cm) and seedling vigour (1288) compared to seeds obtained from the fruits harvested at earlier or later stages.

Dev and Sharma (2002) reported maximum seed recovery, germination and vigour when brinjal fruits were harvested at fully ripened stage (yellow) followed by turning yellow stage.

In brinjal, Sureshbabu *et al*. (2003) observed highest fruit weight (68.11 g), seed weight (1.18 g), germination (85.44%), vigour index (994), field emergence (79.49%) and less electrical conductivity (1.473 dSm-1) per fruit in fruits harvested at full yellow colour stage compared to fruits harvested at purple colour stage (46.89 and 0.89 g respectively).

Results of the study conducted by Verma *et al.* (2003) revealed that germination percent, seedling length, seedling dry weight, speed of germination, seedling vigor index and seed viability decreased significantly as the age of the seed increased in *Brassica campestris* varieties viz., Sangam and TH 68.

Krishnakumary *et al*. (2004) recorded maximum values for fruit characters (weight and length) and seed characters (number, seed weight, germination per cent and vigour index) at 33 days after anthesis and hence this is considered the optimum physiological maturity stage for oriental pickling melon cv. Mudicode for harvest for seed purpose. Early and delayed harvests reduced quality of seeds in this crop.

In an experiment conducted in ash gourd by Ganar *et al.* (2004), a significant increase in 100-seed weight from 5.08 to 7.64 g was observed in fruits harvested at 52, 62 and 72 days after anthesis (DAA) with maximum value (7.64 g) at 72 DAA. The contribution of seed coat to seed weight increased from 51.85 to 59.57%, while the contribution of cotyledons to seed weight decreased from 48.15 to 40.43%. The seed had 32.5, 25.0 and 12.5% fresh ungerminated seeds harvested at 52, 62 and 72 DAA.

Krishnakumary *et al.* (2005) observed that fruit and seed maturation in cowpea (var. Lola) occurred in two phases. The pod length and pod weight reached maximum at 12 days after anthesis and it is considered the optimum harvest stage for vegetable use. The highest germination and vigour was observed in seeds of pods harvested at 18 days after anthesis, which is considered as physiological maturity stage to harvest for seed purpose.

Hilli (2005) reported that seed quality parameters such as germination, field emergence, root length, shoot length and seedling vigour index were significantly higher in ridge gourd fruits harvested after vine drying along with the lowest electrical conductivity compared to colour break stage (green fruit stage).

Sajjan and Vyakarnahal (2005) standardized the harvesting stage in okra as 40 days after anthesis for getting higher seed quality.

Results of the study conducted by Krishnakumary and Gopalakrishnan (2006) revealed that in bush cowpea variety Bhagyalakshmi, seed maturity is attained at 16 days after anthesis.

Shantappa *et al*. (2006) opined that fruits harvested at orange red colour stage resulted in highest dry weight of 100 seed (26.38 g), germination (88.81%) compared to fruits harvested at early or late stage of maturity in bitter gourd.

Shamsheer (2007) reported that in paprika chilli cv. Kt- P1- 19, the fruit weight was significantly influenced by fruit harvesting stages. Harvesting of fruits at earlier stages (dark green stage) resulted in lower fruit weight (234.6 g) which may be due to more number of immature, small and underdeveloped fruits and seeds. Seed quality parameters viz., 1000 seed weight (5.55 g), germination per cent (83.30%), were significantly maximum when the fruits were harvested at red ripe stage and reciprocal values for all these quality parameters were seen in fruits harvested at dark green stage (4.51g, 34.66%, respectively).

Anilkumar *et al.* (2008) reported that growth and development of pod and seed differs with genotypes in garden pea. Fresh weight of the developing pod increased significantly till 35 to 40 days after flowering in different genotypes and the fresh weight of grains per pod increased significantly till 40 days after flowering.

The results of the study conducted by Mistry and Hossain (2008) revealed that in okra (Pusa Sawani), seeds attained maximum development in fruits harvested at 30 DAA and it is considered as the physiological maturity stage.

Joshi *et al.* (2009) conducted physiological maturity studies in muskmelon and reported low seed vigour due to delayed fruit harvest.

Nirmaladevi *et al.* (2009) reported reduction in seed recovery and seed vigour in bittergourd if fruits are not harvested at the correct stage of physiological maturity.

Passam *et al.* (2010) concluded that the optimum time of harvest for seed production is 55 DAA in eggplant cv. Emi and Tsakoniki. Seeds extracted from fruits that were harvested at 25-35 DAA did not germinate, while seeds extracted from fruits harvested at 55 DAA showed highest percent germination.

Results of the study conducted by Krishnakumary and Meagle (2011) revealed that in bittergourd variety Preethi, physiological maturity is attained at 24 days after anthesis.

2.2 INFLUENCE OF FRUIT SIZE AND SEED POSITION ON SEED QUALITY

Proper selection of fruit is an important factor for obtaining high quantity of quality seeds in vegetables.

Maeda *et al.* (1980) revealed that seeds of okra cv. Green Velvet were divided into large and small seed lots using a screen and subdivided visually into grey, green, light yellow to dark brown and black seeds. Seed lots were evaluated by the standard germination test, first count germination, root length, colour distribution and 1000 seed weight. The germination test was the most sensitive for detecting quality differences independent of seed size among seeds of different colours, and grey seeds had the highest germination per cent. Grey seeds were also superior in all parameters among small seeds but black seeds had the highest vigour among large seeds.

Arya *et al.* (1983) graded the cabbage heads into large, medium and small based on head size and found that large sized heads were early in sprouting, flower

and pod formation and produced more number of branches and pods per plant with almost negligible mortality due to the fact that floral buds are covered by large number of leaves which protect it from low and sudden changes in temperature ultimately resulting in highest seed yield. However, there was no significant difference with respect to 1000 seed weight and germination per cent.

Karivaratharaju *et al*. (1985) studied the effect of fruit weight (from 40-340 g) on seed quality in brinjal cv. MDU-1 and observed that fruits weighing from 160-340 g gave the maximum seed recovery (4.13%) with high per cent of germination (93%) and vigour index (940) than those of smaller grade fruits which recorded less recovery of seeds because of poor filling of seeds or abortion of ovules or lack of fertilization.

Vanangamudi and Palanisamy (1989) graded the bittergourd fruits into very long (>30 cm), long (25-30 cm), medium (20-25 cm), short (15-20) and very short (<15 cm), based on fruit length and found that 100 seed weight, germination per cent, shoot length and vigour index were maximum in very long fruits which was on par with that of long fruits.

Supe and Lawande (1990) graded the bittergourd (cv. Co-2) fruits into five grades (viz., 150, 125, 100, 75 and 50 g) by weight and observed that yield of mature seed steadily increased with decrease in fruit weight and smaller fruits weighing 50 to 75 g recorded higher seed yield (78-87 g) but per cent of mature seeds was maximum in bigger fruits (i.e. 150 125 g). However, there was no significant difference with respect to germination.

In a study conducted by Palanisamy and Karivaratharaju (1990), seeds of 10 genotypes of tomato obtained from fruits picked at 8 different stages of physiological maturity were graded using an 8 × 8 wire mesh sieve as retained (G1) or passed (G2). For all genotypes seed obtained from early pickings had higher values for all parameters measured.

Srimathi *et al*. (1992) reported that the seed size, weight, germination and vigour of the seeds collected from the distal and other portions of cowpea pods did not vary widely excepting the reduced vigour of seedlings of small sized seeds. The distal end seeds recorded the higher germination and lower vigour compared to others.

The seeds of bittergourd collected from the proximal one third portion registered higher seed weight, germination per cent, shoot length. The seeds from the distal one third portion was of poor quality which was due to the poor seed development (Vijaykumar *et al*., 1994).

According to Pandita and Randhawa (1996) seed recovery was highest (44.0%) in the medium size grade fruits (1.0-1.2 mm) of tomato.

Devadas *et al*. (1998) studied the effect of fruit size (large, medium or small with lengths of 100-130, 75-95 and 50-80 cm, respectively) on seed quality in *T. anguina*. Large fruits had the highest number of seeds (101.47/fruit), the heaviest seeds (100 g seed weight of 31.17 g) and produced the heaviest seedlings (0.72 g dry weight). Seed size did not significantly influence germination (69.7-74.3%).

Devadas *et al*. (1999) graded pumpkin (*C. moschata* cv. Ambili) fruits into big, medium and small based on fruit size and found that total number and dry weight of seeds and 100 seed weight were maximum in big fruits than that of medium and small fruits. However, there was no significant difference with respect to seed germination, seedling length and vigour index and per cent of unfilled seeds per fruit. Their study revealed that fruit weight is significantly correlated with total number and dry weight of seeds/fruit and 100-seed weight. Seedling length was correlated with total number of seeds/fruit and dry weight of seeds/fruit. Germination and vigour index were not significantly related to fruit size parameters.

Mini *et al.* (2000) opined that seeds from fruits of different size groups in ash gourd recorded no significant difference in germination per cent, but showed a gradual increase in vigour index with increase in fruit size. They also observed that seeds of large size fruits recorded maximum vigour index (964) followed by medium (657) and small fruits (329).

Menaka *et al.* (2002) observed higher germination and vigour in seeds of middle position of the inflorescence than the seeds of proximal and distal positions in amaranth.

Vijayakumar *et al.* (2002) studied the relation of fruit weight and position of seeds in the fruit on seed quality in bittergourd and observed variations in seed vigour from different positions of the fruit.

Sarkar *et al.* (2003) studied the pattern of pod and seed development in garden pea and observed an initial period of slow increase in fruit weight followed by rapid increase and a final phase of slow rate of increase.

Roopa (2006) reported that the performance of big size fruit of muskmelon was better compared to other size fruits for fruit physical parameters and seed quality parameters. The big size fruits also recorded significantly higher number of filled seeds per fruit (527), total number of seeds per fruit (563), filled seeds per cent (93.61%), speed of germination (27.58), germination (94.63%), seedling length (35.27 cm), seedling dry weight (247 mg/10 seedlings), seedling vigour index (3337) and 100-seed weight (4.24 g).

Rana *et al.* (2006) studied the effect of fruit size on seed quality in bitter gourd and observed maximum seed germination and vigour in large sized fruits.

Geetharani *et al*. (2007) observed higher values for seed and seedling characteristics in large sized fruits compared to medium sized fruits in pumpkin

variety CO 2. They suggested that large sized fruits should be selected at the field level to ensure production of bolder seeds, thereby producing healthy vigorous seedlings.

Renugadevi *et al.* (2009) reported that seed size and seed quality exerted a positive association in cluster bean.

2.3 EFFECT OF STORAGE ON SEED QUALITY AND LONGEVITY

2.3.1 Seed quality and seed deterioration

Seed deterioration is defined by Delouche (1973) as summation of all physical, physiological, biochemical changes occurring in a seed, which ultimately lead to its death. He also characterized seed deterioration as inexorable, irreversible, minimal at the time of physiological maturity and variable among the seed kinds, varieties, seed lots of same variety and among individual seeds. Many researchers opined that seed deterioration is a progressive deleterious process which has far reacting consequence (Ellis and Roberts, 1981 and Ghosh *et al*. 1981).

Generally, seed viability and vigour are maximum at the time of physiological maturity. After physiological maturity, quality of seeds begin to deteriorate at varying rates depending on genetic factor and on the conditions of storage environment (Roberts, 1972).

Delouche and Baskin (1973) and Copeland (1988) had highlighted the consequences of deteriorative changes leading to death of seed which include membrane degradation, accumulation of toxic metabolites, decreased enzymatic activity, lipid autoxidation, failure of repair mechanisms, genetic degradation, reduced yield, finally loss of germination or death. Some of the major physiological and biochemical events of deterioration are presented below.

2.3.1.1 Enzyme activity and seed deterioration

Peroxidase activity was found to decrease appreciably with ageing making the seeds more sensitive to the effects of free radicals in membrane unsaturated fatty acids and production of secondary lipid peroxidation products such as monaldehyde and lipid conjugants. Association of loss of viability with enzymatic activity decline was reported in barley (Harrison and Perry, 1976) and in sorghum (Pearl *et al*. 1978).

Loss of seed viability in storage has also been related to enzymatic activity; Abdul Baki (1980) who pointed out that the respiratory and associated enzymes viz., peroxidase, glutamic acid oxidase and catalase activity decreased with loss of seed viability where as the activity of hydrolytic enzymes viz., phytase, protease and phosphates increased during storage. The increased activity of these enzymes was associated with the degradation of organocellular membranes, nucleoproteins, etc. Similar decline in peroxidase activity with increase in storage period has been reported by Nkang (1988).

Francis and Coolbear (1988) reported accumulation of phospholipase activity in aged seeds of tomato which acts on membrane phosphipids and releases fatty acids, thus indicating the loss of membrane phosphpolipid and subsequent lipid peroxidation.

Biochemical changes in free amino acids, free sugars and volatile aldehydes such as pentane, acetaldehyde and methanol is the consequence of lipid peroxidation mediated by free radicals and lipoxygenase enzymes (Wilson and McDonald, 1986).

Taung and McDonald (1995) reported that enzymes and free lipid hydroperoxides also damage membranes and leads to lipid auto-oxidation reaction in groundnut.

Increase in propetinase, polygalacturnase, pectidepolymerase and lipase enzymes activity resulted in seed deterioration by reducing total germination and oil content and increase in free fatty acid in safflower (Saxena *et al*. 1988).

Muthuraj and Kant (2006) evaluated 20 soybean genotypes for seed storability and observed that 8 genotypes are poor storers with fast deterioration in seed quality whereas 12 genotypes were identified as good storers as these genotypes maintained high germination under ambient condition even after one year of storage.

It has been well documented that certain anabolic enzymes help in maintaining viability while some catabolic enzymes decrease viability. Free radicals and hydrogen peroxides are produced from various metabolic reactions and could be destroyed by the activity of scavenger enzymes like catalase and hydrogen peroxides (Madinur, 2007).

2.3.1.2 Influence of Electrical conductivity (EC) on seed ageing and deterioration

Ghosh *et al*. (1980) reported that loss of electrolyte into the imbibing medium increased with ageing and increased content of amino acids was observed in very old rice seeds.

Negative correlation between EC with germination and field emergence was reported by Urbaniak (1984). He also reported that EC is not the accurate estimate of seed quality in frenchbean.

Doijode (1985) reported that the losses of seed sugars, amino acids and leachate conductivity were directly proportional to ageing period and inversely proportional to seed germination of onion.

Kalpana and Rao (1995) reported that in pigeon pea seeds, progressive loss in seed viability and vigour reduced water uptake, increased leakage of solutes and a decline in respiratory activity were accompanied with ageing of seeds. These changes associated with ageing were interpreted as resultants of membrane deterioration.

Perez and Arguello (1995) reported that changes in membrane integrity associated with seed deterioration occurred first in the embryonic axes and can best be monitored by conductivity tests.

A study conducted by Taylor *et al*. (1995) revealed a slight increase in amino acid leakage when onion, cabbage, tomato and pepper seeds were artificially aged at 45^0C temperature and 90 per cent relative humidity.

Faster decline in seed germination and seedling vigour was associated with greater leakage and higher production of volatile aldehydes in soybean (Shanmugavel *et al*. 1996). Similar observations were also made by Nautiyal *et al*. (1997) in groundnut during ageing.

Studies conducted by Verma *et al.* (2003) revealed that Electrical conductivity (µmhos/cm/seed) increased significantly with increase in the age of the seed in *Brassica campestris* varieties viz., Sangam and TH 68.

Electrical conductivity of stored seeds showed a progressive increase with increase in storage period, the average initial EC value was 0.51 and the final value was 0.66 at the end of 10 months of storage (Basavaraj *et al*. 2008) in onion.

In chilli, a study conducted by Manjunatha *et al*. (2008) revealed that electrical conductivity of seed leachate increased with increase in the storage period.

2.3.2 Influence of seed ageing and storage on seedling vigour

Gontia (1992) evaluated five genotypes of black gram seeds collected at 42 DAA and were stored for 6 months under ambient conditions and evaluated for per cent germination, moisture content, and seedling dry weight and length at monthly intervals. Highest per cent germination was attained by seeds collected at 42 DAA for each genotype throughout the storage period.

Manjunath (1993) reported that groundnut seeds with high initial germination exhibited higher root length (12.41 cm) and shoot length (8.16 cm).

In a study conducted by Pandian *et al*. (1994) reduction in both root and shoot length in 23 genotypes of paddy seeds were noticed when they were subjected to accelerated ageing for five days.

Kalpana and Rao (1995) reported that pigeon pea seeds showed progressive loss in seedling vigour due to accelerated ageing.

Suryawanshi and Patil (1995) reported that seeds of watermelon when dried under shade gave higher germination (99%) than those dried in sun (97%). Further, low drying temperature minimizes possible stress damage to seed due to gradual loss of the moisture.

Biradar (1996) observed that non aged seeds of sunflower recorded higher germination and greater shoot and root length and vigour indices while periodical accelerated ageing showed reduction in root length (15.75 to 12.11 cm) and shoot length (13.98 to 12.24 cm) and vigour indices during eight days of ageing.

In groundnut seeds, accelerated ageing from 0 to 12 days decreased the hypocotyl length from 1.66 to 0.25 cm and root length from 7.16 to 1.25 cm (Nautiyal *et al.* 1997).

Simpson *et al.* (2001) revealed that storage under 15^0C (control temperature) and 40% air humidity supported the germination and the vigour of dolichos bean seeds until 7 months. Storage without environmental control conditions decreased the germination and the vigour of dolichos bean seeds up to 6 months, and the seeds did not germinate after 7 months.

Kunkur *et al*. (2007) reported that in cotton, decrease in vigour index was noticed as the storage period increased.

Manjunatha *et al*. (2008) reported that chilli seeds showed a drastic decrease in vigour index (795) at the end of 12 months of storage as compared to initial vigour index (1554).

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The present investigation on "Seed maturity and seed longevity studies in snake gourd (*Tricosanthes anguina* L.) varieties" was carried out in the Department of Olericulture, College of Horticulture, Vellanikkara during 2010-2012.

The experimental site is located at 10^0 31^1 N latitude, 76^0 13^1 E longitude at an altitude of 22.25 m above Mean Sea Level. The area experiences typical warm humid tropical climate and receives an average rainfall of 2663 mm per year. The soil of the experiment site is lateritic in origin grouped under the textural class of sandy clay loam and acidic in reaction.

3.1. Experiment material

The high yielding varieties of snake gourd namely "Kaumudi" and "Baby" released by Kerala Agricultural University were selected for the study.

3.2. Experiment site

Seed maturity and seed longevity studies in snake gourd (*Tricosanthes anguina* L.) varieties were carried out in the field and laboratory of Department of Olericulture, College of Horticulture, Kerala Agricultural University, Vellanikkara during the year 2010-12 (plate 1).

3.3. Experiment details

3.3.1 Experiment- I: Physiological maturity studies in snake gourd varieties.

Snake gourd varieties namely "Kaumudi" and "Baby" were grown in the research fields of Department of Olericulture, Vellanikkara in November- April,

2010- 11. During the period of crop growth, the recommended cultural operations and plant protection measures (KAU, 2007) were carried out.

During flowering, the female flowers were tagged on the day of flower opening (anthesis). Developing fruits from the tagged flowers were harvested at three days intervals starting from 21st day after anthesis up to 45th day after anthesis were designated serially as T_1 to T_9 and were observed for fruit and seed characters. Ten fruits per replication were harvested in each maturity group and the extracted seeds were subjected to lab tests for recording seed quality parameters as per ISTA procedures.

3.3.1.1. Source of seeds

Snake gourd seeds of "Kaumudi" and "Baby" varieties obtained from seed store of Department of Olericulture were used for the experiment.

3.3.1.2. Design of experiment

The design of experiment adopted was a Complete Randomized Design (CRD) with three replications and nine treatments (different maturity group) of two varieties namely "Kaumudi" and "Baby".

3.3.1.3. Collection of experimental data

The fruits were harvested in each maturity group and the extracted seeds had been subjected to lab tests and the following parameters were recorded.

3.3.1.3.1. Morphological description of fruits and seeds

Morphological description of fruits at various stages of fruit development such as colour, smoothness and hairiness of fruit skin etc. was recorded at each

Plate 1. Field view of snake gourd varieties.

Snake gourd: Female flowers

stage. Similarly, the physical appearance of the seeds and colour were also recorded. Observations were recorded from ten fruits per replication per stage of development.

Fruit characters

3.3.1.3.2. Fruit length (cm)

The distance between the "pedicel end" and "stylar end" of the fruit was considered as the length of the fruit. The fruit length excluding the stalk was measured from base to the tip in thirty fruits in each group and average fruit length was calculated and expressed in centimetre (cm).

3.3.1.3.3. Fruit weight (g)

Immediately after harvest, fruits were weighed individually in each group (30 fruits) and average fruit weight was calculated and expressed in grams (g).

3.3.1.3.4. Fruit diameter at middle portion (cm)

The diameter of fruits was measured at highest girth in middle portion and the average was expressed in centimetre (cm).

Seed characters

3.3.1.3.5. Number of seeds per fruit

From each group, seeds from the fruits were separated and counted manually in each fruit and the average was expressed as number of seeds per fruit.

3.3.1.3.6. Fresh weight of seeds per fruit (g)

Seeds were extracted from the fruits and weighed immediately to determine the fresh weight of seeds per fruit and expressed in grams.

3.3.1.3.7. Dry weight of seeds per fruit (g)

Seeds after separation were dried under shade till they attain constant weight to arrive at the dry weight of seeds per fruit and expressed in grams.

3.3.1.3.8. 100 seed weight (g)

The weight of the 100 seeds drawn randomly from each group was recorded as per the procedure given by International Seed Testing Association (ISTA) Rules (ISTA, 1999) and the average was expressed in grams.

3.3.1.3.9. Germination per cent

In each group, germination was assessed adopting the sand method advocated by ISTA. Four hundred seeds from each treatment were sown in trays containing sterilized sand (4 replications with 100 seeds per replication) and allowed to germinate under ambient conditions. Daily observation of germination was recorded upto 10^{th} day. The initial (1^{st} count) and final (2^{nd} count) germination counts were made on sixth and tenth day of germination. The mean number of normal seedlings produced to the total number of seeds sown was expressed as germination per cent.

3.3.1.3.10. Speed of germination

The daily germination count was taken up to the final count. The Speed of Germination (SG) was calculated by adopting the method suggested by Agarwal (2000) and expressed in number.

Speed of Germination (SG)= $G_1/T_1 + G_2/T_2 + \ldots\ldots\ldots + G_n/T_n$

Where, G_1, G_2,..... G_n are the number of seeds germinated each day.

T_1, T_2 .....T_n are the days of germination test

Seedling characters:

3.3.1.3.11. Root length of seedling (cm)

At the end of the germination test period i.e. on the final count day, twenty normal seedlings were carefully uprooted at random from the test sample, washed in water and measured the root length and computed the mean. The length between collar and tip of the root was measured as root length of seedling and expressed in centimetre (cm).

3.3.1.3.12. Shoot length of seedling (cm)

From the sample after measuring root length, the length between collar and base of the primary leaf was measured as shoot length of seedling and the mean computed and expressed in centimetre (cm).

3.3.1.3.13. Seedling length (cm)

From the sample after measuring root length and shoot length, seedling length was measured from the tip of the root to base of the primary leaf and the mean computed and expressed in centimeter (cm).

3.3.1.3.14. Vigour index of seedling

The Vigour Index (VI) was calculated by adopting the method suggested by Abdul-Baki and Anderson (1973) and expressed in number.

Vigour Index= Germination (per cent) x Seedling length (cm)

3.3.1.3.15. Fruit fly attack

Incidence of fruit fly attacked was observed.

3.2.2 Experiment- II: Influence of fruit size and seed position on seed quality

Uniform ripe fruits of snake gourd were graded into three based on weight (small, medium, large), to find out the relation of fruit size on seed quality. Graded fruits were divided into 3 equal parts (pedicel end, middle and stylar end portions). Seeds were extracted separately from different portions for assessing seed quality parameters. Based on fruit size (weight), three different groups were identified

Fruit size:

Baby:

S- Small size fruits (250-400 grams)

M- Medium size fruits (400- 500 grams)

L- Large size fruits (>500 grams)

Kaumudi:

S- Small size fruits (700-900 grams)

M- Medium size fruits (900- 1700 grams)

L- Large size fruits (>1700 grams)

3.3.2.1. Design of experiment

The design of experiment adopted was a Complete Randomized Design (CRD) with three replications and nine treatments (3 X 3) of two varieties namely "Kaumudi and Baby".

3.3.2.2. Observation

The harvested fruits in each group (small, medium and large) and the extracted seeds from different portions *viz*, pedicel, middle and stylar end positions were subjected to lab test and the following parameters were recorded.

3.3.2.2.1. Fruit length:

Recorded as detailed under item **3.3.1.3.2.**

3.3.2.2.2. Fruit weight:

Recorded as detailed under item **3.3.1.3.3.**

3.3.2.2.3. Seed number per fruit:

Recorded as detailed under item **3.3.1.3.5.**

3.3.2.2.4. Fresh weight of seeds per fruit:

Recorded as detailed under item**3.3.1.3.6.**

3.3.2.2.5. Dry weight of seeds per fruit:

Recorded as detailed under item**3.3.1.3.7.**

3.3.2.2.6. 100 seed weight:

Recorded as detailed under item**3.3.1.3.8.**

3.3.2.2.7. Germination percent:

Recorded as detailed under item **3.3.1.3.9.**

3.3.2.2.8. Speed of germination:

Recorded as detailed under item **3.3.1.3.10.**

3.3.2.2.9. Root length:

Recorded as detailed under item **3.3.1.3.11.**

3.3.2.2.10. Shoot length:

Recorded as detailed under item **3.3.1.3.12.**

3.3.2.2.11. Seedling length:

Recorded as detailed under item **3.3.1.3.13.**

3.3.2.2.12. Vigour index:

Recorded as detailed under item **3.3.1.3.14.**

3.2.3 Experiment- III: Effect of storage on seed quality and longevity

Seeds collected from the fruits were extracted manually and dried to 8% moisture. The dried seeds were sealed in polythene bags of 700 gauge thickness and stored at i) ambient conditions and ii) Air- conditioned storage (A/C condition) for a period of one year from the month of April, 2011. Monthly observations on seed quality parameters were recorded.

3.3.3.1. Design of experiment

The design of experiment adopted was a Complete Randomized Design (CRD) with two replications. Treatments included twelve months of observation at

ambient conditions and A/C conditions (2 x 12 months) of two varieties namely "Kaumudi" and "Baby".

3.3.3.2. Observations

Seeds stored in sealed polythene bags at ambient conditions and A/C conditions were subjected to lab test for one year. The stored seed samples were sown in germination trays and the seed quality parameters viz., germination per cent (first and final count on 6^{th} and 10^{th} day respectively), speed of germination, shoot length (cm), root length (cm), seedling length (cm) and vigour index were recorded. Tests on electrical conductivity and dehydrogenase enzyme activity of the seed samples were also done.

3.3.3.2.1. Germination per cent:

Recorded as detailed under item **3.3.1.3.9.**

3.3.3.2.2. Speed of germination:

Recorded as detailed under item **3.3.1.3.10.**

3.3.3.2.3. Root length (cm):

Recorded as detailed under item **3.3.1.3.11.**

3.3.3.2.4. Shoot length (cm):

Recorded as detailed under item **3.3.1.3.12.**

3.3.3.2.5. Seedling length (cm):

Recorded as detailed under item **3.3.1.3.13.**

3.3.3.2.6. Vigour index:

Recorded as detailed under item **3.3.1.3.14.**

3.3.3.2.6. Enzyme activity (Enzyme dehydrogenase test)

Aqueous solution of 2, 3, 5- Triphenyl Tetrazolium Chloride (T.T.C-0.25per cent at pH 7.0) was prepared in 1000ml of Sorenson's phosphate buffer. The buffer was prepared by mixing 400 ml of aqueous solution of A (9.078g KH_2PO_4 in 1 litre distilled water) with 600 ml of aqueous solution B (11.376g Na_2HPO_4 in 1 litre distilled water).

Seeds were preconditioned by soaking in water for 24 hours. The embryos of 10 seeds from each replication were removed carefully and placed over a filter paper in petridish. T.T.C was added to immerse the embryos and kept in darkness for 12 hours. The excess T.T.C solution was decanted and seeds were thoroughly washed with distilled water. The colour was eluted from the stained embryos by steeping in 2ml of 2-methoxy ethanol (methyl cellulosolve) for 1 hour before decanting the solution. The intensity of red colour of the decanted solution was read in spectrophotometer at 470 nm.

3.3.3.2.7. Electrical conductivity (EC) of the seed leachate (dSm^{-1})

In each treatment, five grams of seeds per replication were surface sterilized using 0.1 per cent mercuric chloride solution and rinsed with water thoroughly. These seeds were soaked in 25ml distilled water in a beaker and kept in an incubator maintained at 25 $\pm 10^0$C temperature. After 24 hrs of soaking, the solution was decanted and the volume made up to 25 ml using distilled water. The electrical conductivity was recorded using the digital conductivity meter and expressed in decisiemens per metre (dSm^{-1}) as suggested by Presley (1958).

RESULTS

4. RESULTS

4.1 PHYSIOLOGICAL MATURITY STUDIES IN SNAKE GOURD VARIETIES (BABY AND KAUMUDI)

4.1.1. Morphological characters of fruits and seeds

Morphological change in fruits studied at various developmental stages with respect to colour of fruit skin and flesh in both varieties are given in Table 4.1.1a and Table 4.1.1c. Initially, the fruit was white in colour having light hairs on fruit skin, creamy white and firm placenta. Later, fruit colour changed to light red and red. Colour of placenta turned from white to light orange, and finally red. The texture of placenta changed from spongy to mucilaginous. Thickness of the seed coat increased with increased number of days in both varieties.

In Baby, on 36 DAA, fruits were light green with red tinged tip portion and mucilaginous placenta (plate 2). Seeds were hard and detached from placenta. At 39 DAA, whole fruit turned red with deep red tip portion. The stylar end of fruits started to burst open causing the seeds to drop down into soil. (Table 4.1.1a). However in variety Kaumudi, on 39 DAA, fruits were white in colour and fruit tip turns red with mucilaginous placenta (plate 3). Seeds were hard and detached from placenta. Later on 42 DAA, whole fruit turned red with red tip portion and fruit end started bursting which led to drop of seeds into soil (Table 4.1.1c).

Morphological characters of seeds studied at various developmental stages showed changes in seed colour and thickness in both varieties (Table 4.1.1b and Table 4.1.1d). Initially the seeds were ill- filled and creamy white in colour and the ring on the seeds were absent. Later, seed colour changed to light brown, brown and dark brown and the ring became visible (plate 4). The thickness of the seed coat increased with increased number of days in both varieties.

Table 4.1.1a. Morphological characters of fruits at different stages of development in snake gourd variety (Baby).

Maturity stage	Morphological characters of fruits in Baby
T1 (21 DAA)	Fruits white in colour, light hairs on fruit skin, placenta is creamy white and firm
T2 (24 DAA)	Fruits white in colour, light hairs on fruit skin, smooth and shiny, placenta is creamy white and firm
T3 (27 DAA)	Fruits white in colour, light hairs on fruit skin, smooth and shiny Placenta turning to light orange and spongy
T4 (30 DAA)	Fruits white in colour, placenta turning to light orange to red and spongy
T5 (33 DAA)	Fruits white in colour having light green tinge, no hairs on fruit skin, smooth and shiny; Placenta turning to light orange to red and spongy; seed coat hard
T6 (36 DAA)	Fruits white in colour and fruit tip (1/3 portion of the fruit) turns red, no hairs on fruit skin, smooth and shiny; reddish tinted placenta changes from spongy to mucilage and become loose; seed coat hard and detached from placenta
T7 (39 DAA)	Whole fruits became dark red, no hairs on fruit skin, fruit skin is smooth, placenta dark red, mucilage and loose and seed hard.
T8 (42 DAA)	Fruit tip starts brusting, no hairs on fruit skin and skin becomes smooth; placenta dark red, mucilage and loose
T9 (45 DAA)	Whole fruit becomes red, started shrinking and fruit tip burst; placenta dark red, mucilage and loose

Table 4.1.1b. Morphological characters of seeds at different stages of development in snake gourd variety (Baby).

Maturity stage	Morphological characters of seeds in Baby
T1 (21 DAA)	Unfilled creamy white seeds
T2 (24 DAA)	Unfilled creamy white seeds
T3 (27 DAA)	Unfilled creamy white seeds and developed ring on the seed
T4 (30 DAA)	Seeds not filled completely and light brown in colour, well developed ring on the seed
T5 (33 DAA)	Seeds filled completely and brown in colour, well developed ring on the seed, seeds loosely attached to the placenta
T6 (36 DAA)	Seed coat becomes hard and detached from placenta, seeds filled completely and dark brown in colour, well developed ring on the seed
T7 (39 DAA)	Seed coat becomes hard and detached from placenta, seeds filled completely and dark brown in colour; well developed ring on the seed
T8 (42 DAA)	Seed coat becomes hard and detached from placenta, seeds filled completely and dark brown in colour, well developed ring on the seed
T9 (45 DAA)	Seed coat becomes hard and detached from placenta, seeds filled completely and dark brown in colour, well developed ring on the seed

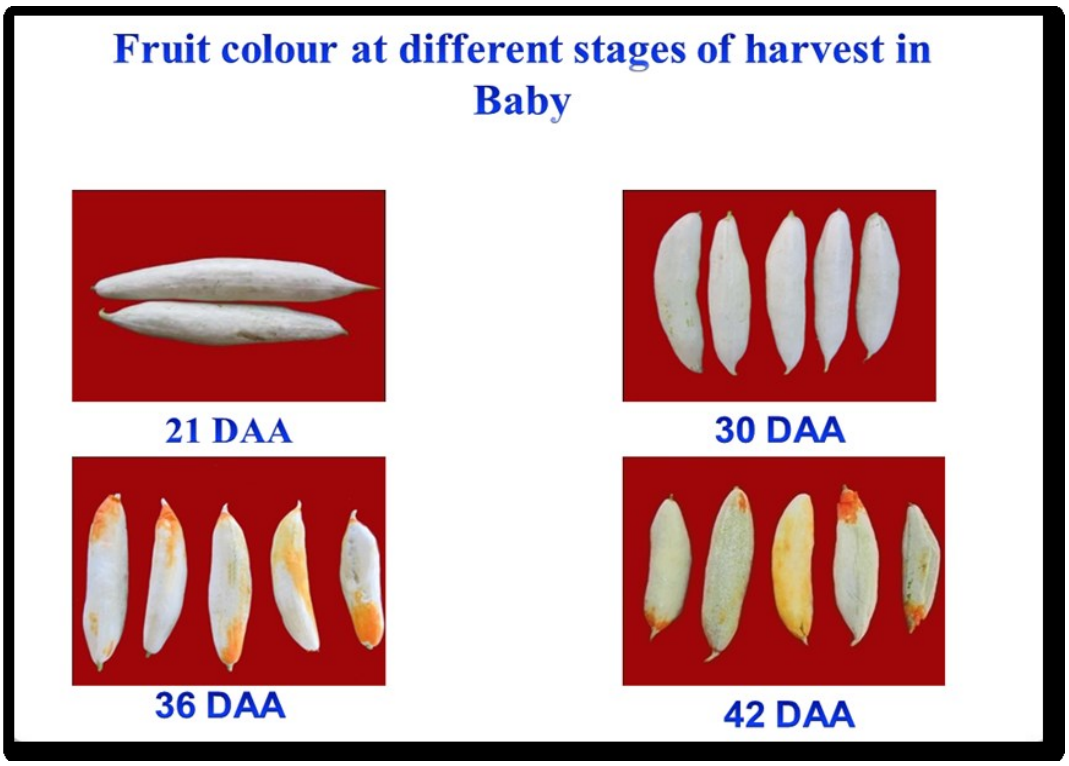
Table 4.1.1c. Morphological characters of fruits at different stages of development in snake gourd variety (Kaumudi).

Maturity stage	Morphological characters of fruits in Kaumudi
T1 (21 DAA)	Fruits white in colour, light hairs on fruit skin, placenta is creamy white- green and firm
T2 (24 DAA)	Fruits white in colour, light hairs on fruit skin, placenta is creamy white- green and firm
T3 (27 DAA)	Fruits white in colour, light hairs on fruit skin, placenta is creamy white- green and firm
T4 (30 DAA)	Fruits white in colour, light hairs on fruit skin, smooth and shiny, placenta turning to light orange and spongy
T5 (33 DAA)	Fruits white in colour, no hairs on fruit skin, smooth and shiny, placenta turning to light orange to red and spongy
T6 (36 DAA)	Fruits white in colour, no hairs on fruit skin, smooth and shiny, placenta becomes red and spongy, seed coat hard
T7 (39 DAA)	Fruits white in colour and fruit tip (1/3 portion of fruit) turns red, no hairs on fruit skin, smooth and shiny, reddish tinted placenta changes from spongy to mucilage, seed coat hard and detached from placenta
T8 (42 DAA)	Whole fruits turns dark red and fruit tip becomes red, no hairs on fruit skin and fruit skin is smooth, placenta dark red, mucilage and loose , seed hard and detached from placenta.
T9 (45 DAA)	Whole fruit becomes red and starts shrinking, fruit tip starts bursting, placenta dark red, mucilage and loose

Table 4.1.1d. Morphological characters of seeds at different stages of development in snake gourd variety (Kaumudi).

Maturity stage	Morphological characters of seeds in Kaumudi
T1 (21 DAA)	Unfilled creamy white seeds
T2 (24 DAA)	Unfilled creamy white seeds
T3 (27 DAA)	Unfilled creamy white seeds and developed ring on the seed
T4 (30 DAA)	Seeds not filled completely and light brown in colour, developed ring on the seed
T5 (33 DAA)	Seeds not filled completely and light brown in colour, well developed ring on the seed, seeds loosely attached to the placenta
T6 (36 DAA)	Seed coat becomes hard, seeds filled completely and brown in colour, well developed ring on the seed
T7 (39 DAA)	Seed coat becomes hard and detached from placenta, seeds bold and dark brown in colour, well developed ring on the seed
T8 (42 DAA)	Seed coat becomes hard and detached from placenta, seeds bold and dark brown in colour, well developed ring on the seed
T9 (45 DAA)	Seed coat becomes hard and detached from placenta, seeds bold and dark brown in colour, well developed ring on the seed

Plate 2. Variation in fruit and seed placenta colour at different stages of harvest in Snake gourd varieties.



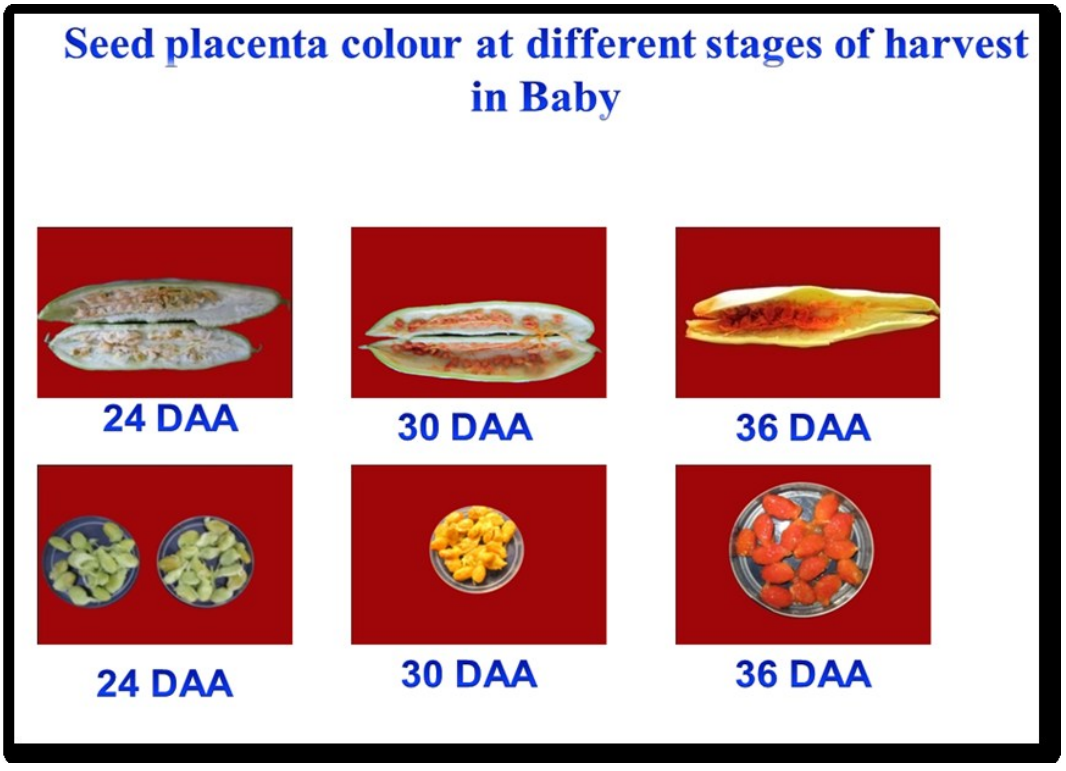
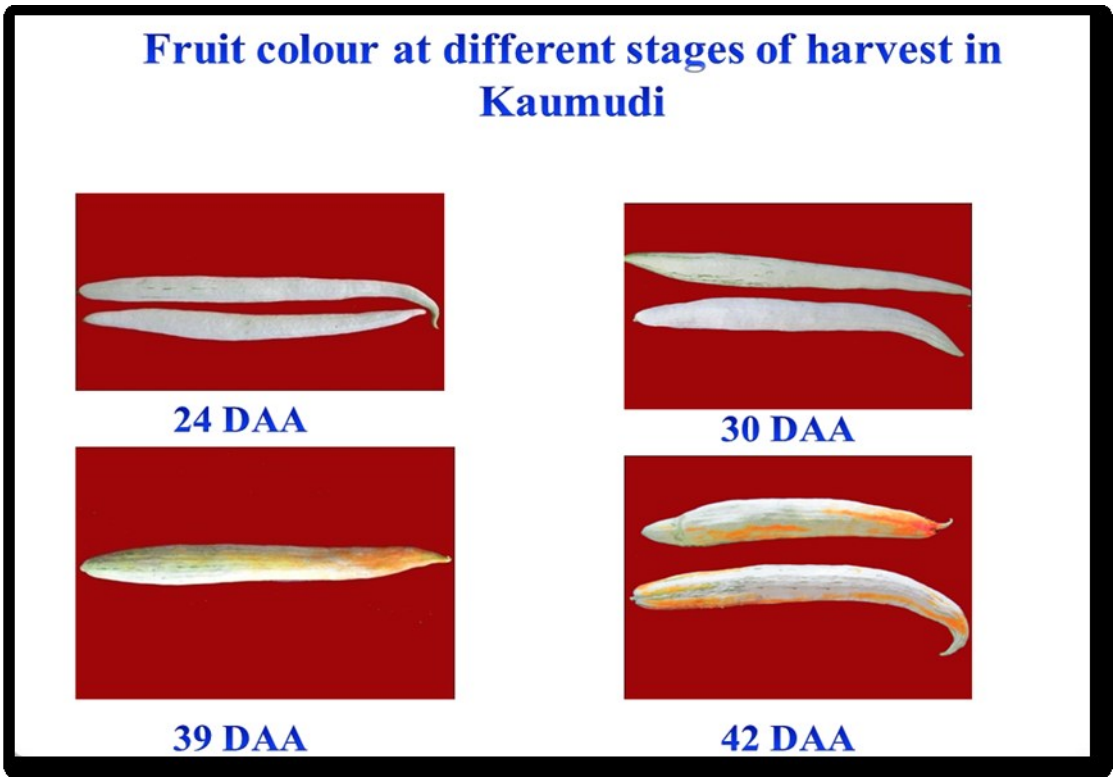


Plate 3. Variation in fruit and seed placenta colour at different stages of harvest in Snake gourd varieties.



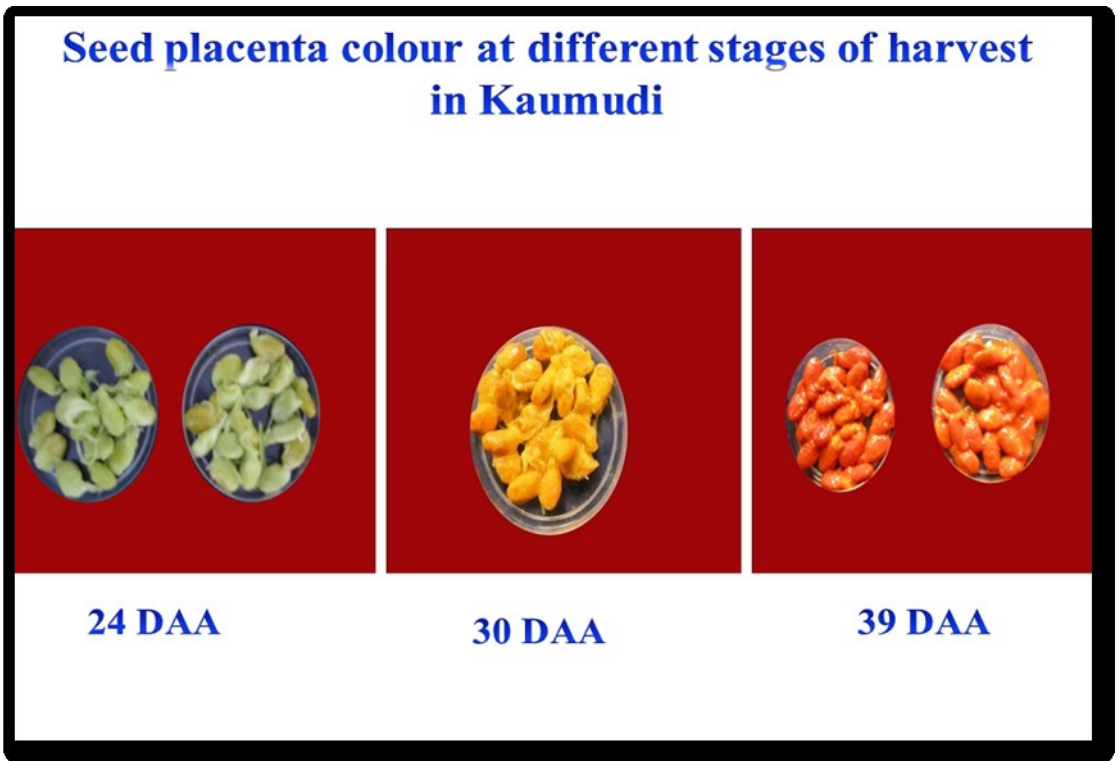
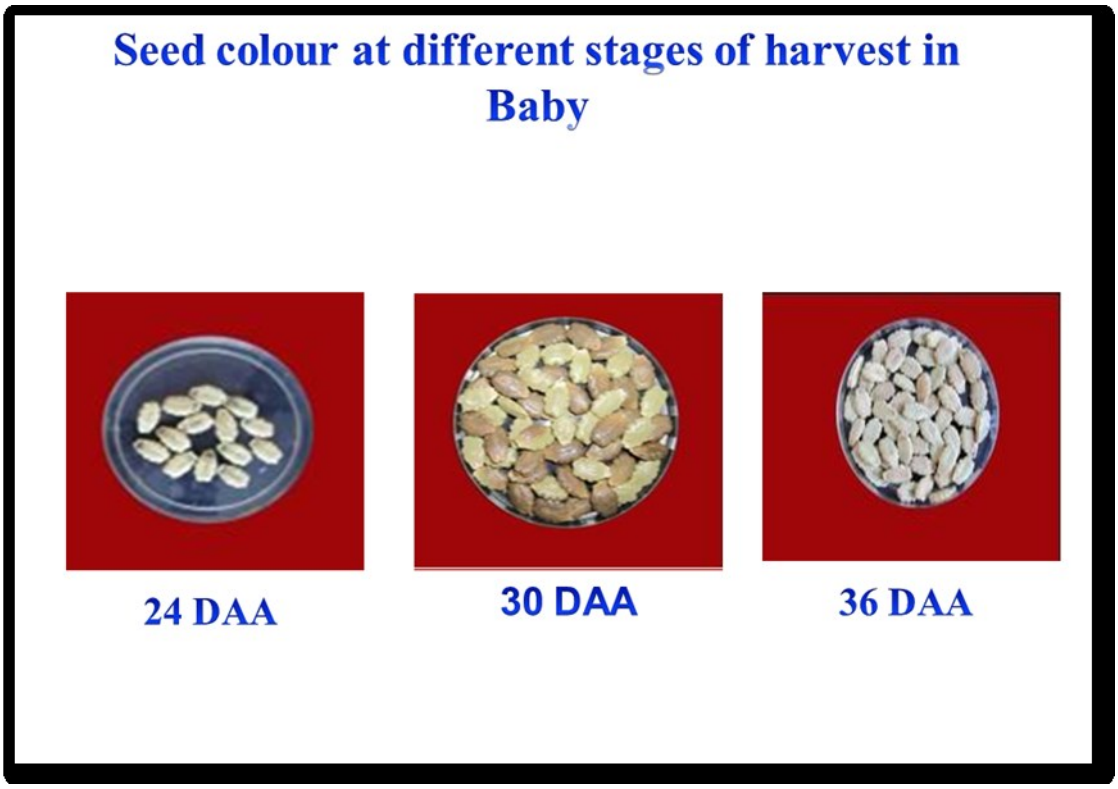
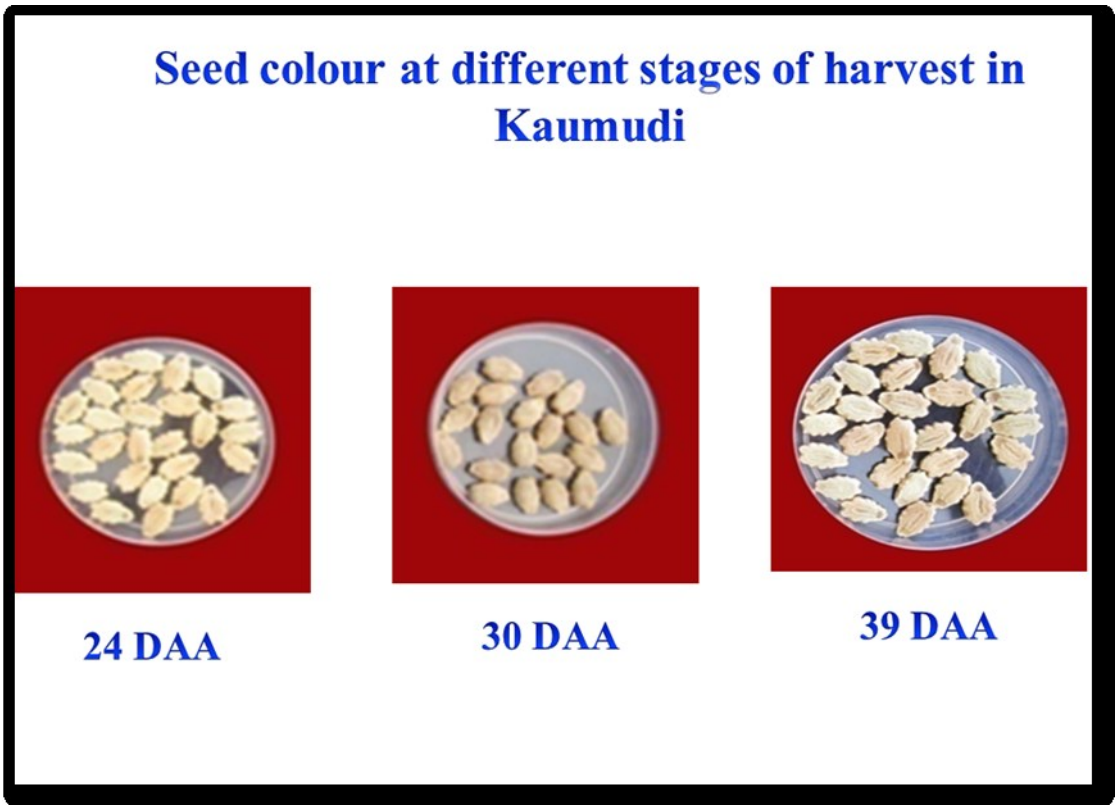


Plate 4. Variation in seed colour at different stages of harvest in Snake gourd varieties.





In Baby, on 36 DAA, seed coat becomes hard and detached from placenta. Seeds filled completely and having brown colour and well developed ring on the seed (Table 4.1.1b). In Kaumudi, on 39 DAA, seed coat becomes hard and detached from placenta. Seeds were filled completely, bold having brown colour and also developed ring on the seed (plate 4). Afterwards, no change was noticed for seeds.

Fruit and seed characters (Quantitative)

4.1.2. Fruit length (cm)

The length of the developing fruits increased significantly from T1 (32.40 cm) to T7 (37.32 cm) in Baby (Table 4.1a). In Kaumudi, length of the developing fruits increased significantly from T1 (70.83 cm) and reached maximum at T7 (102.77 cm) (Table 4.1b).Thereafter, a slight decrease in length of fruit was observed in both varieties. The differences in fruit length at different stages of development were highly significant between T1 to T5 in Baby and T1 to T7 in Kaumudi.

4.1.3. Fruit weight (g)

The fruit weight of developing fruits of both varieties increased gradually from the day of anthesis (Table 4.1a and Table 4.1b). Mean weight of developing fruits increased from T1 (351.30 g) to T6 (474.83 g) in Baby, whereas in Kaumudi, it increased from T1 (836 g) to T7 (1355.80 g). After attaining the maximum weight, a slight decrease in weight was observed in both varieties. The rate of increase in fruit weight was the highest between T1 to T6 in Baby and T1 to T7 in Kaumudi.

4.1.4. Fruit diameter (cm)

Fruit diameter at middle portion of the developing fruits increased significantly from T1 (6.66 cm) to T6 (7.33 cm) in Baby (Table 4.1a). In Kaumudi, diameter of the developing fruits increased significantly from T1 (7.20 cm) and reached maximum at T7 (9.53 cm) (Table 4.1b). Thereafter, a slight decrease in diameter of fruit was observed in both varieties. The differences in fruit diameter at different stages of development were highly significant between T1 to T6 in Baby and T1 to T7 in Kaumudi.

4.1.5. Number of seeds

The number of seeds in the developing fruits increased gradually with days of anthesis. In Baby, number of seeds at 21 DAA was 33.27 and later increased and reached maximum at T6 (58.70). Afterwards, no significant difference was noticed for seed number per fruit (Table 4.1a). In Kaumudi, number of seeds increased from T1 (66.34) to T7 (89.87) and later a slight decrease in number of seeds per fruit was observed (Table 4.1b). The rate of increase in number of seeds per fruit was the higher from T1 to T6 in Baby and T1 to T7 in Kaumudi.

4.1.6. Fresh weight of seeds per fruit (g)

Fresh weight of seeds obtained from the fruit at different growth stages is presented in table 4.1a and table 4.1b. Seed weight increased gradually with increase in days from anthesis in both varieties. Mean number of seeds of developing fruits increased from T1 (8.32 g) to T6 (17.20 g) in Baby, whereas in Kaumudi, it increased from T1 (16.85 g) to T7 (30.38 g). The rate of increase in seed weight was more upto T6 in Baby and T7 in Kaumudi. After attaining maximum seed weight (fresh), a decrease in seed weight was noticed in both the varieties.

Table 4.1a Fruit and seed characters in snake gourd var. Baby at different stages of harvest.

Treatment	Fruit length (cm)	Fruit weight (g)	Fruit diameter (cm)	No. of seeds per fruit	Fresh weight of seeds (g)	Dry weight of seeds (g)
T1 (21 DAA)	32.40^{d}	351.30^{g}	6.66^{c}	33.27^{g}	8.32^{h}	6.64^{g}
T2 (24 DAA)	33.20^{d}	375.00^{f}	6.68^{c}	36.73^{f}	9.66^{g}	7.79^{f}
T3 (27 DAA)	34.50^{c}	409.83^{e}	6.86^{c}	43.60^{e}	11.99^{f}	9.81^{e}
T4 (30 DAA)	35.42^{b}	434.67^{d}	7.09^{b}	51.77^{d}	14.55^{e}	13.08^{d}
T5 (33 DAA)	36.37^{a}	448.53^{cd}	7.12^{ab}	56.70^{abc}	16.29^{bc}	14.75^{b}
T6 (36 DAA)	37.23^{a}	474.83^{a}	7.33^{a}	58.70^{a}	17.20^{a}	15.90^{a}
T7 (39 DAA)	37.32^{a}	472.60^{ab}	7.30 ^{ab}	57.53 ^{ab}	16.86 ^{ab}	14.97^{b}
T8 (42 DAA)	37.28^{a}	461.33^{abc}	7.22 ^{ab}	55.70^{bc}	16.06^{c}	14.06^{c}
T9 (45 DAA)	37.26^{a}	456.23^{bc}	7.22 ^{ab}	54.43^{c}	15.20^{d}	13.61^{cd}
CD (P=0.05)	0.85	15.44	0.19	2.22	0.60	0.56

Table 4.1a contd...

Treatment	Germination per cent	Speed of germination	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Vigour index
T1 (21 DAA)	0	0	0	0	0	0
T2 (24 DAA)	0	0	0	0	0	0
T3 (27 DAA)	0	0	0	0	0	0
T4 (30 DAA)	30.67^{d}	2.65^{d}	4.75^{c}	9.00^{e}	13.75^{e}	422.00^{e}
T5 (33 DAA)	60.00^{c}	6.59^{c}	5.48^{b}	10.17^{d}	15.65^{d}	939.00^{d}
T6 (36 DAA)	84.00^{a}	9.14^{a}	6.80^{a}	16.77^{a}	23.57^{a}	1980.00^{a}
T7 (39 DAA)	81.33^{a}	8.89^{ab}	6.73^{a}	16.65^{a}	23.38^{a}	1901.00^{a}
T8 (42 DAA)	78.67^{ab}	8.67^{ab}	6.82^{a}	15.95^{b}	22.77^{b}	1791.00^{b}
T9 (45 DAA)	74.67^{b}	8.42^{b}	6.47^{a}	15.13^{c}	21.60^{c}	1613.00^{c}
CD (P=0.05)	4.92	0.44	0.32	0.40	0.47	99.00

Table 4.1b Fruit and seed characters in snake gourd var. Kaumudi at different stages of harvest.

Treatment	Fruit length (cm)	Fruit weight (g)	Fruit diameter (cm)	No. of seeds per fruit	Fresh weight of seeds (g)	Dry weight of seeds (g)
T1 (21 DAA)	70.83^{g}	836.00^{h}	7.20^{g}	66.34^{h}	16.85^{h}	16.32^{h}
T2 (24 DAA)	75.93^{f}	899.00^{g}	7.42^{f}	69.33^{g}	18.17^{g}	17.61^{g}
T3 (27 DAA)	81.63^{e}	984.43^{f}	7.89^{e}	73.20^{f}	19.69^{f}	19.18^{f}
T4 (30 DAA)	86.12^{d}	1054.33^{e}	8.21^{d}	77.83^{e}	21.46^{e}	21.48^{e}
T5 (33 DAA)	93.22^{c}	1168.33^{d}	8.80^{c}	82.33^{d}	24.04^{d}	22.66^{d}
T6 (36 DAA)	99.45^{b}	1260.00^{c}	9.19^{b}	85.47^{c}	26.93^{c}	26.31^{b}
T7 (39 DAA)	102.77^{a}	1355.80^{a}	9.53^{a}	89.87^{a}	30.38^{a}	27.71^{a}
T8 (42 DAA)	102.62^{a}	1304.33^{b}	9.27^{b}	87.90^{ab}	29.21^{b}	26.47^{b}
T9 (45 DAA)	100.82^{b}	1290.30^{b}	8.91^{c}	87.17^{bc}	27.18^{c}	25.28^{c}
CD (P=0.05)	1.72	14.76	0.13	1.91	0.64	0.52

Table 4.1b contd...

Treatment	Germination per cent	Speed of germination	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Vigour index
T1 (21 DAA)	0	0	0	0	0	0
T2 (24 DAA)	0	0	0	0	0	0
T3 (27 DAA)	0	0	0	0	0	0
T4 (30 DAA)	33.33^{d}	3.13^{d}	5.61^{d}	9.58^{e}	15.20^{e}	507.00^{e}
T5 (33 DAA)	61.33^{c}	7.16^{c}	6.53^{c}	10.28^{d}	16.81^{d}	1031.00^{d}
T6 (36 DAA)	81.33^{b}	9.26^{b}	6.82^{c}	16.83^{c}	23.65^{c}	1924.00^{c}
T7 (39 DAA)	88.00^{a}	10.36^{a}	8.23^{a}	17.78^{a}	26.02^{a}	2288.00^{a}
T8 (42 DAA)	84.00^{ab}	10.35^{a}	7.68^{b}	17.15^{b}	24.83^{b}	2053.00^{b}
T9 (45 DAA)	82.67^{ab}	9.68^{ab}	7.60^{b}	16.87^{bc}	24.47^{b}	2015.00^{bc}
CD (P=0.05)	4.92	0.69	0.36	0.27	0.55	108.00

4.1.7. Dry weight of seeds per fruit (g)

Significant difference was noticed for dry weight of seeds obtained from fruits at different growth stages in both varieties. Dry weight of seeds increased from T1 (6.64 g) to T6 (15.90 g) in Baby, whereas in Kaumudi, it increased from T1 (16.32 g) to T7 (27.71 g). After attaining maximum seed weight at T6 in Baby and T7 in Kaumudi, the seed weight decreased thereafter.

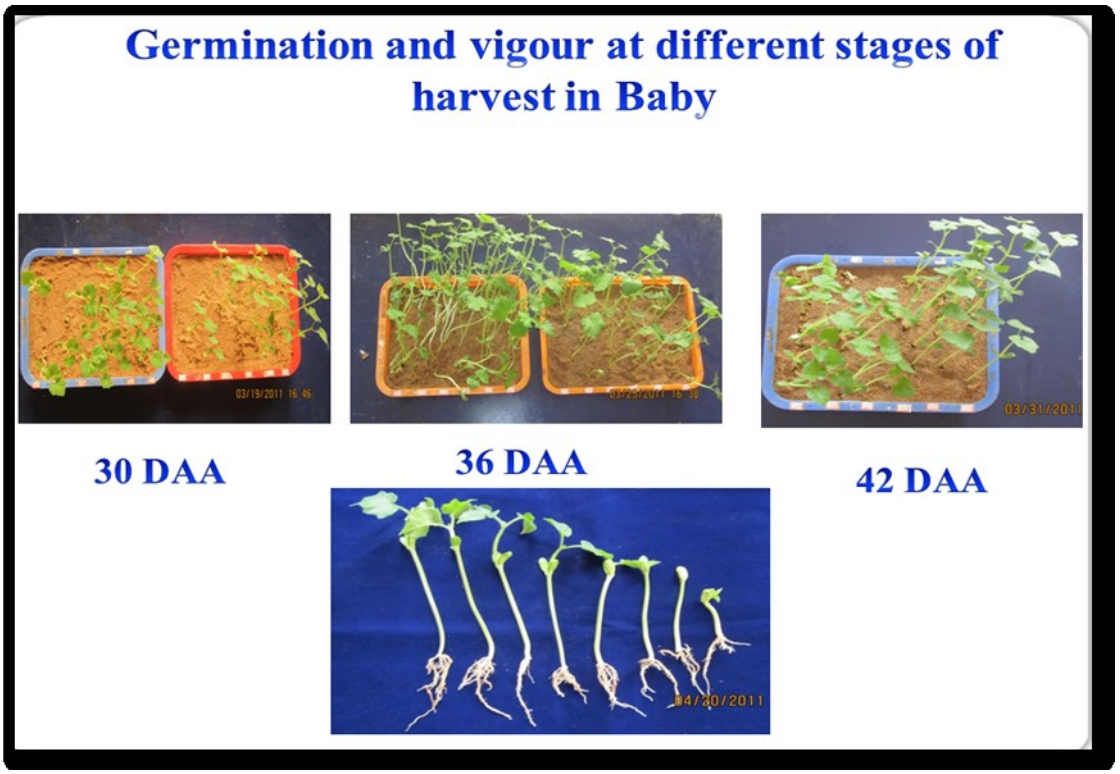
4.1.8. 100 seed weight (g)

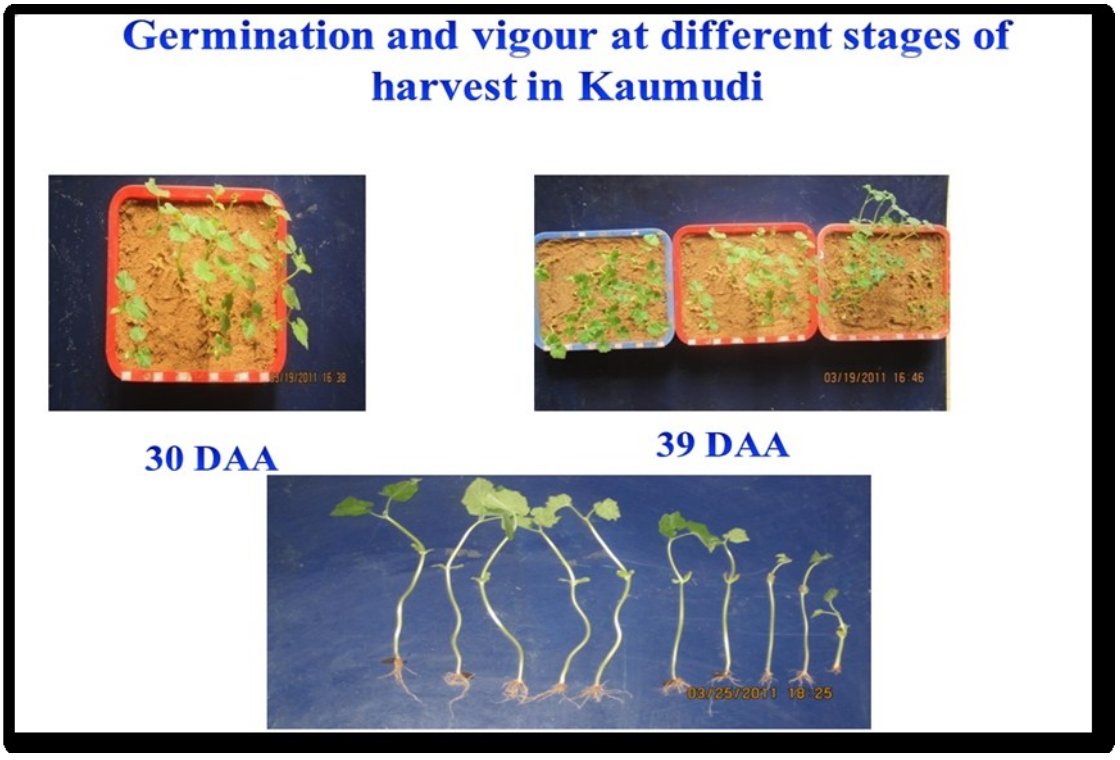
Average weight of 100 seeds in Baby and Kaumudi varieties are presented in Table 4.1a and Table 4.1b respectively. In Baby, 100 seed weight increased from T1 (20.60 g) and reached maximum in T6 (27.08 g), whereas in Kaumudi, it increased from T1 (24.61 g) reaching maximum in T7 (30.95 g). After attaining the maximum 100 seed weight in T6 (Baby) and T7 (Kaumudi), a slight decrease was noticed in seed weight of both varieties later on. The differences in 100 seed weight among the treatments were highly significant in both the varieties studied.

4.1.9. Germination per cent

Significant variation for germination per cent of seeds at different maturity stages of fruit were observed in both the varieties (plate 5). Seeds from fruits of T1, T2 and T3 (21- 27 days after anthesis) did not germinate in both varieties. In Baby, least germination was recorded in T4 (30.67 %). It increased and reaching maximum in T6 (84 %). Thereafter a slight decrease in germination was observed. In Kaumudi, seeds germinated at T4 (33.33 %) and it gradually increased (61.33 % in T5 and above 80 % in T6, T7, T8 and T9). Highest germination per cent was observed in T7 and thereafter a slight decrease in germination was observed.

Plate 5. Variation in seed germination and vigour at different stages of harvest in Snake gourd varieties.





4.1.10. Speed of germination

Significant difference in speed of germination was noticed in seeds at different stages of development in both the varieties. Value of speed of germination for T1, T2 and T3 were 0 since no seed germination in these treatments. In Baby, lowest speed of germination was recorded in T4 (2.65) and the highest (9.14) in T6. Thereafter, a decrease in speed of germination was observed in T7, T8 and T9. In Kaumudi, lowest speed of germination was recorded in T4 (3.13) and the highest in T7 (10.36) and thereafter it decreased to 9.68 in T9.

Seedling characters:

4.1.11. Root length of seedlings (cm)

The root length of seedlings from seeds of different stages of development and maturity significantly differed in both varieties. In Baby, root length of seedlings was the lowest in T4 (4.75 cm) and it increased. Root length of seedlings was on par in T6, T7, T8 and T9 (> 6 cm). In Kaumudi, least root length of seedlings was recorded in T4 (5.61 cm) and the highest in T7 (8.23 cm). Thereafter a slight decrease in root length of seedling was observed in T8 (7.68 cm) and T9 (7.60 cm).

4.1.12. Shoot length of seedlings (cm)

Significant variation was observed for shoot length of seedlings from seeds of different stages of development and maturity in both varieties. In Baby, shoot length of seedlings was the lowest in T4 (9.00 cm) and highest in T6 (16.77 cm) and T7 (16.65 cm). In Kaumudi, lowest value for shoot length was recorded in T4 (9.58 cm) and the highest in T7 (17.78 cm). A decrease in shoot length of seedlings was observed later (T8 and T9) in both varieties after the attainment of maximum shoot length.

4.1.13. Seedling length (cm)

In Baby, lowest value for seedling length was recorded in T4 (13.75 cm) and highest in T6 and T7 with a seedling length of more than 23 cm. In Kaumudi, seedling length was lowest in T4 (15.20 cm) and highest in T7 (26.02 cm). In both varieties, seedling length decreased later after the attainment of maximum value.

4.1.14. Vigour index of seedling

The vigour index of seedlings from seeds of different stages of development and maturity differed significantly in both varieties. As T1, T2 and T3 recorded no germination in both varieties, the vigour index value was zero. In Baby, vigour index of seedlings was the lowest in T4 (422) and highest in T6 (1980). Thereafter a decrease in vigour index of seedling was observed. In Kaumudi, lowest value for vigour index was observed in T4 (507) and the highest in T7 (2288). Thereafter a decrease in vigour index of seedling was observed.

4.1.15. Fruit fly attack

Since pheromone traps were placed in the field, fruit fly attacked was not noticed.

4.2 INFLUENCE OF FRUIT SIZE AND SEED POSITION ON SEED QUALITY

The data on influence of fruit size on seed characters in snake gourd var. Baby and Kaumudi are presented in Table 4.2a, 4.2b and plate 6 and the data on influence of fruit size and seed position on seed characters in both varieties are presented in Table. 4.2c and 4.2d.

4.2.1 Fruit length (cm)

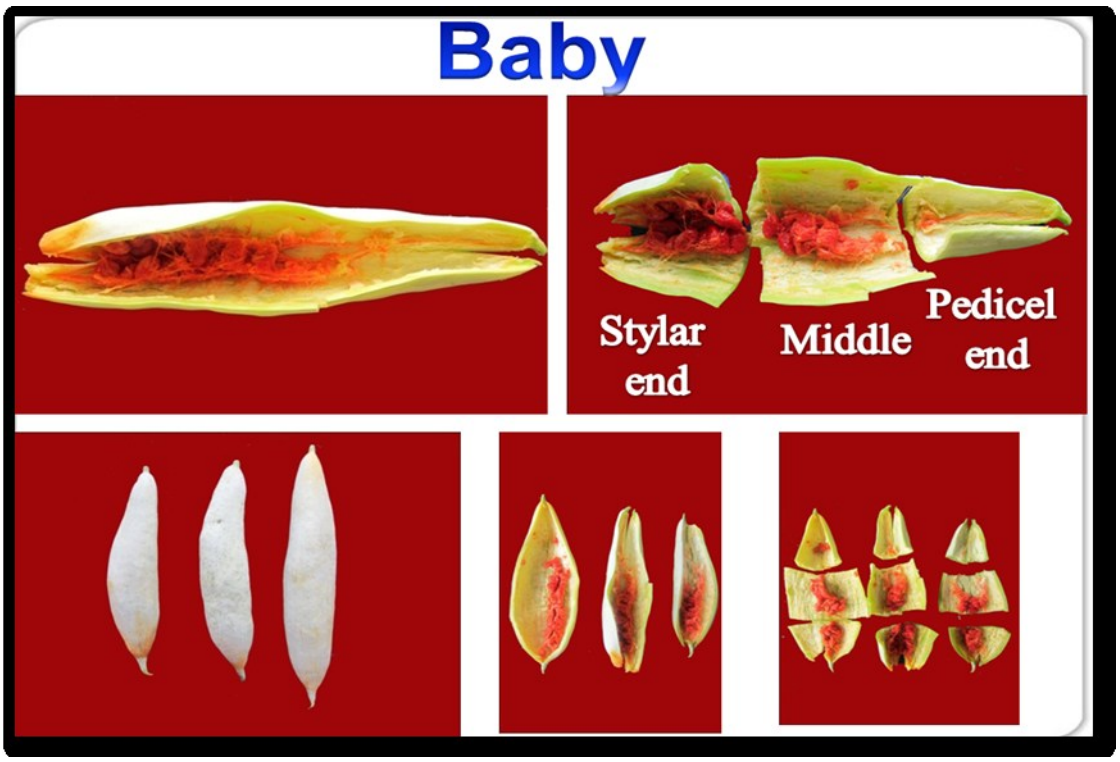
Fruit length differed significantly with difference in fruit sizes. The large sized fruits recorded higher fruit length (42.45 cm) significantly higher than medium sized fruits (36.33 cm) while, small sized fruits recorded significantly lower fruit length (32.45 cm) in Baby (Table 4.2a). In Kaumudi also, large sized fruits recorded significantly higher fruit length (112.97 cm) than medium sized fruits (95.17 cm) and small sized fruits (73.85 cm) (Table 4.2b).

Since the fruit is divided into three equal parts, the fruit length of pedicel, middle and stylar regions remains the same in all categories of fruits. Fruit length of each portion (pedicel, middle and stylar end) was 10.80 cm in small sized fruit and 12.10 cm, 14.15 cm for each portion of medium and large fruits in Baby variety (Table. 4.2c). In Kaumudi, fruit length of each portion (pedicel, middle and stylar end) of small sized, medium sized and large sized fruits were 24.61 cm, 31.75 cm and 37.65 cm respectively (Table 4.2d).

4.2.2 Fruit weight (g)

The fruit weight was found to vary significantly with fruit sizes. The large sized fruits recorded significantly higher fruit weight (626 g) compared to medium sized fruits (467 g) whereas the average weight of small sized fruits was 315 g in Baby (Table 4.2.a).

Plate 6. Influence of fruit size and seed position on seed quality in snake gourd varieties.



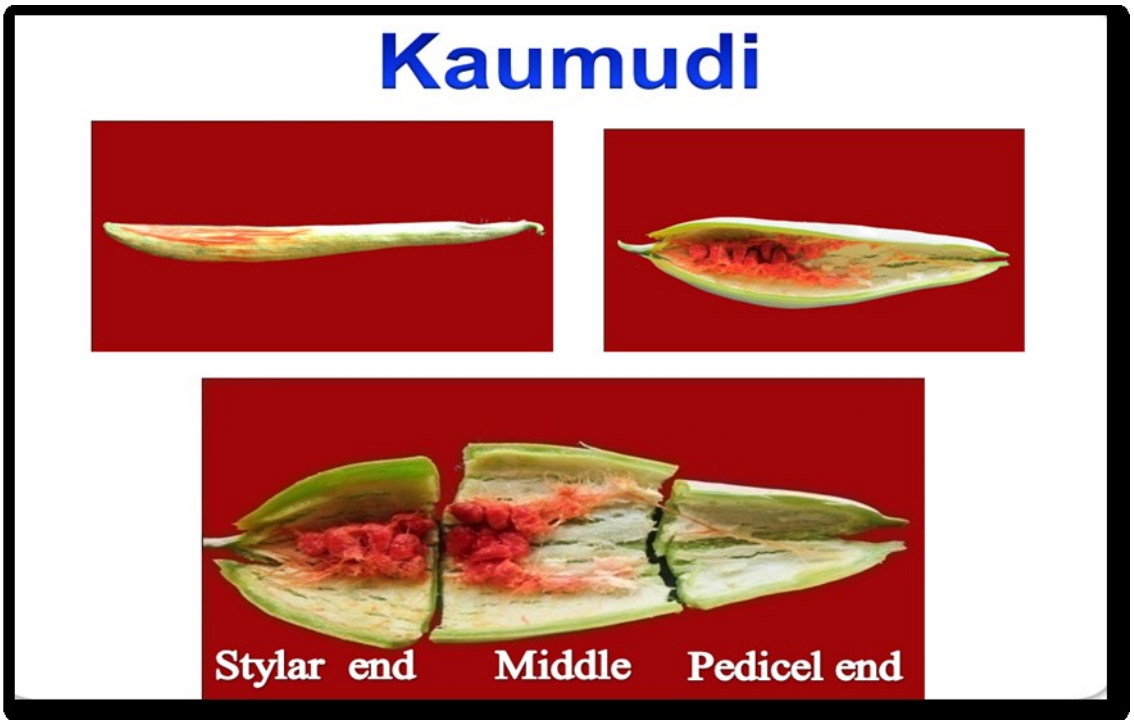


Table 4.2a Influence of fruit size on seed characters in snake gourd var. Baby.

Characters	**Small (S)**	**Medium (M)**	**Large (L)**	**CD (P=0.05)**
Fruit length (cm)	32.45[c]	36.33[b]	42.45[a]	0.79
Fruit weight (g)	315.00 [c]	467.00 [b]	626.00 [a]	15.73
No. of seeds per fruit	44.40 [c]	56.20 [b]	65.10 [a]	2.49
Fresh weight of seeds (g)	13.32 [c]	17.99 [b]	20.83 [a]	0.77
Dry weight of seeds (g)	11.99 [c]	16.13 [b]	18.67 [a]	0.69
100 seed weight (g)	27.37 [b]	28.54 [a]	28.72 [a]	0.19
Germination percentage	75.00 [a]	80.00 [a]	79.00 [a]	6.62
Speed of germination	8.25 [c]	9.55 [a]	9.00 [b]	0.18
Root length (cm)	6.18 [b]	7.00 [a]	6.76 [a]	0.54
Shoot length (cm)	14.89 [b]	16.00[a]	15.63 [ab]	0.75
Seedling length (cm)	21.07 [b]	23.00 [a]	22.39 [ab]	1.27
Vigour index	1575.00[b]	1842.00 [a]	1761.00 [ab]	222.00

Table 4.2b Influence of fruit size on seed characters in snake gourd var. Kaumudi.

Characters	**Small (S)**	**Medium (M)**	**Large (L)**	**CD (P=0.05)**
Fruit length (cm)	73.85 [c]	95.17 [b]	112.97 [a]	1.96
Fruit weight (g)	831.00 [c]	1558.00 [b]	2167.00 [a]	47.65
No. of seeds per fruit	65.10 [c]	87.13 [b]	101.67 [a]	2.24
Fresh weight of seeds (g)	22.07 [c]	27.88 [b]	32.53 [a]	0.78
Dry weight of seeds (g)	17.91 [c]	25.68 [b]	29.69 [a]	0.80
100 seed weight (g)	27.86 [c]	29.45 [b]	30.05 [a]	0.30
Germination percentage	78.00 [b]	87.00 [a]	84.00 [a]	5.47
Speed of germination	9.49 [b]	10.27 [a]	10.20 [a]	0.13
Root length (cm)	8.22 [a]	8.51 [a]	8.32 [a]	0.34
Shoot length (cm)	17.10 [a]	17.55 [a]	17.24 [a]	0.72
Seedling length (cm)	25.32 [a]	26.06 [a]	25.56 [a]	1.05
Vigour index	1970.00 [b]	2258.00 [a]	2149.00[ab]	216.00

In Kaumudi, the large fruits recorded significantly higher fruit weight (2167 g) compared to medium fruits (1558 g) and small fruits (831 g) (Table 4.2.b).

Fruit weight was found to vary significantly with position of seed in different sized fruits in both varieties. The middle region of small, medium and large sized fruits recorded significantly higher fruit weight (121.67 g, 200.00 g and 269.17 g, respectively) compared to stylar end (107.50 g, 148.33 g and 215.83 g, respectively). Fruit weight of pedicel end region was low fruits of all sizes (85.83 g, 118.33 g and 140.83 g in small, medium and large sized fruits in Baby) (Table 4.2.c). In Kaumudi, the middle portion of small, medium and large sized fruits recorded significantly higher fruit weight (348.33 g, 626.67 g and 918.33 g, respectively) compared to stylar end region (246.00 g, 545.83 g and 736.67 g, respectively) and pedicel region (238.50 g, 399.17 g and 521.67 g, respectively) (Table 4.2.d).

4.2.3 Number of seeds

The number of seeds per fruit in “Baby” was significantly influenced by the fruit size. The large sized fruits recorded higher number of seeds (65.10) compared to medium sized fruits (56.20), and small sized fruits (44.40) in Baby (Table 4.2.a). In Kaumudi, the number of seeds in large sized fruit was 101.67 whereas medium and small sized fruits contained a seed number of 87.13 and 65.10, respectively.

Seed number was found to vary significantly with respect to fruit size and different portions of fruit (pedicel, middle and stylar end region of the fruit) in both varieties. In Baby, the middle region of small, medium and large sized fruits recorded significantly higher number of seeds (22.40, 29.63 and 35.70, respectively) followed by stylar region of small, medium and large sized fruits (15.37, 18.57 and 20.67, respectively). Number of seeds observed in pedicel end region of different sized fruits were low (6.70, 7.90 and 8.77, respectively) in Baby (Table 4.2.c). In snake gourd variety Kaumudi, the middle region of different sized

fruits recorded significantly higher number of seeds (35.97, 50.30 and 59.33 in small, medium and large fruits, respectively) compared to stylar end region (20.57, 25.53 and 28.67, respectively) and pedicel end region (8.60, 11.30 and 13.67, respectively) (Table 4.2.d).

4.2.4 Fresh weight of seeds (g)

Fresh weight of seeds per fruit differed significantly with fruit sizes and it was higher in large sized fruits (20.83 g) followed by medium sized fruits (17.99 g) and small sized fruits (13.32 g) in Baby (Table 4.2.a). In Kaumudi, also the same trend in observed recording significantly higher fresh weight for seeds (32.53 g) in large sized fruits over medium (27.88 g) and small sized fruits (22.07 g) (Table 4.2.b).

Fresh weight of seeds per fruit was found to vary with fruit sizes and seed position within the fruit in both varieties. The middle region of small, medium and large sized fruits recorded significantly higher fresh weight of seeds (6.72 g, 9.48 g and 11.42 g, respectively) followed by stylar end region (4.61 g, 5.94 g and 6.61 g, respectively). Fresh weight of seeds was low (2.01 g, 2.53 g and 2.81 g) in the pedicel region of small, medium and large sized fruits respectively in Baby (Table 4.2.c). In Kaumudi also, the middle region of small, medium and large sized fruits recorded significantly higher fresh weight of seeds (12.23 g, 16.09 g and 18.99 g, respectively) compared to stylar end region (6.99 g, 8.17 g and 9.17 g, respectively) and pedicel end region of small, medium and large sized fruits, (2.92 g, 3.62 g and 4.37 g respectively) (Table 4.2.d).

Table 4.2c Influence of seed position on fruit and seed characters in snake gourd var. Baby.

Treatment	Fruit length (cm)	Fruit weight (g)	No. of seeds	Fresh weight of seeds (g)	Dry weight of seeds (g)	100 seed weight (g)
SP (Small- Pedicel end)	10.80^{c}	85.83^{g}	6.70^{h}	2.01^{g}	1.81^{g}	27.17^{h}
SM (Small- Middle)	10.80^{c}	121.67^{e}	22.40^{c}	6.72^{c}	6.05^{c}	27.77^{f}
SS (Small- Stylar end)	10.80^{c}	107.50^{f}	15.37^{f}	4.61^{e}	4.15^{e}	27.50^{g}
MP (Medium- Pedicel end)	12.10^{b}	118.33^{e}	7.90^{g}	2.53^{f}	2.27^{f}	28.29^{e}
MM (Medium- Middle)	12.10^{b}	200.00^{c}	29.63^{b}	9.48^{b}	8.50^{b}	28.91^{a}
MS (Medium- Stylar end)	12.10^{b}	148.33^{d}	18.57^{e}	5.94^{d}	5.33^{d}	28.44^{d}
LP (Large- Pedicel end)	14.15^{a}	140.83^{d}	8.77^{g}	2.81^{f}	2.51^{f}	28.58^{c}
LM (Large- Middle)	14.15^{a}	269.17^{a}	35.70^{a}	11.42^{a}	10.25^{a}	28.92^{a}
LS (Large- Stylar end)	14.15^{a}	215.83^{b}	20.67^{d}	6.61^{c}	5.93^{c}	28.67^{b}
CD (P=0.05)	N.S.	8.00	1.12	0.35	0.31	0.08

Table 4.2c contd...

Treatment	Germination per cent	Speed of germination	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Vigour index
SP (Small- Pedicel end)	68.00^{d}	7.81^{f}	5.82^{d}	14.23^{c}	20.05^{d}	1364.00^{d}
SM (Small- Middle)	80.00^{abc}	8.74^{d}	6.48^{abcd}	15.47^{ab}	21.95^{abcd}	1758.00^{abc}
SS (Small- Stylar end)	76.00^{bc}	8.19^{e}	6.24^{cd}	14.98^{bc}	21.22^{cd}	1615.00^{c}
MP (Medium- Pedicel end)	76.00^{bc}	9.03^{c}	6.48^{abcd}	15.47^{ab}	21.95^{abcd}	1670.00^{bc}
MM (Medium- Middle)	84.00^{a}	10.31^{a}	7.28^{a}	16.33^{a}	23.62^{a}	1986.00^{a}
MS (Medium- Stylar end)	80.00^{abc}	9.30^{b}	7.22^{ab}	16.20^{a}	23.42^{ab}	1875.00^{ab}
LP (Large- Pedicel end)	75.00^{c}	8.68^{d}	6.37^{bcd}	15.25^{abc}	21.62^{bcd}	1614.00^{c}
LM (Large- Middle)	83.00^{ab}	9.37^{b}	7.12^{ab}	16.00^{ab}	23.12^{abc}	1910.00^{ab}
LS (Large- Stylar end)	79.00^{abc}	8.95^{c}	6.80^{abc}	15.63^{ab}	22.43^{abc}	1765.00^{abc}
CD (P=0.05)	6.05	0.17	0.78	1.04	1.76	231.00

Table 4.2d Influence of seed position on fruit and seed characters in snake gourd var. Kaumudi.

Treatment	Fruit length (cm)	Fruit weight (g)	No. of seeds	Fresh weight of seeds (g)	Dry weight of seeds (g)	100 seed weight (g)
SP (Small- Pedicel end)	24.61^{c}	238.50^{g}	8.60^{i}	2.92^{i}	2.37^{i}	27.66^{i}
SM (Small- Middle)	24.61^{c}	348.33^{f}	35.97^{c}	12.23^{c}	9.89^{c}	28.13^{g}
SS (Small- Stylar end)	24.61^{c}	246.00^{g}	20.57^{f}	6.99^{f}	5.66^{f}	27.78^{h}
MP (Medium- Pedicel end)	31.75^{b}	399.17^{e}	11.30^{h}	3.62^{h}	3.30^{h}	29.13^{f}
MM (Medium- Middle)	31.75^{b}	626.67^{c}	50.30^{b}	16.09^{b}	14.69^{b}	29.77^{c}
MS (Medium- Stylar end)	31.75^{b}	545.83^{d}	25.53^{e}	8.17^{e}	7.45^{e}	29.44^{e}
LP (Large- Pedicel end)	37.65^{a}	521.67^{d}	13.67^{g}	4.37^{g}	3.97^{g}	29.55^{d}
LM (Large- Middle)	37.65^{a}	918.33^{a}	59.33^{a}	18.99^{a}	17.36^{a}	30.54^{a}
LS (Large- Stylar end)	37.65^{a}	736.67^{b}	28.67^{d}	9.17^{d}	8.37^{d}	30.04^{b}
CD (P=0.05)	N.S.	31.87	0.93	0.30	0.30	0.05

Table 4.2d contd...

Treatment	Germination per cent	Speed of germination	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Vigour index
SP (Small- Pedicel end)	72.00^{d}	8.93^{f}	8.00^{c}	16.78^{b}	24.78^{c}	1785.00^{d}
SM (Small- Middle)	83.00^{bc}	10.28^{b}	8.40^{bc}	17.43^{ab}	25.83^{abc}	2136.00^{bc}
SS (Small- Stylar end)	79.00^{c}	9.27^{e}	8.25^{bc}	17.10^{b}	25.35^{bc}	1995.00^{cd}
MP (Medium- Pedicel end)	83.00^{bc}	9.71^{d}	8.25^{bc}	17.10^{b}	25.35^{bc}	2095.00^{bc}
MM (Medium- Middle)	91.00^{a}	10.99^{a}	8.85^{a}	18.17^{a}	27.02^{a}	2449.00^{a}
MS (Medium- Stylar end)	87.00^{ab}	10.11^{c}	8.43^{abc}	17.37^{ab}	25.80^{abc}	2171.00^{bc}
LP (Large- Pedicel end)	80.00^{c}	9.64^{d}	8.15^{bc}	16.95^{b}	25.10^{bc}	2010.00^{cd}
LM (Large- Middle)	88.00^{ab}	10.92^{a}	8.55^{ab}	17.67^{ab}	26.22^{ab}	2309.00^{ab}
LS (Large- Stylar end)	84.00^{bc}	10.04^{c}	8.25^{bc}	17.10^{b}	25.35^{bc}	2131.00^{bc}
CD (P=0.05)	5.45	0.13	0.40	0.81	1.20	221.00

4.2.5 Dry weight of seeds (g)

Dry weight of seeds per fruit varied significantly with fruit sizes. Large sized fruits recorded significantly higher dry weight of seeds (18.67 g) followed by medium sized fruits (16.13 g) and small sized fruits (11.99 g) in Baby (Table 4.2.a).In Kaumudi, significantly higher dry weight of seeds (29.69 g) was observed in large sized fruits than medium and small sized fruits (25.68 g and 17.91 g respectively) (Table 4.2.b).

Dry weight of seeds varied with the position of seed in different sized fruits. Fruit size and seed position within the fruit influenced dry weight of seeds in both varieties. The middle region of small, medium and large sized fruits recorded significantly higher dry weight of seeds (6.05 g, 8.50 g and 10.25 g respectively) compared to stylar end region (4.15 g, 5.33 g and 5.93 g respectively) and pedicel end region (1.81 g, 2.27 g and 2.51 g respectively) in Baby (Table 4.2.c). In Kaumudi also, the middle region of small, medium and large sized fruits recorded significantly higher dry weight of seeds (9.89 g, 14.69 g and 17.36 g respectively) followed by stylar end region (5.66 g, 7.45 g and 8.37 g respectively). Dry weight of seeds was very low (2.37 g, 3.30 g and 3.97 g respectively) in pedicel end region of small, medium and large sized fruits respectively (Table 4.2.d).

4.2.6 100 seed weight (g)

The 100 seed weight differed significantly with fruit sizes. Large sized fruits recorded a 100 seed weight of 28.72 g which was on par with that in medium sized fruits (28.54 g). Lowest 100 seed weight was recorded in small sized fruits of Baby (27.37 g) (Table 4.2.a). In Kaumudi, significantly highest 100 seed weight was recorded in large sized fruits (30.05 g) followed by medium sized fruits (29.45 g) while it was lowest in small sized fruits (27.86 g) (Table 4.2.b).

The 100 seed weight was found to vary significantly with the position of seeds in different sized fruits in both varieties. In variety Baby, middle region

recorded higher 100 seed weight (27.77 g, 28.91 g and 28.92 g in small, medium and large fruits respectively) compared to stylar end region (27.50 g, 28.44 g and 28.67 g respectively) and pedicel end region (27.17 g, 28.29 g and 28.58 g respectively). With respect to fruit sizes and seed position within the fruit maximum hundred seed weight was observed in the middle portion of the medium sized fruits of Baby (28.91 g). This was on par with the 100 seed weight in the middle portion of large sized fruits (28.92 g) (Table 4.2.c). In Kaumudi, the middle region of small, medium and large sized fruits recorded significantly higher 100 seed weight (28.13 g, 29.77 g and 30.54 g respectively) compared to stylar end region (27.78 g, 29.44 g and 30.04 g respectively). 100 seed weight was lower in the pedicel end region of small, medium and large sized fruits (27.66 g, 29.13 g and 29.55 g respectively). Among the different sizes and regions of the fruit, middle region of the large sized fruit (LM) recorded highest hundred seed weight (30.54 g) (Table 4.2.d).

4.2.7 Germination per cent

The germination per cent did not differ significantly with fruit sizes. However, higher germination per cent was recorded by medium sized fruits (80) which was on par with large (79 %) and small fruits (75 %) in Baby (Table 4.2.a). In Kaumudi (Table 4.2.b), highest germination per cent was recorded by seeds of medium sized fruits (87 %) and it was on par with seeds obtained from large sized fruits (84 %). Germination per cent was less than 80 in seeds of small sized fruits (78 %).

The germination per cent of seeds obtained from different regions of different sized fruits was found to be significantly different in both varieties. In Baby, seeds of the middle region of small, medium and large sized fruits recorded significantly higher germination per cent (80, 84 and 83 respectively) followed by seeds of stylar end region (76, 80 and 79 respectively) and pedicel end region (68, 76 and 75 respectively) of small, medium and large sized fruits respectively in

Baby. Germination was above 80 % in seeds obtained from middle region of medium sized (84 %) and large sized fruits (83 %) (Table 4.2.c). In Kaumudi, seeds of the middle region of small, medium and large sized fruits recorded significantly higher germination per cent (83, 91 and 88, respectively) compared to stylar end region (79, 87 and 84, respectively) and pedicel end region (72, 83 and 80 respectively). Highest germination was recorded in seeds of middle region of medium sized fruits (91 %) in Kaumudi (Table 4.2.d).

4.2.8 Speed of germination

Speed of germination in both varieties of snake gourd varied significantly with size of fruit. Highest speed of germination was recorded by seeds of medium sized fruits (9.55) followed by seeds of large sized fruits (9.00) and small sized fruits (8.25) in Baby (Table 4.2.a). In Kaumudi, speed of germination was highest in seeds of medium (10.27) and large sized fruits (10.20) followed by seeds in small sized fruits (9.49) (Table 4.2.b).

The speed of germination was found to vary significantly between fruit sizes and seed position within the fruit in both varieties. Seeds of the middle region of small, medium and large sized fruits of Baby recorded significantly higher speed of germination (8.74, 10.31 and 9.37 respectively) compared to stylar end region (8.19, 9.30 and 8.95 respectively) and seeds of pedicel end region (7.81, 9.03 and 8.68 respectively) (Table 4.2.c). In Baby, seeds obtained from middle region of medium sized fruit exhibited highest speed of germination (10.31) followed by stylar end region of medium sized fruits (9.30). In Kaumudi, seeds of the middle region of small, medium and large sized fruits recorded significantly higher speed of germination (10.28, 10.99 and 10.92 respectively) compared to stylar end region (9.27, 10.11 and 10.04 respectively). Speed of germination was the lowest in seeds obtained from pedicel end region of small, medium and large sized fruits (8.93, 9.71 and 9.64 respectively) (Table 4.2.d). Comparing the different sizes and regions of the fruit, seeds from middle portions of medium sized (10.99) and large sized

fruits (10.92) recorded highest speed of germination in snake gourd variety Kaumudi and were on par with each other.

4.2.9 Root length of seedling (cm)

Highest root length of seedling was recorded by seeds of medium sized (7.00 cm) and large sized fruits (6.76 cm) whereas, seeds of small sized fruits recorded a root length of 6.18 cm in Baby (Table 4.2.a). In Kaumudi, no significant difference was noticed for root length in different sized fruits and the root length ranged from 8.22 to 8.32 in small and large sized fruits respectively (Table 4.2.b).

The root length of seedling was found to vary significantly with position of seeds in different sized fruits in both varieties. Among the different regions of the fruit, the middle region of small, medium and large sized fruits recorded significantly higher root length of seedling (6.48 cm, 7.28 cm and 7.12 cm respectively) compared to stylar end region (6.24 cm, 7.22 cm and 6.80 cm respectively). Root length of seedling was low in the seeds obtained from pedicel end region of the fruit (5.82 cm, 6.48 cm and 6.37 cm) in Baby (Table 4.2.c). In Kaumudi also, the middle region of small, medium and large sized fruits recorded significantly higher root length of seedling (8.40 cm, 8.85 cm and 8.55 cm respectively) compared to stylar end region (8.25 cm, 8.43 cm and 8.25 cm respectively) and pedicel end region of small, medium and large sized fruits (8.00 cm, 8.25 cm and 8.15 cm respectively) (Table 4.2.d).

4.2.10 Shoot length of seedling (cm)

Highest shoot length of seedling was recorded by medium sized fruits (16.00 cm) followed by large (15.63 cm) and small sized fruits (14.89 cm) in Baby (Table 4.2.a). In Kaumudi, shoot length of different sized fruits did not show significant variation and it ranged from 17.10 cm in small sized fruits to 17.55 cm in large sized fruits (Table 4.2.b).

The shoot length of seedlings was found to vary significantly with the position of seed in different sized fruits in both varieties. Among the different regions of the fruit, middle region recorded significantly higher shoot length (15.47 cm, 16.33 cm and 16.00 cm in small, medium and large sized fruits respectively) followed by stylar end region of small, medium and large sized fruits (14.98 cm, 16.20 cm and 15.63 cm respectively). Shoot length was lowest (14.23 cm, 15.47 cm and 15.25 cm) in pedicel end region of small, medium and large sized fruits in Baby (Table 4.2.c). In Kaumudi, the middle region of small, medium and large sized fruits recorded significantly higher shoot length of seedling (17.43 cm, 18.17 cm and 17.67 cm respectively) compared to stylar end region (17.10 cm, 17.37 cm and 17.10 cm respectively) and pedicel end region of small, medium and large sized fruits (16.78 cm, 17.10 cm and 16.95 cm respectively) (Table 4.2.d).

4.2.11 Seedling length (cm)

The seedling length differed significantly due to fruit sizes. Highest seedling length was recorded by medium sized fruits (23.00 cm) over large sized fruits (22.39 cm) and small sized fruits (21.07 cm) in Baby (Table 4.2.a). In Kaumudi, no significant difference was noticed between fruit sizes for seedling length and it ranged from 25.32 to 26.06 cm (Table 4.2.b).

Variation in the seedling length was found to be significant with fruit sizes and seed position within the fruit in both varieties. Among the different regions of the fruit, seeds from middle region of small, medium and large sized fruits recorded significantly higher seedling length (21.95 cm, 23.62 cm and 23.12 cm respectively) followed by those from stylar end region (21.22 cm, 23.42 cm and 22.43 cm respectively) and pedicel end region (20.05 cm, 21.95 cm and 21.62 cm) in Baby (Table 4.2.c). Considering both fruit size and different portions of the fruit, seeds obtained from middle portion of medium sized fruits exhibited maximum seedling length in Baby. In Kaumudi, the middle region of small, medium and large

sized fruits recorded significantly higher seedling length (25.83 cm, 27.02 cm and 26.22 cm respectively) compared to stylar end region (25.35 cm, 25.80 cm and 25.35 cm respectively) and pedicel end region (24.78 cm, 25.35 cm and 25.10 cm) (Table 4.2.d). Considering both fruit size and different fruit portions, highest seedling length was recorded in seeds of middle region of medium sized fruits in Kaumudi.

4.2.12 Vigour index

The vigour index of seedlings differed significantly with fruit sizes. Highest vigour index was recorded in seedlings of medium sized fruits (1842) followed by large sized fruits (1761) and small sized fruits (1575) in Baby (Table 4.2.a). In Kaumudi, highest vigour index of seedling was recorded in medium sized fruits (2258) over large sized fruits (2149) and small sized fruits (1970) (Table 4.2.b).

The vigour index of seedling was found to be significantly influenced by both fruit sizes and seed position on different regions of fruit in both varieties. Among the different portions of the fruit, the middle region of small, medium and large sized fruits recorded significantly higher vigour index of seedlings (1758, 1986 and 1910 respectively) compared to stylar end region (1615, 1875 and 1765 respectively) and pedicel end region (1364, 1670 and 1614 respectively) in Baby (Table 4.2.c). Considering both fruit size and portions of fruit, highest vigour index was noticed in seeds from middle region of medium sized fruits (1986) in Baby. In Kaumudi, the middle region of small, medium and large sized fruits recorded significantly higher vigour index of seedling (2136, 2449 and 2309 respectively) compared to stylar end region (1995, 2171 and 2131 respectively) and pedicel end region (1785, 2095 and 2010 respectively) (Table 4.2.d). Considering both difference in fruit sizes and portions of the fruit, highest vigour index was observed in middle portion of the medium sized fruits (2449) in Kaumudi.

4.2.13 Correlation study

Correlation study was conducted between fruit and seed characters in both varieties of snake gourd and the results are presented in Table 4.2aa and 4.2ab. Correlation studies indicated significant positive influence of fruit length on fruit weight, number of seeds, fresh weight of seeds per fruit, dry weight of seeds per fruit and 100 seeds weight (Table 4.2aa and 4.2ab). Fruit length had no significant correlation with the germination per cent, seedling length and vigour index. Fruit weight is significantly correlated with seed number and seed weight, but no relation was observed with germination, seedling length and vigour. Germination per cent is correlated with speed of germination, seedling length and vigour index. In general, it was observed that the quantity of seeds in snake gourd increases as the fruit size (length and weight) increases. The study indicated the need for selecting big and medium sized fruits for obtaining maximum quantity of good quality seeds in snake gourd.

4.2.14 Interaction study

Among the two varieties, significant variations were noticed for fruit and seed characters. Fruit length, fruit weight, seed number, fresh, dry and 100 seed weight were significantly higher in variety “Kaumudi” than “Baby” (Table 4.2 ac). Among the different fruit sizes, large fruits exhibited significantly high fruit and seed characters namely fruit length and weight and fresh, dry and 100 seed weight. Among the different positions of seed within fruit, middle region recorded maximum number of seeds and seed weight than pedicel and stylar end regions. Seedling quality parameters like germination and vigour index were found to be higher in variety Kaumudi than Baby and in medium sized fruits and middle region of fruits in both varieties (Table 4.2 ad).

Table 4.2aa Correlations between fruit length and fruit and seed parameters in snake gourd variety Baby.

Characters	Fruit weight	Seed number	Fresh weight of seeds	Dry weight of seeds	100 seed weight	Germination per cent	Speed of germination	Root length	Shoot length	Seedling length	Vigour index
Fruit length	0.991(**)	0.968(**)	0.957(**)	0.957(**)	0.860(**)	0.405	0.461	0.494	0.438	0.465	0.448
Fruit weight		0.990(**)	0.985(**)	0.985(**)	0.905(**)	0.470	0.562	0.583	0.539	0.561	0.533
Seed number			0.998(**)	0.998(**)	0.927(**)	0.567	0.644	0.672(*)	0.627	0.650	0.630
Fresh weight of seeds				1.000(**)	0.947(**)	0.576	0.686(*)	0.696(*)	0.653	0.675(*)	0.649
Dry weight of seeds					0.946(**)	0.575	0.684(*)	0.696(*)	0.653	0.676(*)	0.649
100 seed weight						0.537	0.825(**)	0.747(*)	0.704(*)	0.727(*)	0.659
Germination per cent							0.714(*)	0.804(**)	0.778(*)	0.794(*)	0.950(**)
Speed of germination								0.861(**)	0.855(**)	0.863(**)	0.830(**)
Root length									0.974(**)	0.991(**)	0.945(**)
Shoot length										0.995(**)	0.932(**)
Seedling length											0.943(**)

** Significant at 1% level

* Significant at 5% level

Table 4.2ab Correlations between fruit length and fruit and seed parameters in snake gourd variety Kaumudi.

Characters	Fruit weight	Seed number	Fresh weight of seeds	Dry weight of seeds	100 seed weight	Germination per cent	Speed of germination	Root length	Shoot length	Seedling length	Vigour index
Fruit length	1.000(**)	0.996(**)	0.998(**)	0.990(**)	0.979(**)	0.602	0.838(**)	0.271	0.199	0.224	0.517
Fruit weight		0.996(**)	0.997(**)	0.990(**)	0.979(**)	0.613	0.842(**)	0.274	0.205	0.228	0.526
Seed number			0.998(**)	0.998(**)	0.990(**)	0.636	0.869(**)	0.294	0.220	0.246	0.548
Fresh weight of seeds				0.993(**)	0.980(**)	0.608	0.843(**)	0.266	0.200	0.223	0.520
Dry weight of seeds					0.996(**)	0.668(*)	0.896(**)	0.334	0.256	0.284	0.584
100 seed weight						0.711(*)	0.927(**)	0.367	0.278	0.310	0.624
Germination per cent							0.902(**)	0.816(**)	0.748(*)	0.777(*)	0.980(**)
Speed of germination								0.609	0.506	0.545	0.838(**)
Root length									0.965(**)	0.985(**)	0.911(**)
Shoot length										0.996(**)	0.862(**)
Seedling length											0.886(**)
** Significant at 1% level											
* Significant at 5% level											

Table 4.2ac Interaction of varieties, fruit sizes and seed positions on fruit and seed quality parameters.

Treatments/Characters	Fruit length (cm)	Fruit weight (g)	No. of seeds	Fresh weight of seeds (g)	Dry weight of seeds (g)	100 seed weight (g)
Variety						
Baby	12.36	156.39	18.41	5.79	5.20	28.25
Kaumudi	31.33	509.02	28.22	9.17	8.12	29.17
CD (P= 0.05)	0.21	8.11	0.36	0.11	0.11	0.02
Fruit sizes						
Small	17.71	191.31	18.27	5.91	4.99	27.67
Medium	21.92	339.72	23.87	7.64	6.92	29.00
Large	25.90	467.08	27.80	8.90	8.07	29.38
CD (P= 0.05)	0.26	9.93	0.44	0.14	0.13	0.03
Seed Positions						
Pedicel end region	18.94	250.72	9.49	3.04	2.71	28.40
Middle region	26.04	414.03	38.89	12.49	11.12	29.01
Stylar end region	20.55	333.36	21.56	6.92	6.15	28.65
CD (P= 0.05)	0.26	9.93	0.44	0.14	0.13	0.03

Table 4.2ac contd...

Treatments/Characters	Germination per cent	Speed of germination	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Vigour index
Variety						
Baby	77.78	8.93	6.65	15.51	22.15	1728.59
Kaumudi	82.82	9.99	8.35	17.30	22.64	2120.15
CD (P= 0.05)	2.00	0.05	0.22	0.32	0.53	78.89
Fruit sizes						
Small	76.22	8.87	7.20	16.00	23.20	1775.54
Medium	83.33	9.91	7.75	16.77	24.53	2041.13
Large	81.33	9.60	7.54	16.43	23.97	1956.44
CD (P= 0.05)	2.46	0.07	0.27	0.40	0.64	96.62
Seed Positions						
Pedicel end region	75.56	8.97	7.18	15.96	23.14	1756.28
Middle region	84.67	10.10	7.78	16.84	24.63	2091.33
Stylar end region	80.67	9.31	7.53	16.40	23.93	1925.50
CD (P= 0.05)	2.46	0.07	0.27	0.40	0.64	96.62

Table 4.2ad Interaction of varieties, fruit sizes and seed positions on fruit and seed quality parameters.

Treatments/Characters	Fruit length (cm)	Fruit weight (g)	No. of seeds	Fresh weight of seeds (g)	Dry weight of seeds (g)	100 seed weight (g)
Variety x Fruit Size						
Baby x Small	10.81	105.00	14.82	4.45	4.00	27.48
Baby x Medium	12.11	155.56	18.70	5.98	5.37	28.54
Baby x Large	14.15	208.61	21.71	6.95	6.23	28.72
Kaumudi x Small	24.62	277.61	21.71	7.38	5.97	27.86
Kaumudi x Medium	31.72	523.89	29.04	9.29	8.48	29.45
Kaumudi x Large	37.66	725.56	33.89	10.84	9.90	30.04
CD (P= 0.05)	0.37	14.05	0.62	0.20	0.18	0.04
Variety x Seed Position						
Baby x Pedicel end region	11.70	115.00	7.79	2.45	2.20	28.01
Baby x Middle region	13.13	196.94	29.24	9.21	8.27	28.53
Baby x Stylar end region	12.23	157.22	18.20	5.72	5.14	28.20
Kaumudi x Pedicel end region	26.18	386.44	11.19	3.64	3.21	28.78
Kaumudi x Middle region	38.95	631.11	48.53	15.77	13.98	29.48
Kaumudi x Stylar end region	28.87	509.50	24.92	8.11	7.16	29.09
CD (P= 0.05)	0.37	14.05	0.62	0.20	0.18	0.04

Table 4.2ad contd...

Treatments/Characters	Germination per cent	Speed of germination	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Vigour index
Variety x Fruit Size						
Baby x Small	74.67	8.25	6.18	14.89	21.08	1579.08
Baby x Medium	80.00	9.55	6.99	16.00	22.99	1843.73
Baby x Large	78.67	9.00	6.76	15.63	22.39	1762.97
Kaumudi x Small	77.78	9.49	8.21	17.11	25.32	1972.00
Kaumudi x Medium	86.67	10.27	8.51	17.54	26.06	2238.53
Kaumudi x Large	84.00	10.20	8.31	17.24	25.56	2149.91
CD (P= 0.05)	3.48	0.09	0.38	0.56	0.91	136.64
Variety x Seed Position						
Baby x Pedicel end region	72.89	8.51	6.23	14.98	21.21	1549.27
Baby x Middle region	82.22	9.47	6.96	15.93	22.89	1884.69
Baby x Stylar end region	78.22	8.81	6.75	15.61	22.36	1751.83
Kaumudi x Pedicel end region	78.22	9.43	8.13	16.94	25.08	1963.29
Kaumudi x Middle region	87.11	10.73	8.60	17.76	26.36	2297.98
Kaumudi x Stylar end region	83.11	9.81	8.31	17.19	25.50	2099.18
CD (P= 0.05)	3.48	0.09	0.38	0.56	0.91	136.64

4.3 EFFECT OF STORAGE ON SEED QUALITY AND LONGEVITY

Seeds collected from the fruits of correct maturity were processed manually and dried to 8% moisture. Seeds were stored in sealed polythene bags at ambient temperatures and A/C conditions for a period of one year to study the dormancy and longevity of seeds. Monthly observations on seed quality parameters were recorded which are given below and interaction studies on two storage conditions were also done.

4.3.1. Germination per cent

At 0 month (before storage), the germination per cent recorded was 77 in Baby and 80 in Kaumudi. Germination per cent increased significantly and reached maximum at 3rd (84%) and 4th (91%) month of storage in variety Baby in ambient and A/C conditions respectively. In Kaumudi variety also, it increased and significantly highest value was obtained at 3rd month (90%) in ambient condition and 4th month (97%) in A/C storage condition. Thereafter it decreased and the lowest germination per cent was recorded at 12 month of storage in both ambient and A/C conditions (65% and 75% respectively) in Baby and (67% and 78%, respectively) in Kaumudi (Table 4.3a).

At 6 months of storage, germination was found to be below 80% (76% in ambient storage condition and 83% under A/ C conditions) in Baby. In Kaumudi, at 6th months of storage, germination was 80% in open and 90% in A/C storage condition. Less than 80% germination was recorded in 7th month in ambient condition (78%) and in 11th month in A/C storage condition (78%). Significant difference was noticed for germination of two varieties between the two conditions of storage. Germination was 65% and 67% at 12th month when seeds were stored in ambient condition in Baby and Kaumudi respectively whereas under A/C storage condition, germination was maintained at 75% and 78% respectively in these varieties. Germination was found to be higher in variety Kaumudi than Baby.

4. 3.2. Speed of germination

At 0 month (before storage), the values recorded for speed of germination were 9.39 for Baby and 10.24 in the variety Kaumudi. It increased and reached maximum (>10) at 3rd and 4th month of storage under ambient condition and 3rd, 4th and 5th month under A/C storage condition in Baby. In Kaumudi, highest values for speed of germination were recorded at 3rd and 4th month in both storage conditions. Lowest speed of germination was recorded at 12th month of storage in both varities in ambient and A/C storage condition (8.13 and 8.40 respectively) in Baby and (8.40 and 8.73 respectively) and Kaumudi (Table 4.3b).

After 6th month of storage, speed of germination was found to decrease considerably with values of 9.39 and 9.71 in ambient and A/C conditions in Baby and 9.98 and 10.24 respectively in Kaumudi. Speed of germination was less than 9 at 10th month under open storage condition and 11th month under A/C storage condition in Baby and at 11th and 12th month of storage in Kaumudi (Table 4.3b).

4.3.3. Root length

Root length of seedlings decreased with increase in the storage period in both the varieties. At 0 month (before storage), the highest root length of seedlings was recorded (7.34 cm) in Baby and Kaumudi (8.85 cm), whereas the lowest value for root length was recorded at 12th month of storage in ambient and A/C conditions of storage in Baby (5.93 cm and 6.04 cm respectively) and Kaumudi (6.04 cm and 6.22 cm, respectively) (Table 4.3c).

At 6th months of storage, the values recorded for root length of seedlings were 6.53 cm and 6.65 cm in ambient and A/C storage conditions in Baby and 6.89 cm and 6.94 cm respectively in Kaumudi. At 9th months of storage, the values for root length were 6.40 cm and 6.45 cm in ambient and A/C conditions in Baby and 6.60 cm and 6.65 cm respectively in Kaumudi.

Table 4.3a Effect of storage conditions on germination per cent in snake gourd varieties.

Months/Treatments	Baby		Kaumudi	
	Open	A/C	Open	A/C
0	77^{cd}	77^{g}	80^{cd}	80^{g}
1	78^{cd}	83^{d}	81^{bcd}	85^{ef}
2	80^{bc}	85^{c}	82^{bc}	86^{de}
3	84^{a}	90^{a}	90^{a}	94^{b}
4	82^{ab}	91^{a}	84^{b}	97^{a}
5	80^{bc}	87^{b}	82^{bc}	93^{b}
6	76^{de}	83^{d}	80^{cd}	90^{c}
7	75^{de}	83^{d}	78^{de}	87^{d}
8	73^{ef}	81^{e}	76^{ef}	84^{f}
9	73^{ef}	79^{f}	74^{fg}	80^{g}
10	70^{fg}	76^{gh}	72^{g}	80^{g}
11	68^{gh}	76^{gh}	68^{h}	78^{h}
12	65^{h}	75^{h}	67^{h}	78^{h}
CD (P=0.05)	3.51	1.36	2.94	1.70
CD (OPEN X A/C) (P=0.05)	2.79		2.52	

Table 4.3b Effect of storage conditions on speed of germination in snake gourd varieties.

Months/Treatments	Baby		Kaumudi	
	Open	A/C	Open	A/C
0	9.39^{bcd}	9.39^{bcd}	10.24^{bc}	10.24^{bcd}
1	9.45^{bcd}	9.71^{abc}	10.26^{bc}	10.44^{abc}
2	9.71^{abc}	9.98^{ab}	10.31^{abc}	10.48^{abc}
3	10.31a	10.24^{a}	10.97^{a}	10.75^{ab}
4	10.26^{a}	10.44^{a}	10.73^{ab}	10.97^{a}
5	9.98^{ab}	10.24^{a}	10.26^{bc}	10.48^{abc}
6	9.39^{bcd}	9.71^{abc}	9.98^{cd}	10.24^{bcd}
7	9.32^{bcd}	9.39^{bcd}	9.71^{cd}	9.96^{cde}
8	9.32^{bcd}	9.39^{bcd}	9.71^{cd}	9.96^{cde}
9	9.07^{cde}	9.32^{bcd}	9.45^{d}	9.71^{de}
10	8.73^{def}	9.07^{cde}	9.32^{de}	9.45^{ef}
11	8.40^{ef}	8.73^{de}	8.73^{ef}	9.07^{fg}
12	8.13^{f}	8.40^{e}	8.40^{f}	8.73^{g}
CD (P=0.05)	0.71	0.70	0.63	0.60
CD (OPEN X A/C) (P=0.05)	0.74		0.64	

Table 4.3c Effect of storage conditions on root length (cm) in snake gourd varieties.

Months/Treatments	Baby		Kaumudi	
	Open	A/C	Open	A/C
0	7.34^{a}	7.34^{a}	8.85^{a}	8.85^{a}
1	7.25^{ab}	7.25^{a}	8.80^{a}	8.85^{a}
2	6.89^{bc}	6.94^{ab}	8.70^{a}	8.80^{a}
3	6.65^{cd}	6.89^{abc}	8.00^{b}	8.20^{b}
4	6.60^{cde}	6.89^{abc}	7.25^{c}	8.00^{b}
5	6.53^{cde}	6.65^{bcd}	6.89^{d}	7.50^{c}
6	6.53^{cde}	6.65^{bcd}	6.89^{d}	6.94^{d}
7	6.45^{de}	6.53^{bcd}	6.65^{de}	6.70^{de}
8	6.45^{de}	6.53^{bcd}	6.65^{de}	6.70^{de}
9	6.40^{def}	6.45^{cde}	6.60^{de}	6.65^{ef}
10	6.22^{efg}	6.40^{de}	6.45^{ef}	6.60^{ef}
11	6.04^{fg}	6.22^{de}	6.22^{fg}	6.40^{fg}
12	5.93^{g}	6.04^{e}	6.04^{g}	6.22^{g}
CD (P=0.05)	0.37	0.41	0.33	0.24
CD (OPEN X A/C) (P=0.05)	0.41		0.30	

Table 4.3d Effect of storage conditions on shoot length (cm) in snake gourd varieties.

Months/Treatments	Baby		Kaumudi	
	Open	A/C	Open	A/C
0	16.28^{a}	16.28^{a}	18.18^{a}	18.18^{a}
1	16.10^{ab}	16.25^{a}	18.05^{a}	18.10^{a}
2	15.93^{abc}	16.03^{ab}	17.90^{a}	18.05^{a}
3	15.80^{abc}	15.93^{abc}	16.90^{b}	17.00^{b}
4	15.70^{abc}	15.93^{abc}	16.03^{c}	16.80^{b}
5	15.55^{bcd}	15.80^{abcd}	15.93^{c}	16.40^{c}
6	15.55^{bcd}	15.80^{abcd}	15.93^{c}	16.03^{d}
7	15.40^{cd}	15.55^{bcd}	15.80^{cd}	15.90^{d}
8	15.40^{cd}	15.55^{bcd}	15.80^{cd}	15.90^{d}
9	15.30^{cd}	15.40^{cde}	15.70^{cd}	15.80^{d}
10	14.95^{de}	15.30^{de}	15.40^{d}	15.70^{d}
11	14.60^{e}	14.95^{ef}	14.95^{e}	15.30^{e}
12	14.40^{e}	14.60^{f}	14.60^{e}	14.95^{f}
CD (P=0.05)	0.55	0.53	0.40	0.33
CD (OPEN X A/C) (P=0.05)	0.57		0.39	

Table 4.3e Effect of storage conditions on seedling length (cm) in snake gourd varieties.

Months/Treatments	Baby		Kaumudi	
	Open	A/C	Open	A/C
0	23.61[a]	23.61[a]	27.03[a]	27.03[a]
1	23.35[ab]	23.50[a]	26.85[a]	26.95[a]
2	22.81[abc]	22.96[ab]	26.60[a]	26.85[a]
3	22.45[bcd]	22.81[abc]	24.90[b]	25.20[b]
4	22.30[cd]	22.81[abc]	23.28[c]	24.80[b]
5	22.08[cde]	22.45[bcd]	22.81[cd]	23.90[c]
6	22.08[cde]	22.45[bcd]	22.81[cd]	22.96[d]
7	21.85[cde]	22.08[bcde]	22.45[de]	22.60[de]
8	21.85[cde]	22.08[bcde]	22.45[de]	22.60[de]
9	21.70[de]	21.85[cde]	22.30[de]	22.45[de]
10	21.17[ef]	21.70[de]	21.85[ef]	22.30[e]
11	20.64[f]	21.17[ef]	21.17[fg]	21.70[f]
12	20.33[f]	20.64[f]	20.64[g]	21.17[g]
CD (P=0.05)	0.88	0.87	0.68	0.53
CD (OPEN X A/C) (P=0.05)	0.92		0.64	

Table 4.3f Effect of storage conditions on vigour index in snake gourd varieties.

Months/Treatments	Baby		Kaumudi	
	Open	A/C	Open	A/C
0	1818^{a}	1818^{c}	2162^{a}	2162^{d}
1	1822^{a}	1951^{b}	2175^{a}	2291^{c}
2	1826^{a}	1952^{b}	2181^{a}	2309^{bc}
3	1886^{a}	2053^{a}	2241^{a}	2369^{ab}
4	1829^{a}	2076^{a}	1955^{b}	2406^{a}
5	1765^{ab}	1953^{b}	1871^{bc}	2223^{d}
6	1679^{bc}	1863^{bc}	1825^{cd}	2067^{e}
7	1641^{bc}	1832^{c}	1751de	1966^{f}
8	1595^{cd}	1788^{cd}	1706^{ef}	1898^{g}
9	1584^{cd}	1727de	1650^{fg}	1796^{h}
10	1483de	1649^{ef}	1574^{g}	1784^{h}
11	1403^{ef}	1609^{fg}	1439^{h}	1693^{i}
12	1322^{f}	1548^{g}	1383^{h}	1652^{i}
CD (P=0.05)	122	83	93	65
CD (OPEN X A/C) (P=0.05)	110		84	

4.3.4. Shoot length

Shoot length of seedlings decreased with increase in the storage period in both the varieties. At 0 month (before storage), shoot length was the highest with values of 16.28 cm in Baby and 18.18 cm in Kaumudi. Lowest shoot length of seedlings was recorded at 12th month of storage in both ambient and A/C conditions of storage (14.40 cm and 14.60 cm respectively) in Baby and (14.60 cm and 14.95 cm respectively) in Kaumudi (Table 4.3d).

At 6th months of storage, the values recorded for shoot length of seedlings under ambient and A/C storage conditions were 15.55 cm and 15.80 cm respectively in Baby and 15.93 cm and 16.03 cm respectively in Kaumudi. At 11th months of storage, shoot length of seedlings was found to decrease considerably with values of 14.60 cm and 14.95 cm in ambient and A/C conditions of storage in Baby and 14.95 cm and 15.30 cm respectively in Kaumudi.

4.3.5. Seedling length

Seedling length decreased with increase in the storage period in both the varieties. At 0 month (before storage), the highest seedling length was recorded in Baby (23.61 cm) and Kaumudi (27.03 cm). Lowest seedling length was observed at 12th month of storage in ambient and A/C conditions of storage in Baby (20.33 cm and 20.64 cm respectively) and Kaumudi (20.64 cm and 21.17 cm respectively) (Table 4.3e).

At 6th months of storage, values recorded for seedling length were 22.08 cm and 22.45 cm in Baby under ambient and A/C conditions of storage and 22.81 cm and 22.96 cm respectively in Kaumudi. At 9th month of storage, seedling length was found to decrease and the values recorded in ambient and A/C conditions were 21.70 cm and 21.85 cm respectively in Baby and 22.30 cm and 22.45 cm respectively in Kaumudi. Significant difference was noticed for seedling length

under two environmental (ambient and A/C conditions) in both the varieties (Table 4.3e)

4.3.6. Vigour index

At 0 month (before storage), the vigour index of seedlings recorded was 1818 in Baby and 2162 in Kaumudi. Vigour index of seedlings increased, but the increase was not statistically significant and reached maximum at 3rd (1886) month of storage in variety Baby in ambient storage condition. Under A/C storage condition vigour index recorded significantly higher values in 3rd and 4th month of storage. In Kaumudi variety also, it increased and reached maximum at 3rd month (2241) in ambient condition (no significant difference between 0-3 months) and 4th month (2406) in A/C storage condition. Thereafter it decreased and the lowest seedling vigour index was recorded at 12 month of storage in ambient and A/C conditions (1322 and 1548 respectively) in Baby and (1383 and 1652, respectively) in Kaumudi (Table 4.3f).

At 6 months of storage, vigour index of seedlings was found to decrease and values of recorded in ambient and A/C conditions were 1679 and 1863 respectively in Baby and 1825 and 2067 respectively in Kaumudi. Vigour index of seedlings was found to be differing significantly with the environmental conditions of storage (ambient and A/c conditions) in both the varieties (Table 4.3f).

4.3.7. Enzyme dehydrogenase test (O. D. value)

Values of enzyme dehydrogenage test decreased with increase in the storage period in both the varieties. Highest enzyme activity under ambient storage condition was observed in Baby from 0-3 months of storage and the values during this period were on par. Under A/C storage conditions, highest OD values were observed during 0-4 months of storage in Baby. In Kaumudi, OD values for the enzyme test were highest at 0 month (1.57). Later, it decreased and lowest values

Table 4.3g Effect of storage conditions on enzyme dehydrogenase test (O. D. value) in snake gourd varieties.

Months/Treatments	Baby		Kaumudi	
	Open	A/C	Open	A/C
0	1.09^{a}	1.09^{a}	1.57^{a}	1.57^{a}
1	1.09^{a}	1.09^{a}	1.07^{b}	1.43^{ab}
2	1.08^{a}	1.08^{a}	1.03^{b}	1.41^{ab}
3	1.06^{a}	1.08^{a}	1.00^{b}	1.39^{ab}
4	0.93^{ab}	1.06^{a}	0.95^{b}	1.37^{abc}
5	0.86^{abc}	0.99^{b}	0.94^{b}	1.24^{bcd}
6	0.84^{abc}	0.99^{b}	0.92^{b}	1.22^{bcd}
7	0.84^{abc}	0.97^{bc}	0.91^{b}	1.20^{bcd}
8	0.83^{abc}	0.94^{cd}	0.87^{b}	1.19^{bcd}
9	0.76^{bc}	0.94^{cd}	0.84^{b}	1.19^{bcd}
10	0.74^{bc}	0.91^{de}	0.75^{b}	1.12^{cd}
11	0.71^{bc}	0.89^{e}	0.73^{b}	1.10^{d}
12	0.69^{c}	0.85^{f}	0.72^{b}	0.98^{d}
CD (P=0.05)	0.32	0.04	0.40	0.22
CD (OPEN X A/C) (P=0.05)	0.24		0.34	

Table 4.3h Effect of storage conditions on electrical conductivity (EC) of the seed leachate (dSm^{-1}) in snake gourd varieties.

Months/Treatments	Baby		Kaumudi	
	Open	A/C	Open	A/C
0	0.85^{g}	0.85^{e}	0.87^{j}	0.87^{j}
1	0.85^{g}	0.85^{e}	0.89^{ij}	0.89^{ij}
2	0.87^{g}	0.86^{e}	0.93^{hi}	0.89^{ij}
3	0.89^{g}	0.88^{e}	0.97^{h}	0.92^{i}
4	1.12^{f}	0.89^{e}	1.19^{g}	0.99^{h}
5	1.26^{e}	1.24^{d}	1.29^{f}	1.20^{g}
6	1.29^{e}	1.26^{d}	1.39^{e}	1.28^{f}
7	1.51^{d}	1.42^{c}	1.61^{d}	1.46^{e}
8	1.61^{c}	1.44^{bc}	1.65^{d}	1.48^{de}
9	1.67^{bc}	1.49^{b}	1.77^{c}	1.51^{cd}
10	1.72^{b}	1.56^{a}	1.80^{bc}	1.55^{bc}
11	1.79^{a}	1.58^{a}	1.85^{ab}	1.59^{ab}
12	1.83^{a}	1.60^{a}	1.88^{a}	1.63^{a}
CD (P=0.05)	0.06	0.04	0.04	0.04
CD (OPEN X A/C) (P=0.05)	0.06		0.05	

for the enzyme test were recorded at 12th months of storage in ambient and A/C conditions (0.69 and 0.85 respectively) in Baby and (0.72 and 0.98 respectively) in Kaumudi.

At 6th month of storage, enzyme dehydrogenage values were found to be low in Baby both in ambient and A/C conditions (0.84 and 0.99 respectively) whereas in Kaumudi, values were slightly higher than Baby under both conditions of storage (0.92 and 1.22 respectively). At 9th month of storage, dehydrogenage values observed in ambient and A/C conditions of storage were 0.76 and 0.94 respectively in Baby and 0.84 and 1.19 respectively in Kaumudi. Enzyme dehydrogenage test values differ significantly with the storage conditions (ambient and A/C conditions) in both the varieties. Generally, values were higher under A/C storage condition when compared to open condition of storage in all the months (Table 4.3g).

4.3.8. Electrical conductivity (dSm^{-1})

Electrical conductivity values of the seed leachate increased with increase in the storage period in both the varieties. But the increase was very slow initially upto 3rd month under open storage condition and 4th month under A/C storage condition in both varieties and later the EC values increased very fast. At 0 month (before storage), electrical conductivity values were the lowest in Baby (0.85) and Kaumudi (0.87), whereas highest values were recorded at 12th month of storage in Baby under open and A/C conditions (1.83 and 1.60 respectively) and (1.88 and 1.63 respectively) in Kaumudi. Generally, EC values were higher under open storage condition when compared to A/C storage. At 4th month of storage, electrical conductivity values were found to increase in ambient and A/C conditions (1.12 and 0.89 respectively) in Baby and (1.19 and 0.99 respectively) in Kaumudi (Table 4.3h).

At 7th month of storage, electrical conductivity values were found to increase considerably both in ambient and A/C conditions (1.51 and 1.42 respectively) in Baby and (1.61 and 1.46 respectively) in Kaumudi. At 9th month of storage, electrical conductivity values recorded in Baby in ambient and A/c conditions were 1.67 and 1.49 respectively and 1.77 and 1.51 respectively in Kaumudi. Electrical conductivity values were found to be differing significantly with the environmental storage conditions (ambient and A/c conditions) in both the varieties (Table 4.3h).

DISCUSSION

5. DISCUSSION

5.1 PHYSIOLOGICAL MATURITY STUDIES IN SNAKE GOURD VARIETIES (BABY AND KAUMUDI)

Quality seeds play an important role in vegetable crop production. The quality of seed is influenced by stages of harvesting and seeds attain maximum quality at their physiological maturity as indicated by maximum dry weight, germination and vigour of the seeds (Helmer *et al*., 1962). Harvesting either at early or later stage of physiological maturity results in lower seed yield with poor quality. Growth pattern of snake gourd fruits and seeds was studied at three days intervals in two varieties namely Baby and Kaumudi to find out the stage of physiological maturity of fruit for setting good quality seeds.

Fresh weight, length and diameter of fruits were found to increase from anthesis and maximum fruit development was achieved by 36 days after anthesis in Baby and 39 DAA in Kaumudi. At 36 DAA, fruits of "Baby" variety recorded a length of 37.23 with 7.33 cm diameter and an average fruit weight of 474.83 g (Table 4.1a). In "Kaumudi", fruits recorded a length of 102.77 cm with 9.53 cm as diameter and a fruit weight of 1355.8 g at 39 DAA (Table 4.1b). Stages of harvesting of fruit had significant influence on seed weight. Upto 30 DAA, the developing seeds could not be separated from placenta and seed coat was not fully developed in variety Baby, whereas by 36 DAA, seed coat was differentiated and the seeds could be separated from placenta. Harvesting of fruits at 36 DAA (T6) and 39 DAA (T7) recorded significantly higher developed seed weight per fruit in Baby and Kaumudi varieties respectively. The seeds obtained from 21 DAA to 30 DAA were immature, under developed, which is evident from lower 100-seed weight, germination percentage and vigour index.

Similar results have been reported by Singh *et al*. (1985) in tomato, Jayabharathi *et al*. (1990) in brinjal, Choudhari *et al*. (1992) in tomato and Naik *et*

Fig. 1a Fruit weight (g) in snake gourd varieties at different days of harvest.

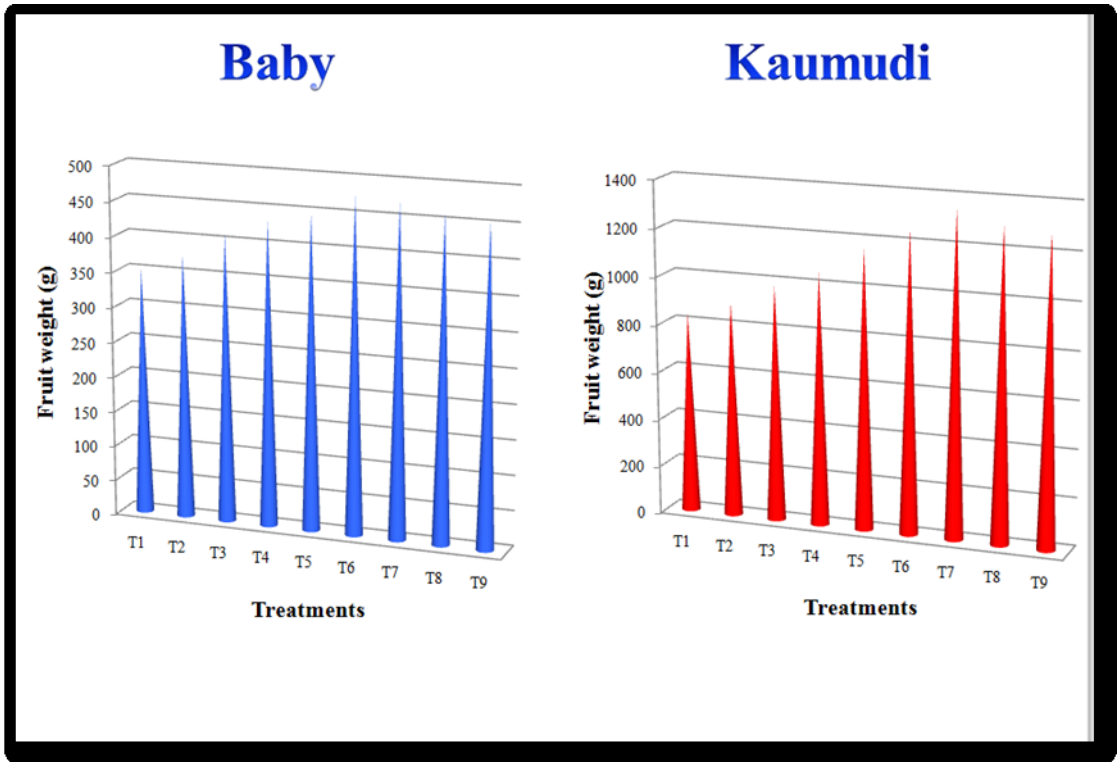
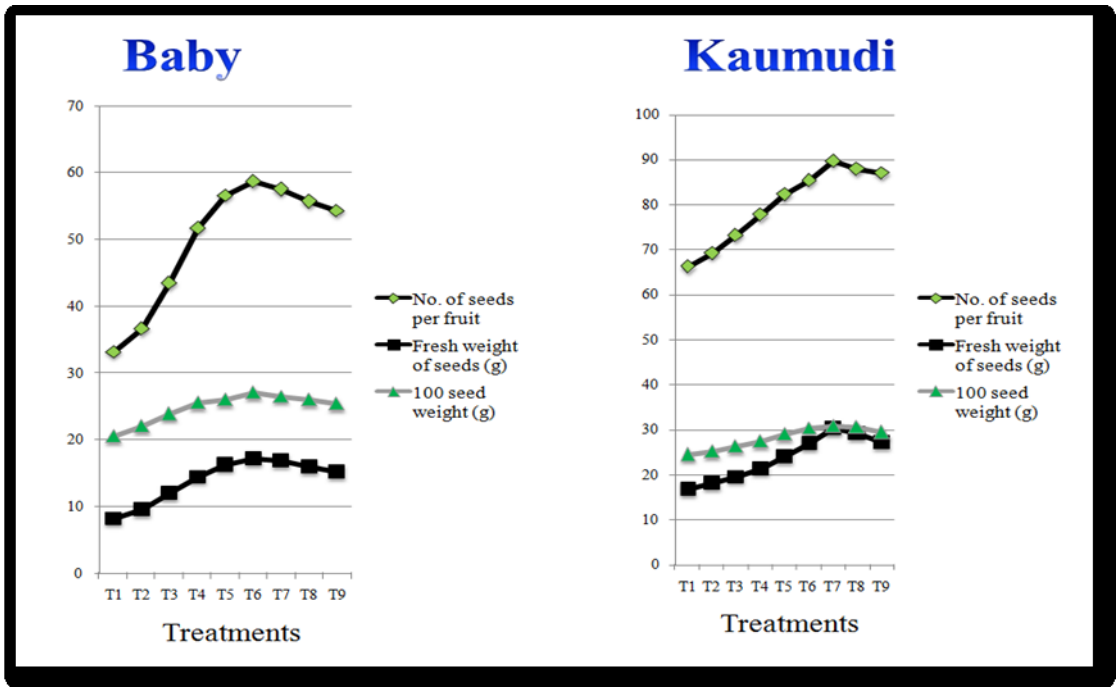


Fig. 1b Seed number and weight (g) in snake gourd varieties at different days of harvest.



al. (1996) in capsicum and Balraj (1999) in chilli. The growing fruit is an active sink that diverts and draws water and solutes from other regions of plant. Bollard (1970) stated that the central theme of fruit growth seems to be the mobilisation of substances into various tissues. Early stages of fruit growth after pollination are characterized by the formation of new cells, but this quickly changes into cell enlargement (Noggle and Fritz, 1989). During this period, embryo develops from zygote by intense cell division and differentiation and by the end of the phase I, embryonic plant is fully differentiated and cell division ceases. Seeds are completely developed with maximum accumulation of food reserves and completion of biochemical processes in the fruits. It was observed that in snake gourd, the maximum fruit weight and seed weight were attained by 36 days in Baby and by 39 days in Kaumudi (Fig1a).

Fruits after attaining a maximum growth in the initial stages, its weight decreased towards the later stages. Such a trend in developing fruits was reported in ash gourd (Krishnaprasad, 1980) and in other cucurbits also viz., *Cucumis melo* (Mann and Robinson, 1950 and Pratt *et al*., 1977), bottle gourd (Chandrasekhran, 1979), bitter gourd (Varatharaj, 1979), watermelon (Hedayat, 1987). This loss in weight of fruits in later stages was associated with changes in moisture content in maturing fruits (Sinnott, 1945; Showalter, 1961; Kolhe and Chavan, 1964; Manohar and Sachan, 1974). In the present study also, in both varieties of snake gourd, fruit weight decreased a little in later stages indicating water loss through transpiration. The rind thickness also increased and became very hard by 36 and 39 DAA in both varieties. There was a general resemblance in the development pattern of fruits and seeds in both varieties upto 33 days. There was a steep rise in the fresh weight of fruits and seeds upto 36 days in Baby and 39 days in Kaumudi and later fruit and seed weight had shown a dip in the development pattern.

Fresh weight of the seed is an important character that determines the quality of the seed. Abdul- Baki and Baker (1973) used the fresh weight of the seed for differentiating between ‘seed development’ and ‘seed maturation’. According to

them, seed development is the period between fertilization and maximum fresh weight of the seeds and seed maturation begins at the end of the seed development and continues upto harvest. In the present investigation, fresh weight of seeds was found to increase as fruit development advanced and maximum fresh weight of seeds per fruit was recorded at 36 and 39 DAA in these varieties (Fig1b). Similar increase in fresh weight of seeds was recorded by Young (1949) in squash and by Harrington (1959) in muskmelon. In the present study, it was observed that fresh weight of seeds, after reaching the maximum, has decreased slightly and this could be attributed to the decrease in water content of seeds and steady accumulation of dry matter during later stages of seed maturation phase. Similar observations have been reported in ribbed gourd and bitter gourd (Varatharaj, 1979) in ash gourd (Krishnaprasad, 1980) and in watermelon (Hedayat, 1987).

The dry weight of developing seeds can be used to assess the maturity of the seeds (Delouche, 1973). From 21 DAA, dry weight of seeds increased continuously in both the varieties irrespective of the variations in fresh weight of fruits and seeds indicating the mobilization and accumulation of photosynthates/ food reserves from fruits to the developing seeds and this is the phase of seed development. During this period, germination also increased at a faster rate as found in this study where germination increased from 21 DAA and reached maximum at 36 and 39 DAA.

The 100 seed weight increased during the seed development phase (Fig1b). In Baby, the maximum 100 seed weight was recorded on 36 DAA and in Kaumudi 39 DAA and thereafter a slight decrease was noticed. This is due to the decrease in moisture content during the seed maturation phase. Harrington (1959) observed maximum 100 seed weight at 37 DAA in muskmelon and beyond that a slight decrease is noticed. Krishnaprasad (1980) also reported similar results in which maximum 100 seed weight in ash gourd was recorded at 60 d.a.a. and thereafter a decrease was observed.

Fig. 1c Germination percent and seedling length (cm) in snake gourd varieties at different days of harvest.

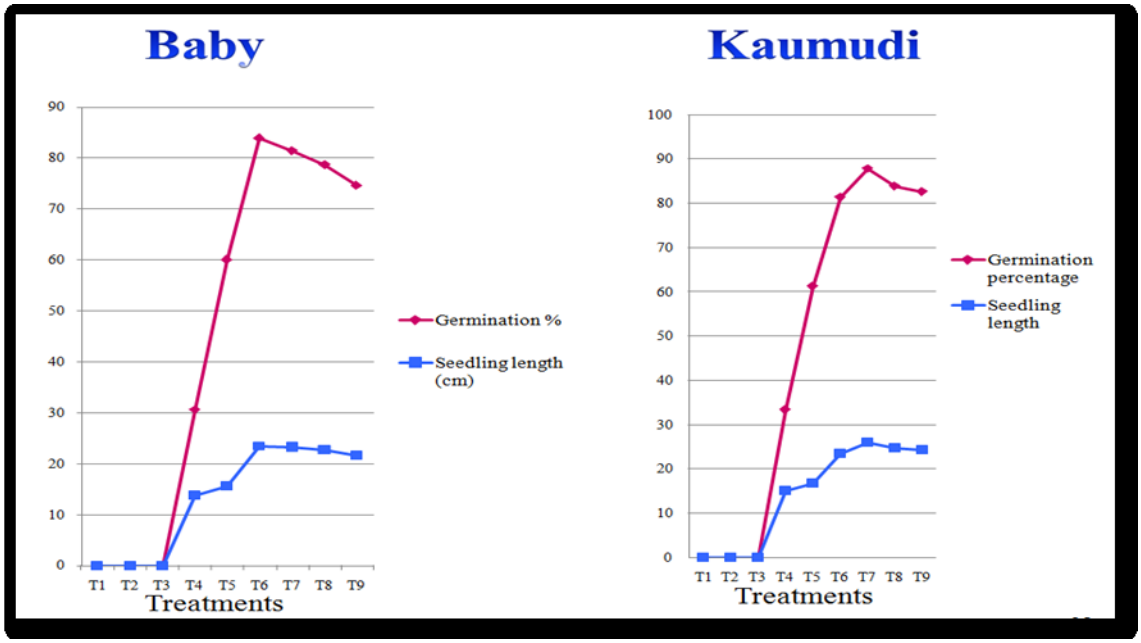
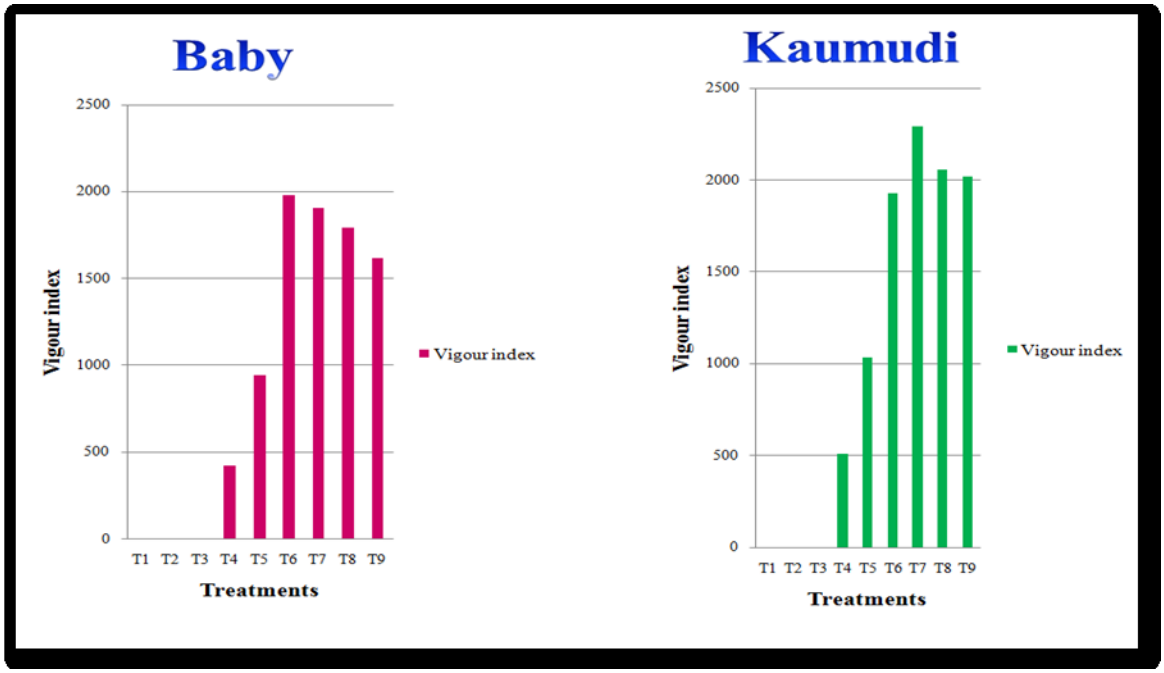


Fig. 1d Vigour index in snake gourd varieties at different days of harvest.



In the present investigation, the germination of seeds obtained from the two varieties differed slightly (Table 4.1a and 4.1b and Fig1c). In both varieties, seeds reached the germinable maturity by 30 DAA. Later, germination increased and reached maximum at 36 DAA in Baby (84%) and 39 DAA in Kaumudi (88%). Low germination per cent in the early stages of development in both snake gourd varieties is due to the presence of immature embryo in seeds and by 36^{th} and 39^{th} DAA the embryos had undergone full ripening process and attained full viability which resulted in highest germination in Baby and Kaumudi respectively. Relationship between germination and embryo development was explained by many scientists (Maheshwari, 1950; Manohar, 1969 and 1970). Germination % was higher in Kaumudi when compared to Baby. This shows varietal difference on seed maturity and germination. The relationship between seed maturity and seed germination was established by many workers (Harrington, 1959; Chin, 1981; Metha, 1983 and Nerson and Paris, 1988). Krishnaprasad (1980) reported that in ash gourd seeds (Co- 1) germination started at 50 DAA and attained maximum germination at 80 DAA and he observed influence of environmental factors and cultivar differences on germinable maturity of seeds. Environmental parameters particularly temperature play an important role in seed germination and seed quality (Gray *et al*., 1988).

The speed of germination is an important aspect of vigour and provides a reasonably good index of vigour of any seed lot (Copeland, 1988). The relative root length (Grabe, 1965) and shoot length (Wold *et al.,* 1972; Egli and Tekrony, 1973) of the seedling would predict their subsequent growth and performance and hence could be regarded as indices of measurement of seed vigour. Seeds may germinate but may not produce vigorous seedlings (Cox and Star, 1927). Fully matured seeds have the advantage of complete physical and physiological development needed for maximum expression of vigour. In the present investigation, a positive correlation was obtained between seed maturity and speed of germination, seedling length and vigour index of seedlings. Similar observations were recorded in carrot by Bothwick (1931) in ridge gourd and bitter

gourd by Varatharaj (1979), in ash gourd by Krishnaprasad (1980) and in watermelon by Hedayat (1987). In the present study, seed quality parameters such as germination (84% and 88%), speed of germination (9.14 and 10.36), root length (6.80 cm and 8.23 cm), shoot length (16.77 cm and 17.78 cm), seedling length (23.57 cm and 26.02 cm) and seedling vigour index (Fig1d 1980 and 2288) were significantly higher in the fruits harvested after 36 DAA and 39 DAA respectively in both varieties and hence it could be concluded that these are the right stages for fruit harvest for getting maximum seed quality attributes. These results are in agreement with the findings of Chauhan and Bhandari (1971) in okra, Worku *et al.* (1975), Dhanaleppagol (1986) and Quagliotti (1977) in chilli, Singh and Sidhu (1985) in brinjal and Nandeesh *et al*. (1995) in cucumber where relationship between seed maturity and seed quality parameters were observed.

The pattern of fruit and seed development in snake gourd from this investigation showed three distinct phases; viz., structural development phase, dry matter accumulation phase and maturity phase.

a.) Structural development phase

This stage was characterized by a steep increase in fruit size. Fresh weight of fruit increased very rapidly due to faster accumulation of water and metabolites whereas dry matter accumulation was slow. As far as fruit development was concerned, this stage can be called as ‘vegetative phase’ because the fruit attains maximum size with a tender fruit rind, poor seed development and hence best suited as vegetable. This extends upto 27 DAA. Early stages of fruit growth were characterized by the formation of new cells, but this quickly changed to cell enlargement.

For seed, this can be concerned as structural development phase or a phase of histo- morphological development. Whitish seeds and watery cotyledons part appeared by 21 DAA. By 30 DAA, the seeds started turning light brown in colour

and developing minute embryos. At this stage, seed development was structurally complete. Noggle and Fritz (1989) reported that Phase I comes to an end when embryonic plant is fully differentiated and cell division ceases.

b.) Dry matter accumulation phase

This was actually the seed filling phase or cotyledon development phase. It was observed that fruit development is a pre- requisite for seed development. This phase was characterized by an increase in dry matter content of fruit and seed. Fruit rind became harder and seed filling completed and seeds became bold and plumpy. Seed coat became a little harder and turned brown in colour and could be easily separated from placenta by 33 DAA. This stage extends upto 33 DAA. Phase II comes to an end as the seeds begin to lose water (Noggle and Fritz, 1989).

c.) Maturity phase

This phase was characterized by an increase in weight of seeds and its germination. Dry matter of seeds increased due to transport of metabolites from fruits to seeds. By the end of this stage (36 DAA in Baby and 39 DAA in Kaumudi), seeds became well matured with hard seed coat, germination and vigour reached the maximum and fruit colour turned red indicating the physiological maturity of seeds.

5.2 INFLUENCE OF FRUIT SIZE AND SEED POSITION ON SEED QUALITY

In vegetables, proper selection of fruit is very important for obtaining high quantity of quality seeds since seed quality varies with fruit size, weight, maturity, etc. In cucurbits, the first formed fruits will be bigger and possess better quality seeds due to the coexistence of development of fruits as well as seeds and they have suppressing effect on development of subsequently formed fruits. Hence, the fruits

Fig. 2a Influence of fruit size on seed and seedling characters in snake gourd varieties.

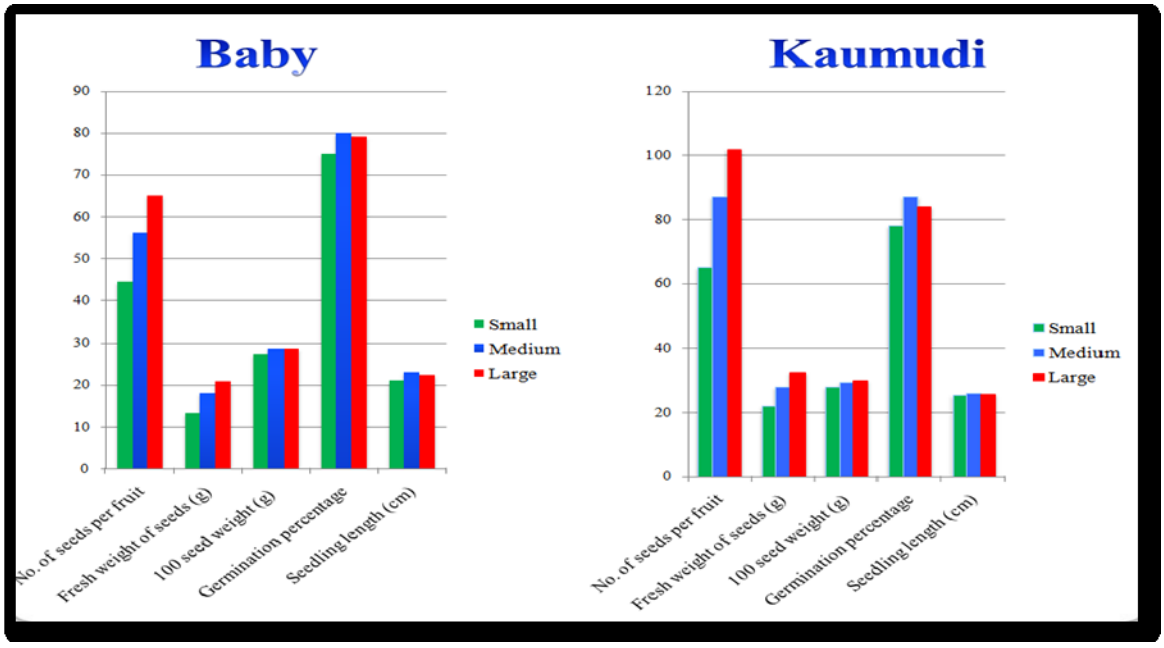
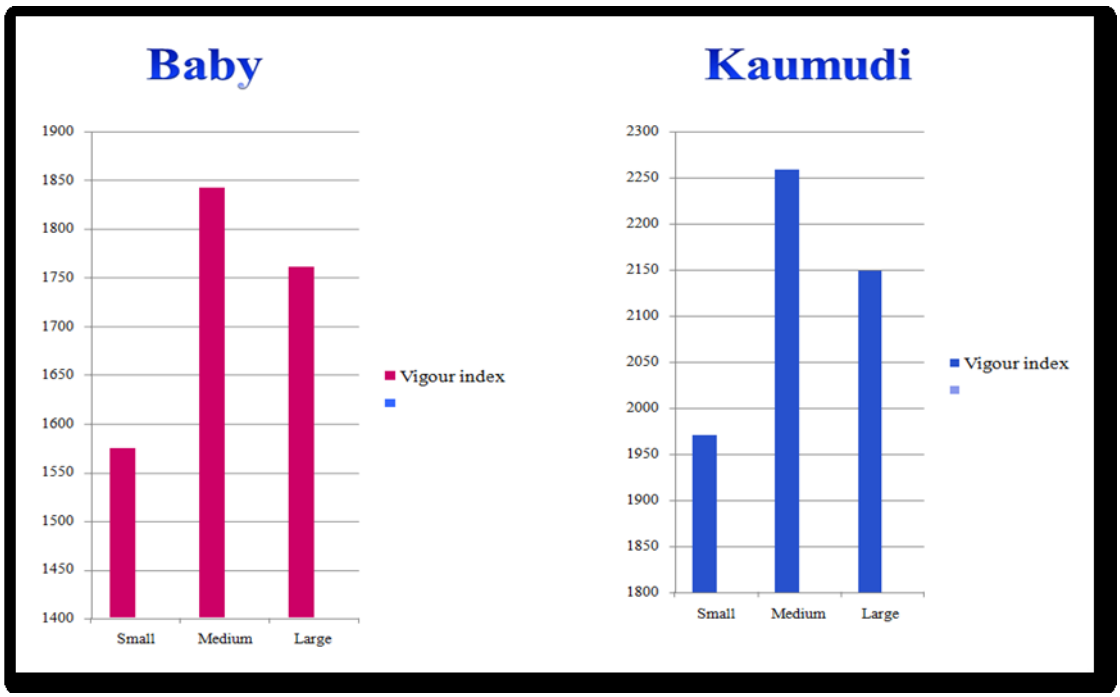


Fig. 2b Influence of fruit size on vigour index in snake gourd varieties.



formed later will be smaller in size and filling of seeds is poor resulting in less dry weight of seeds and low 100 seed weight, ultimately influencing the seed quality parameters like germination and seedling vigour.

In the present study in both varieties, significantly higher seed yield per fruit and its attributing components *viz*., fruit weight (626 g and 2167 g in Baby and Kaumudi respectively), fruit length (42.45 cm and 112.97 cm respectively), fresh seed weight (20.83 g and 32.53 g respectively) and dry seed weight (18.67 g and 29.69 g respectively) were recorded in large sized fruits compared to medium and small sized fruits and lower values for the above parameters recorded in small fruits may be due to the reduced accumulation of photosynthates. Similar observations were made by Rajan (1989) in tomato, Vanangamudi and Palanisamy (1989) in bittergourd and Devadas *et al.* (1999) in pumpkin where they reported that the seeds extracted from very large and long fruits recorded maximum seed size and weight which decreased as the length of fruit decreased.

Large sized fruits recorded significantly higher number of seeds per fruit (65.10 and 101.67 respectively) in Baby and Kaumudi varieties. This is in accordance with the findings of Pet and Garretson (1983) in bittergourd who reported variations in seed number and size due to fruit size. In the present study, the seeds of very long fruits had more 100 seed weight (28.72 g and 30.05 g in Baby and Kaumudi respectively) while, the seeds of small fruits registered less weight in both varieties (Fig 2a). Higher 100 seed weight may be due to the presence of maximum per cent of mature seeds. This is in agreement with the findings of Suryawanshi and Patil (1995) in watermelon. Mini *et al.* (2000) observed direct relationship between seed weight and seed size in ash gourd and suggested that heavier the seed, greater is the size of seedlings and higher photosynthetic efficiency of plants. Devadas *et al.* (1999), in a study in pumpkin observed positive correlation of diameter of fruit with total number of filled seeds and they noticed higher percentage of filled seeds in large sized fruits (93.61%) which differed significantly with other fruit size groups.

In the present study, seed germination did not differ significantly due to fruit sizes. However, numerically higher germination (80% and 87% respectively) was observed in medium sized fruits of Baby and Kaumudi varieties. Highest seedling length (23 cm and 26.06 cm respectively), and seedling vigour index (1842 and 2258 respectively) were observed in medium sized fruits in Baby and Kaumudi varieties (Fig 2b). This is in accordance with the findings of Vanangamudi and Palanisamy (1989) and Supe and Lawande (1990) in bittergourd and they reported that the seed germination was on par with seeds gathered from long and medium fruits.

Position of seed within the fruit influenced seed quality parameters. Fruits of different sizes were cut into three equal portions and fruit length of each portion of small, medium and large fruits was 10.80 cm, 12.10 cm and 14.15 cm in Baby variety (Table 4.2d). In Kaumudi, fruit length of each portion of small sized, medium sized and large sized fruits were 24.61 cm, 31.75 cm and 37.65 cm respectively.

Fruit weight, number of seeds, fresh and dry weight of seeds and 100 seed weight were found to vary significantly with position of seed in different sized fruits in both varieties. The middle region of small, medium and large sized fruits of Baby recorded significantly higher fruit weight (121.67 g, 200.00 g and 269.17 g, respectively), number of seeds (22.40, 29.63 and 35.70, respectively), fresh weight of seeds (6.72 g, 9.48 g and 11.42 g, respectively), dry weight of seeds (6.05 g, 8.50 g and 10.25 g, respectively) and 100 seed weight (27.77 g, 28.91 g and 28.92 g, respectively) than stylar region fruits of all sizes. Pedicel end region is having lower values fruits of all sizes in Baby (Table 4.2c). In Kaumudi also, the same trend was observed whereas the middle region of small, medium and large sized fruits recorded significantly higher fruit weight (348.33 g, 626.67 g and 918.33 g, respectively), number of seeds (35.97, 50.30 and 59.33, respectively), fresh weight of seeds (12.23 g, 16.09 g and 18.99 g, respectively), dry weight of seeds (9.89 g,

Fig. 2c Influence of seed position on germination per cent and seedling length (cm) in snake gourd varieties.

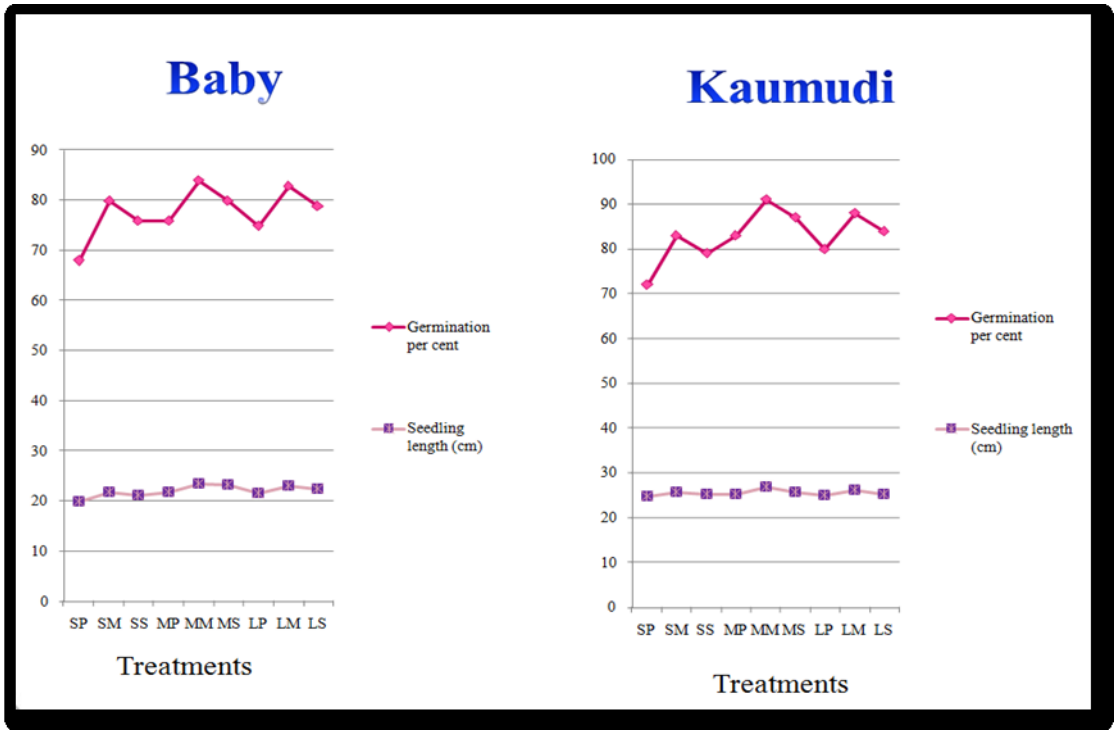
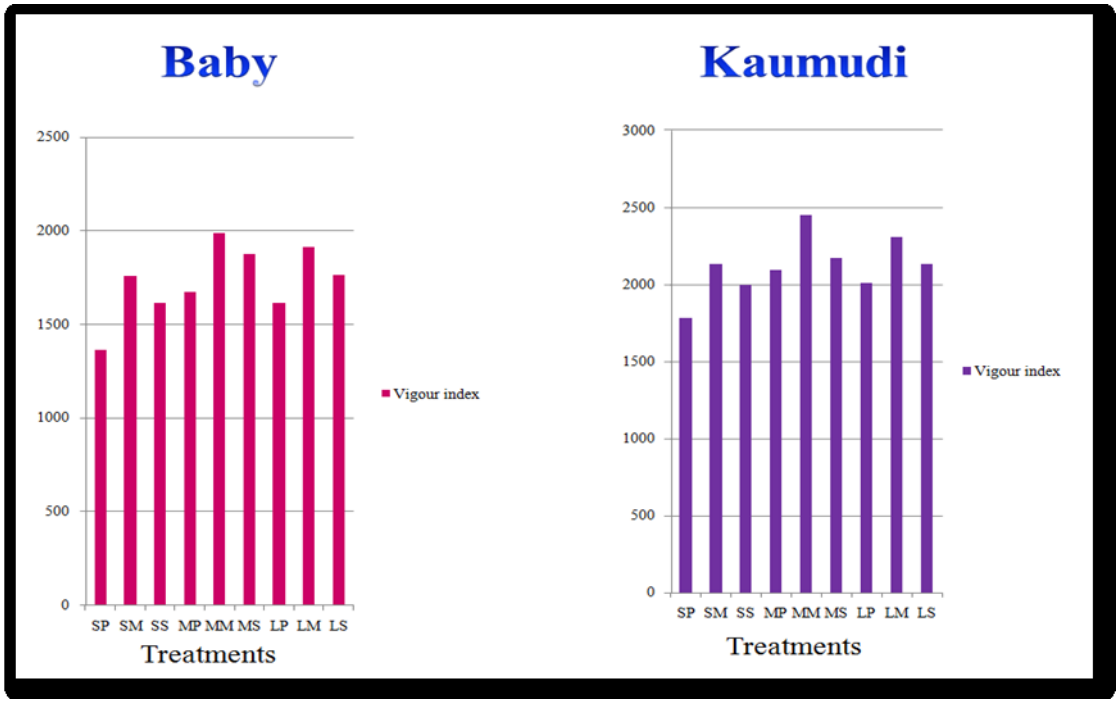


Fig. 2d Influence of seed position on seedling vigour in snake gourd varieties.



14.69 g and 17.36 g, respectively) and 100 seed weight (28.13 g, 29.77 g and 30.54 g, respectively) compared to stylar and pedicel regions of fruit (Table 4.2d).

The seed quality varied due to the different positions occupied by it within the snake gourd fruit. The highest germination and vigour was obtained for seeds in the middle portion fruits of all sizes in both varieties from the figure 2c and 2d. It is clear that middle portion of the medium sized fruits reached higher germination and vigour. From fruit initiation to full maturity a specific period is required for each crop and for snake gourd this is 36- 39 days. Increased girth of the snake gourd fruit was noticed at the mid part and it can be assumed that the seeds at the mid part of the fruit will get more photosynthates such as carbohydrates, lipids, proteins and phosphorus containing compounds, and thus will develop properly and exhibit better germinability. This probably may be the reason for their higher germination percentage.

Speed of germination and seedling length were also significantly lowest for pedicel end and the highest value was recorded by middle portion. As the seed initiates embryo growth, the endosperm nutrients get translocated to the emerging axis. Storage tissues function primarily as reservoirs, from which the emerging axis draws nutrients, and the seeds in the pedicel position in general have less storage tissue, which may be the reason for reduced root length of seedling development from these seeds.

Vigour index being a product of germination percentage and shoot and root length of seedling, pedicel end recording the lowest vigour index is quite expected as observed from their germination percentage. There are abundant information which demonstrate an association between seed size/weight and seed vigour (Austin, 1972; Heydecker, 1972; McDonald, 1975) and in this study the fresh and dry weight of the seeds of pedicel end are low which exhibited low germination and seedling vigour. Burris *et al.*, 1971 and 1973 and Fontes and Ohlrogge (1972) have reported that large seeds of soyabean with high seed weight are superior to small seeds in germination and vigour. Devi (1999) reported that germination per cent,

seedling length and vigour index were significantly influenced by different seed positions in bitter gourd fruit and highest values for these parameters were obtained in seeds from the middle portion than the seeds from pedicel end position.

Correlation studies indicated significant positive influence of fruit length on fruit weight, number of seeds, fresh weight of seeds per fruit, dry weight of seeds per fruit and 100 seeds weight. Fruit weight was also significantly correlated with seed number and seed weight. Fruit length has no significant correlation with the germination per cent. Seeds of bigger fruits may be able to accumulate more photosynthates from the pericarp during seed development. This results in bolder seeds with high vigour. Such positive relationships of fruit size with the quantity of seeds have been reported in bittergourd (Vanangamudi and Palaniswamy, 1989), in tomato (Ayyasamy, 1986; Rajan, 1989), in ash gourd (Devadas *et al*., 1994), and in brinjal (Karivaratharaju *et al*., 1985).

In general, it was observed that the quantity and quality of seeds in snake gourd increases as the fruit size (length and weight) increases. The study indicated the need for selecting big and medium sized fruits for obtaining maximum quantity of good quality seeds in snake gourd.

5.3 EFFECT OF STORAGE ON SEED QUALITY AND LONGEVITY

Seeds collected from the fruits of correct maturity were processed and stored in sealed polythene bags at ambient temperatures and A/C conditions for a period of one year to study the effect of storage on seed quality and longevity.

Results of the study indicated that at 0 month (before storage), the germination per cent was low in Baby (77) and Kaumudi (80). Later, germination per cent increased and reached maximum at 3rd month in open storage condition (84% in Baby and 90% in Kaumudi) and 4th month in A/C storage condition (91% and 97% in Baby and Kaumudi respectively). Thereafter it decreased and the

Fig. 3a Effect of storage conditions on germination per cent in snake gourd varieties.

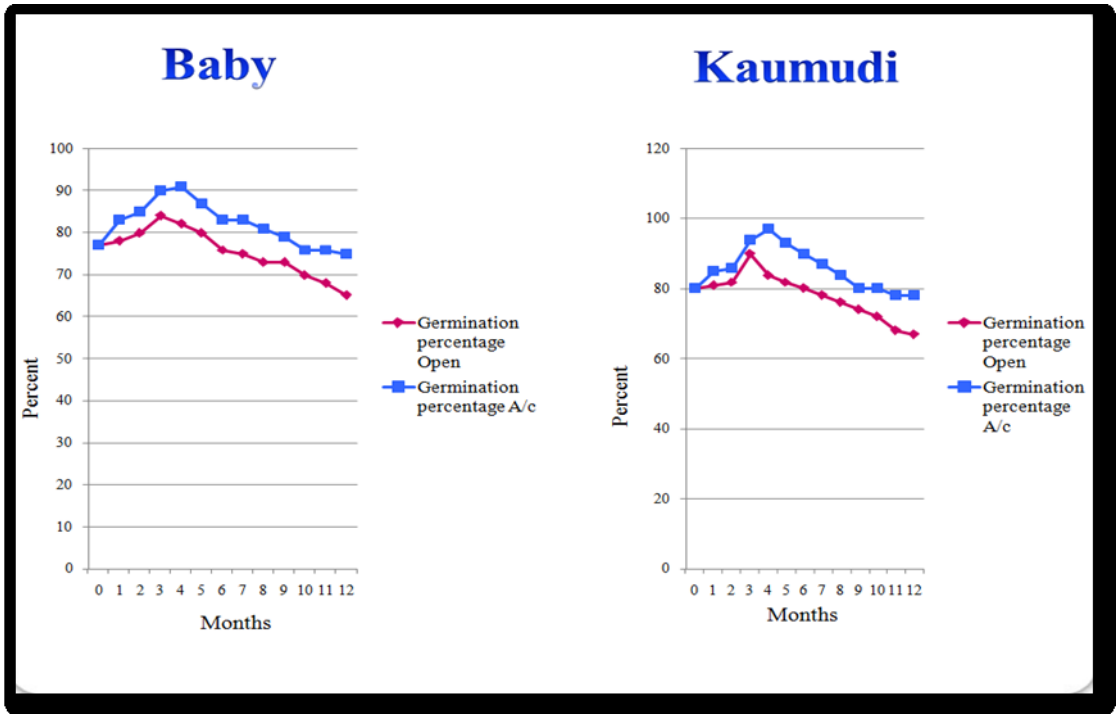
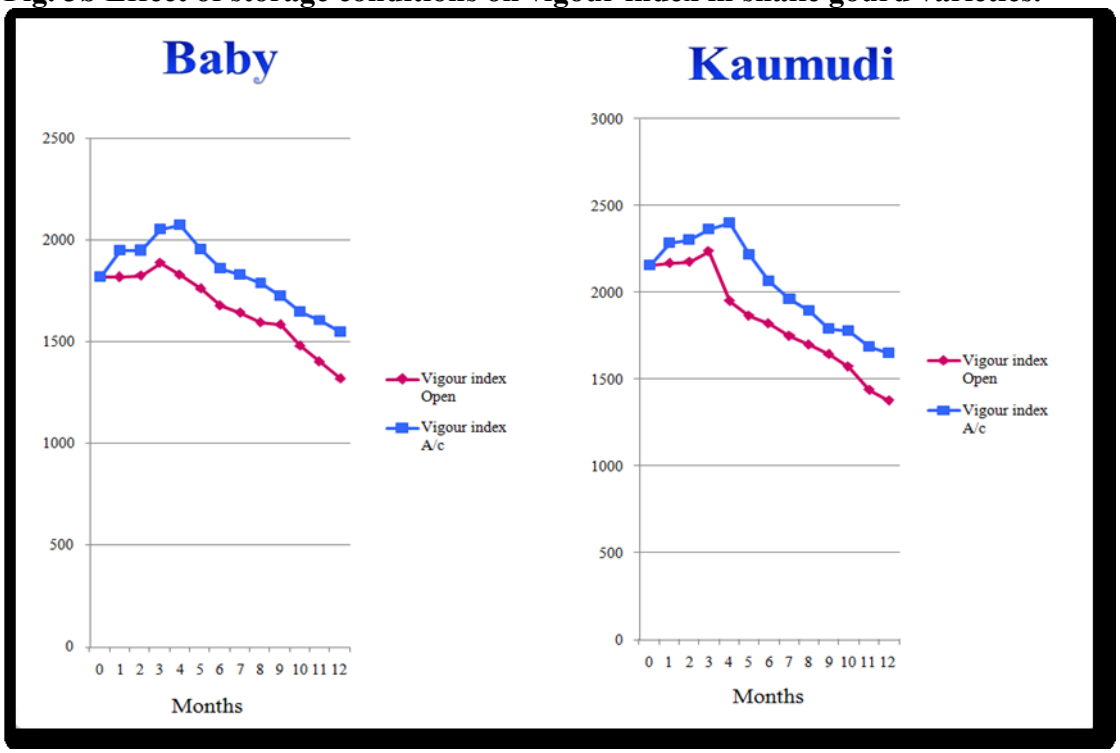


Fig. 3b Effect of storage conditions on vigour index in snake gourd varieties.



lowest germination per cent was recorded at 12 month of storage in ambient and A/c conditions (65 and 75 respectively) in Baby and (67 and 78, respectively) in Kaumudi (fig. 3a). This indicates that snake gourd seed, exhibited dormancy for a period of 3 months in open storage conditions and 4 month in A/C storage conditions. Mohan (2005) reported that snake gourd seeds exhibited natural dormancy for four months and for immediate use of seeds invigoration treatment is inevitable. Dormancy was reported in ash gourd by Ganar *et al*. (2004). Similar results of low germination in storage were reported by Costa *et al*. (2001) in carrot.

Germination was higher in A/C storage condition than open in both varieties and even at the end of one year, above 70% germination could be obtained under A/C storage condition in both varieties. Germination was higher in Kaumudi variety than Baby indicating the varietal differences for this character. Studies concluded by John and Bharathi (2006) in maize seeds and Manjunatha *et al*. (2008) in chilli indicated similar results to the present study where a decrease in germination was noticed with increase in storage period was noticed.

The speed of germination initially increased with increase in the storage period and reached maximum (>10) at 3rd and 4th month of storage under ambient condition and 3rd, 4th and 5th month under A/C storage condition in Baby. In Kaumudi, values for speed of germination were higher upto 5th month in open storage condition and 6th month in A/C storage conditions. High speed of germination is an indication of high germination capacity of the seed which is evident from this study where germination was higher in 3rd (open) and 4th month (A/C) of storage in Baby and Kaumudi. Later, decrease in speed of germination is noticed and it is positively correlated with germination which also decreased in storage.

Seedling length decreased with increase in the storage period in both the varieties. At 0 month (before storage), the highest seedling length was recorded in Baby (23.61 cm) and Kaumudi (27.03 cm). Seedling length was the lowest at 12th

month of storage in ambient and A/C conditions of storage in Baby (20.33 cm and 20.64 cm respectively) and Kaumudi (20.64 cm and 21.17 cm respectively). Significant difference was not obsereved for seedling length between the two environmental storage conditions (ambient and A/C) in both varieties. Similar results of decrease in seedling length with increase in storage period was reported by John and Bharathi (2006) in a study with maize seeds stored for 10 months and Kunkur *et al.,* (2007) in cotton seeds kept in ambient storage condition.

Vigour index is a function of seedling length and germination per cent. Vigour index of seedlings initially increased and reached maximum at 3rd (1886 in Baby and 2241 in Kaumudi) and 4th (2076 in Baby and 2406 in Kaumudi) month of storage in variety Baby in ambient and A/C conditions respectively (fig. 3b). Thereafter it decreased and the lowest vigour index of seedlings was recorded at 12 month of storage in ambient and A/C conditions in Baby (1322 and 1548 respectively) and in Kaumudi (1383 and 1652, respectively) (Table 4.3f). Vigour index of seedlings was found to differ significantly with the environmental conditions of storage (ambient and A/c conditions) in both the varieties (Table 4.3f). Decrease in vigour index with increase in the storage period was reported by Kunkur *et al*. (2007) in cotton seeds. Similar results of drastic decrease in vigour index as compared to initial vigour index at the end of 12 months of storage was reported by Manjunatha *et al.,* (2008) in a study with chilli seeds.

Dehydrogenase enzyme activity is a direct indicator of viability of seeds. The red coloured stain indicates viable seeds and faded colour shows low viability of seeds. Values of enzyme "dehydrogenage" test decreased with increase in the storage period in both the varieties. At 0 month (before storage), highest enzyme activity was observed with OD values of 1.09 in Baby and 1.57 in Kaumudi and it decreased with storage months. Lowest values for the enzyme test were recorded at 12th months of storage in ambient and A/C conditions (0.69 and 0.85 respectively) in Baby and (0.72 and 0.98, respectively) in Kaumudi (fig. 3c). Enzyme dehydrogenage values differ significantly with the storage conditions (ambient and

Fig. 3c Effect of storage conditions on enzyme dehydrogenase activity (O. D. value) in snake gourd varieties.

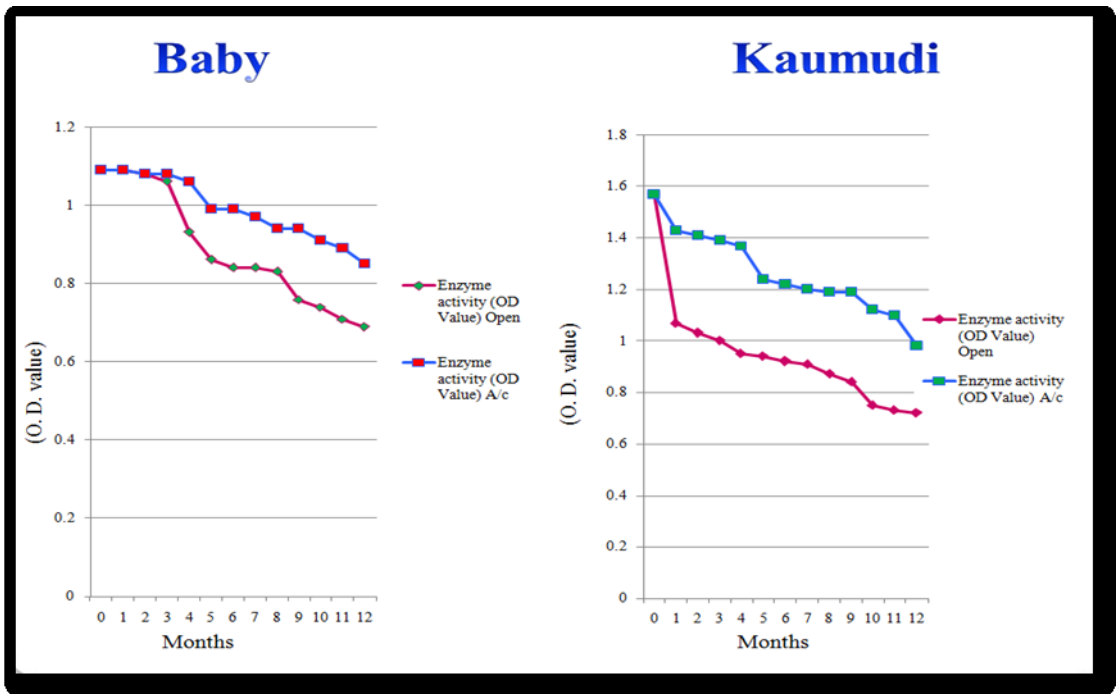
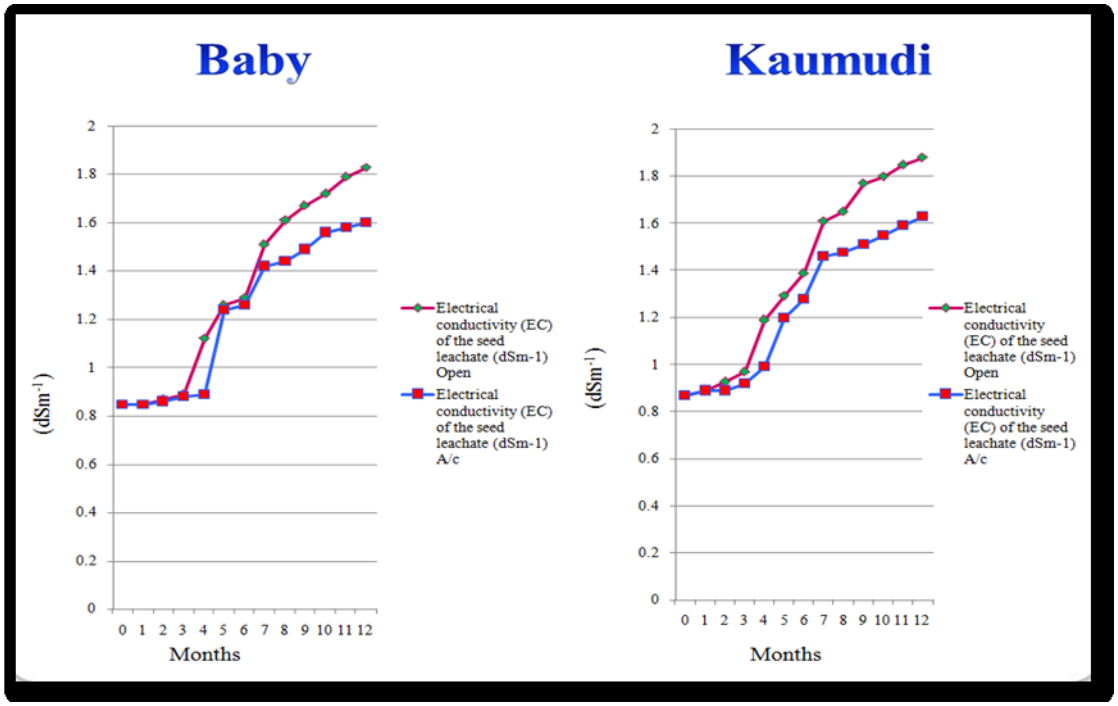


Fig. 3d Effect of storage conditions on electrical conductivity of seed leachate (dSm^{-1}) in snake gourd varieties.



A/c conditions) in both the varieties (Table 4.3g). Generally, values were higher under A/C storage condition when compared to open condition of storage in all the months indicating higher enzyme activity resulting in high germination and vigour in these seedlings under A/C condition. In Kaumudi, OD values for "dehydrogenase" test were higher both in open and A/C storage conditions than Baby which indicates varietal difference for this character under both conditions of storage (0.92 and 1.22 respectively). (Table 4.3g). Similar results of decreased dehydrogenase activity were reported by John and Bharathi (2006) in maize seeds in storage.

Electrical conductivity (EC) value of the seed leachate is an indication of the viability and vigour of the seed. In the present study, values of EC increased with an increase in storage period in both the varieties (fig. 3d). The increase was very slow initially upto 3rd month (open storage) and 4th month (A/C) of storage. Low EC value is an indication of high germination and vigour of the seedlings and it is proved undoubtedly from the result of the present study where high germination percentage and vigour was associated with low EC value in 3rd (open) and 4th (A/C) month of storage. At 0 month (before storage), the lowest electrical conductivity values were recorded in Baby (0.85) and Kaumudi (0.87), whereas the values were highest at 12th month of storage under open and A/C conditions of storage (1.83 and 1.60 respectively in Baby and 1.88 and 1.63 respectively in Kaumudi). Generally, EC values were higher under open storage condition when compared to A/C storage and this can be correlated with the observations of low germination percentage in open storage condition than A/C storage condition. Electrical conductivity values were significantly differing with the environmental conditions (ambient and A/c conditions) in both the varieties (Table 4.3h). Similar findings were quoted by Kunkur *et al.,* (2007) in cotton where treatments with lower EC recorded high germination and Manjunatha *et al*. (2008) reported an increase in EC of seed leachate with increase in storage period. Basavaraj *et al.,* (2008) also reported that in onion, electrical conductivity of stored seeds showed a

progressive increase with increase in storage period with initial EC value of 0.51 dSm^{-1} and final value of 0.66 dSm^{-1} at the end of 10 months of storage.

SUMMARY

6. SUMMARY

The present investigation on "Seed maturity and seed longevity studies in snake gourd (*Tricosanthes anguina* L.) varieties" was carried out in the Department of Olericulture, College of Horticulture, Vellanikkara during the year 2010-2012.

The present study was proposed with the objectives of standardising the physiological maturity in snake gourd varieties for better seed quality, understanding the influence of fruit size and position of seeds within the fruit on seed quality and studying the effect of storage conditions on seed quality and longevity. The results of the three experiments are summarised below:

6.1 PHYSIOLOGICAL MATURITY STUDIES IN SNAKE GOURD VARIETIES (BABY AND KAUMUDI)

1.) Physiological maturity stage of the fruits to obtain maximum seed and seedling qualities varied between the two snake gourd varieties studied (Baby and Kaumudi).

2.) Morphological characters of fruits and seeds studied at various developmental stages showed changes in fruit and seed colour. Initially the fruit was white in colour having light hairs on fruit skin with creamy white and firm placenta. Later, fruit colour changed to light red and red and colour of placenta turned from creamy white to light orange and finally red. The texture of placenta changed from spongy to mucilaginous. Initially seeds were ill filled and creamy white in colour. Later seed colour changed to brown with well developed ring on seed surface. Thickness of the seed coat increased with increased number of days in both varieties.

3.) In Baby, on 36 DAA, fruits tip ($1/3^{rd}$ portion) turned red and placenta became mucilaginous and red in colour. At that stage, seeds were hard and

detached from placenta and later on at 39 DAA, whole fruit turned red. However in variety Kaumudi, fruit tip turned red, placenta became mucilaginous and seeds became hard and detached from placenta at 39 DAA and on 42 DAA, whole fruit turned red. Seeds filled properly at 36 and 39 DAA in Baby and Kaumudi and brown in colour with well developed ring on the surface in both varieties.

4.) The length, weight and diameter of the developing fruits increased significantly and reached maximum at 36 days after anthesis in Baby (37.32 cm, 474.83 g and 7.33 cm respectively) and at 39 DAA in Kaumudi (102.77 cm, 1355.80 g and 9.53 cm respectively). Thereafter, a slight decrease in length, weight and diameter of fruit was observed in both varieties. Fruit length and weight were higher in the variety Kaumudi than Baby.

5.) The number of seeds, fresh, dry and 100 seed weight in the developing fruits increased gradually with days of anthesis. In Baby, number of seeds, fresh, dry and 100 seed weight were found to be significantly highest at 36 DAA with values of 58.70, 17.20 g, 15.90 g and 27.08 g respectively. In Kaumudi, values of these parameters were found to be significantly maximum at 39 DAA (89.87, 30.38 g, 27.71 g and 30.95 g respectively) and later a slight decrease was noticed for these seed parameters in both varieties. Number of seeds and seed weight were higher in Kaumudi when compared to Baby.

6.) Seeds from fruits of T1, T2 and T3 (21- 27 days after anthesis) did not germinate in both varieties. Germination percent, speed of germination, seedling length and vigour index of seedlings were lowest in 30 DAA in both varieties. Significantly high germination, speed of germination, seedling length and vigour index were observed at 36 DAA in Baby (84 %, 9.14, 23.57 cm and 1980) and at 39 DAA in Kaumudi (88 %, 10.36, 26.02 cm and 2288). Thereafter, a decrease in germination percent, speed of

germination, seedling length and vigour index was observed for all these characters in both varieties.

7.) Fruit maturity stage for attaining maximum seed quality was standardized as 36 DAA in snake gourd var. Baby and 39 DAA in Kaumudi.

6.2 INFLUENCE OF FRUIT SIZE AND SEED POSITION ON SEED QUALITY

8.) Fruit length and weight differed significantly with difference in fruit sizes. The number of seeds, fresh, dry and 100 seed weight also differed significantly with difference in fruit sizes. The large sized fruits recorded significantly higher number of seeds, fresh, dry and 100 seed weight (65.10, 20.83 g, 18.67 g and 28.72 g) than medium sized fruits (56.20, 17.99 g, 16.13 g and 28.54 g) whereas, small sized fruits recorded significantly lower values (44.40, 13.32 g, 11.99 g and 27.37 g) in Baby. In Kaumudi also, the large sized fruits recorded higher number of seeds, fresh, dry and 100 seed weight (101.67, 32.53 g, 29.69 g and 30.05 g) significantly higher than medium sized fruits (87.13, 27.88 g, 25.68 g and 29.45 g) while, small sized fruits recorded significantly lower values for these characters (65.10, 22.07 g, 17.91 g and 27.86 g). Seed number and weight were found to be higher in Kaumudi than Baby.

9.) The germination per cent, speed of germination, seedling length and vigour index of seedlings did not differ much with fruit sizes. However, higher germination per cent, speed of germination, seedling length and vigour index of seedlings were recorded by medium sized fruits (80 %, 9.55, 23.00 cm and 1842) followed by large fruits (79 %, 9.00, 22.39 cm and 1761) in Baby. In Kaumudi also, highest germination per cent, speed of germination, seedling length and vigour index of seedlings were recorded by seeds of

medium sized fruits (87 %, 10.27, 26.06 cm and 2258) and it was on par with seeds obtained from large sized fruits (84 %, 10.20, 25.56 cm and 2149) while, small sized fruits recorded lower germination per cent, speed of germination, seedling length and vigour index of seedlings (78 %, 9.49, 25.32 cm and 1970 respectively).

10.) Irrespective of the varieties fruit and seed parameters were maximum in large sized fruits whereas germination and seedling vigour were found to be higher in seeds obtained from medium sized fruits.

11.) Studies on influence of seed position on fruit and seed characters showed variations. The middle region of small, medium and large sized fruits recorded significantly higher fruit weight (121.67 g, 200.00 g and 269.17 g, respectively) compared to stylar region (107.50 g, 148.33 g and 215.83 g, respectively) and pedicel region (85.83 g, 118.33 g and 140.83 g) in Baby. In Kaumudi also, the same trend was observed wherein the middle portion of small, medium and large sized fruits recorded significantly higher fruit weight (348.33 g, 626.67 g and 918.33 g, respectively) compared to stylar region and pedicel region.

.

12.) The number of seeds, fresh, dry and 100 seed weight were found to vary significantly with respect to fruit size and different portions of fruit (pedicel, middle and stylar region of the fruit) in both varieties. In Baby, the middle region of small, medium and large sized fruits recorded significantly higher number of seeds(22.40, 29.63 and 35.70), fresh (6.72 g, 9.48 g and 11.42 g), dry (6.05 g, 8.50 g and 10.25 g) and 100 seed weight (27.77 g, 28.91 g and 28.92 g respectively) followed by stylar region. In snake gourd variety Kaumudi also, the middle region of different sized fruits recorded significantly higher number of seeds (35.97, 50.30 and 59.33), fresh, dry and 100 seed weight (28.13 g, 29.77 g and 30.54 g) in small, medium and large fruits respectively compared to stylar and pedicel region. Seed number

and weight observed in pedicel region of different sized fruits were low in both varieties.

13.) The germination per cent, speed of germination, seedling length and vigour index of seedlings obtained from different regions of different sized fruits were found to be significantly different in both varieties. In Baby and Kaumudi, seeds of the middle region of different sized fruits (small, medium and large) recorded significantly higher germination per cent (80, 84 and 83), speed of germination (8.74, 10.31 and 9.37), seedling length (21.95 cm, 23.62 cm and 23.12 cm) and vigour index of seedlings (1758, 1986 and 1910) followed by seeds of stylar region and pedicel region.

6.3 EFFECT OF STORAGE ON SEED QUALITY AND LONGEVITY

14.) At 0 month (before storage), germination per cent, speed of germination, seedling length and vigour index of seedlings recorded were 77%, 9.39, 23.61 cm and 1818 in Baby and 80 %, 10.24, 27.03 cm and 2162 in Kaumudi. In both varieties, germination per cent, speed of germination and vigour index of seedlings increased and reached maximum at 3rd (84%, 10.31 and 1886 in Baby and 90%, 10.97 and 2241 in Kaumidi) month of storage under ambient conditions and 4th (91%, 10.44 and 2076 in Baby and 97%, 10.97 and 2406 in Kaumudi) month of storage in A/C conditions. Values of these parameters were found to be high in Kaumudi than in Baby. Later there was a decline in seed quality parameters under open as well as A/C storage conditions and the lowest value for germination per cent, speed of germination, seedling length and vigour index were recorded at 12 months of storage both in ambient and A/C conditions in both varieties. Among the two storage conditions, seeds stored in A/C condition recorded higher quality to those stored under ambient conditions in both varieties. Even at the end of one year, Baby and Kaumudi recorded a germination of

75 per cent and 78 per cent respectively under A/C storage whereas under open storage Baby and Kaumudi gave only 65 and 67 per cent germination.

15.) Values of enzyme dehydrogenage test decreased with increase in the storage period in both the varieties. Higher enzyme activity was observed upto 3 months in open storage and 4^{th} months in A/C storage in both varieties. Lowest values for the enzyme test were recorded at 12^{th} months of storage in ambient and A/c conditions (0.69 and 0.85 respectively) in Baby and (0.72 and 0.98, respectively) in Kaumudi. Generally, values were higher under A/C storage condition when compared to open condition of storage in all the months and among varieties, values were slightly higher in Kaumudi than Baby under both conditions of storage. Enzyme dehydrogenage values differed significantly with the storage conditions (ambient and A/c conditions) in both the varieties.

16.) Electrical conductivity values of the seed leachate increased with increase in the storage period in both the varieties which is an indication of seed deterioration. Initially the increase was very slow upto 3^{rd} month of storage in open condition and 4 month in A/C storage condition. At 0 month (before storage), the lowest electrical conductivity values were recorded in Baby (0.85) and Kaumudi (0.87), whereas the values were highest at 12^{th} month of storage. Generally, EC values were higher under open storage condition when compared to A/C storage in both varieties. Electrical conductivity values were found to differ significantly with the environmental storage conditions (ambient and A/c conditions) in both the varieties.

REFERENCES

REFERENCES

Abbasov, A.M. 1974. Seed production in different cultivars of cucurbitaceous crops and the effect of melon size on seed quality. *Hortic. Abstr.* 45(12): 9563.

Abdul-Baki, A.A. and Baker, J.E. 1973. Change in cellular organelles membranes related to vigour loss in seeds. *Seed Sci. Tech*. 1: 89- 125.

Abdul-Baki, A. and Anderson, J.D. 1973. Vigor determination in Soybean seed by multiple criteria. *Crop. Sci.* **13**: 630-633.

Abdul–Baki, A.A, 1980. Biochemical aspects of seed vigor. *Hort. Sci.* 15:765–71.

Agarwal, R.L. 2000. *Seed Technology* (2nd ed.) Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 827p.

Alekseev, R.V. 1976. Changes in weight, size and germination of developing eggplant seeds. *Referatevnui Zhurna.* 55: 639.

Alvarenga, E.M., Silva, R.F., Araiyo, E.F. and Cardoso, A.A. 1984. Influence of age and post harvest storage of watermelon on seed quality. *Horticultura Brasieleira*. 2(2): 5-8.

Anilkumar, V.R., Sharma, R.R. and Deshmukh, P.S. 2008. Patterns of pod and seed growth during fruit development in garden pea genotypes. *Indian J. Hort.* 65(3): 293-296.

Aroonrungsikul, C., Sukprakarn, S., Nawata, E. and Sakuratani, T. 2000. Development of endogenous seed hormones during seed maturation of two Thai cucumber (*Cucumis sativus* L.) varieties in the dry season. *Thai J. Agric. Sci.* 33(1/2): 65-74.

Arya, P.S., Korla, B.N. and Rastogi, K.B. 1983. Effect of head sized of cabbage on seed yield. *Prog. Hortic.* 15(1-2): 122-125.

Austin, R.B. 1972. Effects of environment before harvesting. In: *Viability of seeds* (ed.) Roberts, E.H. Syracuse University Press, New York. pp.104-109.

Ayyasamy, V. 1986. Genetic control of viability, vigour and storage potential of seed in tomato (*Lycopersicon esculentum* Mill.). M.Sc. (Ag.) thesis, Tamil Nadu Agricultural University, Coimbatore. 122p.

Balraj, R. 1999. Investigations on seed technological aspects in chilli (*Capsicum annuum* L.). Ph. D. thesis, University of Agricultural Science, Dharwad. 146p.

Barbedo, C.J., Coelho, A.S., Zanin, A.C.W. and Nakagawa, J. 1993. Influence of age of cucumber fruits on seed quality. *Horticultura Brasileira.* 11(1): 18-21.

Baruah, G.K.S., Paul, S.R. and Das, R.K. 1996. Effect of fruit maturity stages and drying methods on seed quality of tomato (*Lycopersicon esculentum* Mill.). *Ann. Agric. Res.* 17: 331-332.

Basavaraj, B.O., Patil, B.N.K., Vyakarnahal, B.S., Basavaraj, N., Channappagoudar, B.B. and Hunje, R. 2008. Effect of fungicides and polymer coating on storability of onion seeds. *Karnataka J. Agric. Sci.* 21(2): 212-218.

Biradar, B.R. 1996. Influence of accelerated aged seeds of sunflower restorer lines on growth, seed yield and hybrid performances. M.Sc (Ag) thesis, University of Agricultural Sciences, Dharwad, 112p.

Biradar, B.R. 1999. Investigations of seed technology aspects in chilli (*Capsicum annuum* L.). Ph. D. (Ag.) thesis, University of Agricultural Science, Dharwad.

Biradar, G.S. 1994. Studies on physiological maturity and harvesting of green fruits on seed yield and quality of brinjal (*Solanum melongena* L.). M. Sc. (Ag.) thesis, University of Agricultural Science, Dharwad.

Bollard, E.G. 1970. The physiology and nutrition of developing fruits. (In) The Biochemistry of Fruits and their Products. (ed.) Hulme, A.C. Academic Press, London, pp. 387- 427.

Bothwick, H.A. 1931. Carrot seed germination. *Proc. Amer. Soc. Hort. Sci*. 28: 310-314.

Burris, J.S., Wahab, A.H. and Edje, O.T. 1971. Effect of seed size on seedling performance in soybeans. II. Seedling growth and respiration in the dark. *Crop. Sci*. 11: 429- 436.

Burris, J.S., Edje, O.T. and Wahab, A.H. 1973. Effect of seed size on seedling performance in soybeans. II. Seedling growth, photosynthesis and field performance. *Crop. Sci*. 13: 207- 210.

Chandrasekaran, M. 1979. Studies on maturation, storability and quality of seeds in bottle gourd. M. Sc. (Ag.) thesis, Tamil Nadu Agricultural University, Coimbatore.

Chaudhary, R.V., Meshram, L.D., Zade, V.R. and Kukade, B.K. 1992. Relationship between maturity and seed quality in tomato. *Agric. Sci. Dig.* 12: 38-40.

Chauhan, K.S. and Bhandari, Y.M. 1971. Pod development and germination studies in okra. *Indian J. Agric. Sci.* 41: 852-856.

Chin, H.F. 1981. The effect of time of harvesting on seed storability and subsequent performance. *Acta Hort*. 111: 249- 253.

Copeland, L.O. 1988. *Principles of Seed Science and Technology*. Surjeet Publications, Delhi. 368p.

Cox, J.E. and Star, G.E. 1927. Special cultural practices and equipment necessary in growing good seed. (In) *Seed Production and Marketing*, John Wiley & Sons, Inc. London. pp. 62-87.

Delouche, J.C. 1973. Seed maturation. (In) *Seed Production Manual*. National Seeds Corporation and Rock Feller Foundation. pp. 162- 165.

Delouche, J.C. and Baskin, C.C. 1973. Accelerated ageing technique for predicting the relative storability of seed lots. *Seed Sci. Tech.* 1: 427-452.

Demir, I. 1995. Development of seed quality during seed development in okra. *Acta Hort.* 362: 125-131.

Dev, H. and Sharma, S.K. 2002. Effect of stages of harvesting in recovery and quality of brinjal seed. *Seed Tech. News*. 32(1):43.

Devadas, V.S., Meagle, J.P., Sadankumar, P.G. and Rajan, S. 1994. Effect of fruit grading in ash gourd (*Benincasa hispida*). Abstracts of IX All India Seed Seminar. *Seed Tech. News*. 24(4): 36-37.

Devadas, V.S., Kuriakose, K.J., Rani, T.G., Gopalakrishnan, T.R. and Nair, S.R. 1999. Influence of fruit size on seed content and quality in pumpkin (*Cucurbita moschata* Poir.). *Seed Res.* 27(1): 71-73.

Devadas, V.S., Rani, T.G., Kuriakose, K.J., Seena, P.G. and Gopalakrishnan, T.R. 1998. Effect of fruit grading on seed quality in snakegourd (*Trichosanthes anguina* L.). *The Hort. J.* 11(1): 103-108.

Devi, V.S. 1999. Seed yield and quality in bitter gourd as influenced by vegetable harvests. M.Sc. (Ag.) thesis, Kerala Agricultural University, Vellanikkara, Thrissur.

Dhanaleppagol, M.S. 1986. Studies on drying of chilli seeds in relation to seed quality. MSc. (Ag.) thesis, University of Agricultural Sciences, Dharwad.

Dharmalingam, C. and Basu, R.N. 1989. Seed development and maturation studies in mungbean. *Seed Res.* 17(2): 103-108.

Dharmatti, P.R. 1986. Studies on seed production, quality and physiological maturity in bell pepper. M.Sc. (Ag.) thesis, University of Agricultural Sciences, Bangalore.

Diaz, M.F. 1990. Growth of pods and seeds in Phaseolus vulgaris. *Turriable*. 40(4): 553-561 (Hort. Abstr. 1992: 5793).

Doijode, S.D. 1985. Onion seed quality in relation to seed deterioration under accelerated aging conditions. *Veg. Sci.* 12(2): 59-63.

Doijode, S.D. 1988. Studies on vigour and viability of seeds as influenced by maturity in chilli (*Capsicum annum* L.). *Haryana J. Hort. Sci.* 17(1-2): 94-96.

Domain, A.S. 1982. Quality of eggplant seeds from fruits of different ripening period. *Referativnyi Zhumal.* 62:276.

Edwards, R.L. and Sundstrom, F.J. 1987. After-ripening and harvesting effects on Tabasco pepper seed germination performance. *Hortic. Sci.* 22: 473-475.

Egli, D.B. and Tekrony, D.M. 1973. Laboratory measurements of soyabean seed quality for predicting field emergence. *Agron. Abstr*. 52: 1123.

Eguchi, T. and Yamada, H. 1958. Studies on the effect of maturity on longevity in vegetable seeds. *Natl. Inst. Agr. Sci. Bull*. 7: 145-165.

Ellis, R.H, Roberts, E.H. 1981. The quantification of ageing and survival in orthodox seeds. *Seed Sci. Tech. 9: 373–409.*

Fontes, J.A.N. and Ohlrogge, A.J. 1972. Influence of seed size and population on yield and other characteristics of soybeans. (*Glycine max* (L. Merr.). *Agron. J*. 64: 833- 836.

Francis, A. and Coolbear, P. 1988. Changes in the fatty acid content of the polar lipid fraction of tomato seeds induced by ageing and/or subsequent low temperature pre-sowing treatment. *Seed Sci. Tech.* 16 (7): 87-95.

Ganar, H.D., Kant, K. and Dadlani, M. 2004. Study on physiological maturity in ash gourd (*Benincasa hispida* (Thunb.) Cogn.). *Seed Res.* 32(1): 101-102.

Garris, E.W. and Hoffman, G.P. 1946. Okra enterprises. In: South Indian Horticulture Enterprises. pp. 223- 232. (ed.). Gregory, R. W. and Lippin, J. B. Cotton Company, Chicago, Philadelphia, New York.

Geetharani, P., Vijaykumar, A., Geetha, R. and Natrajan, S. 2007. Effect of fruit size on seed quality characteristics of pumpkin (*Cucurbita moschata*). *Madras Agric. J.* 94(7-12): 278-279.

Ghosh, B., Adhikary, J.A. and Banerjee, W.C. 1980. Changes of some metabolites in rice seeds during aging. *Seed Sci. Tech.* 9: 473-496.

Ghosh, D, Furey W, O'Donnell S, Stout C.D. 1981. Structure of a 7Fe ferredoxin from Azotobacter vinelandii. *J. Biol. Chem.* 256(9):4185–4192.

Godi, S.B. 1982. Studies on graded doses of N and P in relation to production, quality and physiological maturity of chilli seeds. M. Sc. (Ag.) thesis, University of Agricultural Science, Bangalore.

Goncalves, M. and Nascimento, W.M. 1994. Determination of physiological maturity in pea cv. Dileta seeds. *Horticultura Brasileira.* 12(2): 184-187.

Gontia, A.S. 1992 . Seed development and maturation in relation to seed quality of gram genotypes. *New Agriculturist.* 3(2): 153-159.

Gontia, A.S., Nigam, P.K., Sonakia, V.K. and Dwivedi, S.K. 1995. Identification of morphological indices of physiological maturity in soybean (*Glycine max*) genotypes. *Indian J. Agric. Sci.* 65(6): 414-418.

Gopalan, C.R., Ramasastri, B.V. and Balasubramanian, S.C. 1982. Nutritive Value of Indian Foods, Indian Council of Medical Research, National Institute of Nutrition, Hyderabad, 81p.

Grabe, D.F. 1965. Prediction of relative storability of corn seed lots. Proc. Assoc. Offic. *Seed Anal*. 55: 92-96.

Gray, D., Steckel, J.R.A., Dearman, J. and Brocklehurst, P.A. 1988. Some effects of temperature during seed development in carrot (*Daucus carota* L.) seed growth and quality. *Annals Appl. Biol*. 112: 367-376.

Hammet, H.L. and Malethong, S. 1971. Cucumber harvest and yield study. *Mississippi Farm Res*. 34: 6-7.

Harisingh, Lal, T. and Rana, R.S. 1988. Effect of puncturing fruits at various stages of maturity on seed quality. *Seed Res*. 16(1): 13-16.

Harrison, J.G. and Perry, D.A. 1976. Studies on the mechanism of barley seed deterioration. *Annals Applied Biol.* 84: 57-62.

Harrington, J.F. 1959. Effect of fruit maturity and harvesting methods on germination of muskmelon seeds. *J. Amer. Soc. Hort. Sci*. 73: 422- 430.

Harrington, J.F. 1972. Seed storage and longevity. In: *Seed Biology*, (ed.) Kozlowski, T.T. Academic Press Limited, London. 3: 145-245.

Harrington, J.F. 1973. Packaging seed for storage and shipment. *Seed Sci. Tech.* 1: 701-709.

Hedayat, N.A. 1987. Studies on sex expression and standardisation of seed production and storage techniques in watermelon. M.Sc. (Ag.) thesis, Tamil Nadu Agricultural University, Coimbatore.

Hedecker, W. 1972. Viability of seeds (ed*.)* Roberts, E. H. Syracuse University Press. pp.209- 252.

Helmer, J.D., Delouche, J.C. and Leinhard, M. 1962. Some indices of vigour and deterioration in seeds of crimson clover. *Proc. Ass. Off. Seed Anal*. 52: 154.

Hilli, J.S. 2005. Studies on seed production and post- harvest techniques in ridge gourd (*Luffa acutangula* L. Roxb). Ph.D. (Ag.) thesis, University of Agricultural Science*,* Dharwad.

ISTA (1999). International Rules for Seed Testing. *Seed Sci. Tech.* (Supplement rules). 27: 25-30.

Jayabharathi, M., Palaniswamy, V., Kalavathi, D. and Balamurugan, P. 1990. Influence of harvesting conditions on the yield and quality of brinjal seeds. *Veg. Sci.* 17: 113-118.

John, S.S. and Bharathi, A. 2006. Film coating technology on seed quality and shelf life of maize. In: *Abstract XII, National seed seminar on prosperity through quality seed,* 24-26 Feb, Hyderabad, pp 84.

Joshi, M.A., Ahuja, S. and Kumar. 2009. Study on physiological maturity in muskmelon. *Seed Res.* 37(1&2): 179-181.

Kalpana, R. and Rao, M.K.V. 1995. On the aging mechanism in pigeon pea (*Cajanus cajan* (L) Mill sp.) seeds. *Seed Sci. Tech.* 23(1): 1-9.

Kannath, B., 1996. Effect of fruit maturity, seed processing and storage methods on seed quality of ash gourd cv. BH-21. M. Sc. (Hort.) thesis, Kerala Agricultural University, Vellanikkara, Thrissur. P.165.

Kanwar, J.S. and Saimbhi, M.S. 1987. Pod maturity and seed quality in okra (*Abelmoschus esculentus* (L) Moench). *Punjab Hort. J.* 27(3-4): 234-238.

Karivaratharaju, T.V., Palanisamy, V. and Kumaresan, K. 1985. A note on the effect of fruit weight on seed quality in brinjal cv. MDU-1. *South Indian Hort.* 33: 209-210.

KAU [Kerala Agricultural University]. 2007. KAU home page [online]. Available: http://www.kau.edu/varieties.htm. [14 June. 2012].

Kolhe, A.K. and Chavan, V.M. 1964. Development of fruits, yielding capacity and influence of fruit maturity on the vegetative and reproductive behaviour of okra. *Indian J. Agric. Sci*., 37(3): 155- 166.

Krishnakumary, K., Devadas, V.S. and Meagle, J.P. 2004. Studies on physiological maturity of oriental pickling melon (*Cucumis melo* var. conomon) seeds. *Seed Res.* 32(1): 52-54.

Krishnakumary, K., Devadas, V.S., Mini, C. and Gopalakrishnan, T.R. 2005. Pattern of fruit and seed development in vegetable cowpea [*Vigna*

unguiculata (L.) Walp ssp. sesquipedalis (L.) Verdc.]. *Seed Tech.* 27(1): 76-80.

Krishanakumary, K. and Gopalakrishnan, T.R. 2006. Physiological maturity studies in vegetable cowpea. In: *Abstract. XII, National seed seminar on prosperity through quality seed*. p89.

Krishnakumary, K. and Meagle, J.P. 2011. Bittergourd seed quality in relation to harvest. *Seed Res.* 39(2): 138-142.

Krishnamurthy, V. 1995. Effect of harvesting stages, drying, seed extraction and size grading on seed yield and quality in chilli (*Capsicum annuum* L.). M.Sc. (Ag.) thesis, University of Agricultural Science, Bangalore.

Krishnaprasad, S. 1980. Studies on the development maturation and storage of seeds in ash gourd (*Benincasa hispida* (Thumb.) Cong.) CO-1. M. Sc. (Ag.) thesis, Tamil Nadu Agricultural University, Coimbatore.

Kunkur, V., Hunje, R., Patil, B.N.K. and Vyakarnhal, B.S. 2007. Effect of seed coating with polymer, fungicide and insecticide on seed quality in cotton during storage. *Karnataka J. Agric. Sci.* 20(1): 137-139.

Longman, O. 2002. *Indian medicinal plants compendium of 500 species.* Orient Longman Pvt. Ltd. Chennai. pp.320-322.

Madinur, N.I. 2007. Seed viability studies in drumstick (*Moringo oleifera* Lamk.). M. Sc. (Ag.) thesis, University of Agricultural Science, Dharwad.

Maeda, J.A., Passos, F.A. and Bernardi, J.B. 1980. Influence of colour and size on the vigour of okra seeds. II - Laboratory tests. *Revista Brasileira de Sementes*. 2(2): 99-107.

Maheshwari, P. 1950. *An introduction to the embryology of angiosperms*. Mc Graw-Hill Company, Inc. New York. 356p.

Manjunath, T. 1993. Effect of seed vigout levels on field performance and yield of TMV-2 groundnut (*Arachis hypogea* L.) M.Sc. (Ag.) thesis, University of Agricultural Sciences, Bangalore, pp. 77-90.

Manjunatha, S.N., Hunje, R., Vyakaranahal, B.S. and Kalappanavar, I.K. 2008. Effect of seed coating with polymer, fungicide and containers on seed quality of chilli during storage. *Karnataka J. Agric. Sci.* 21(2): 270-273.

Mann, L.K. and Robinson, J. 1950. Fertilization, seed development and fruit growth as related to fruitset in cantaloupe (*Cucumis melo* L.). *Amer. J. Bot*. 37: 685- 697.

Manohar, M.S. 1969. Pod development and germination of bhendi (*Abelmoschus esculentus*). *Expl. Agric*. 5: 249-255.

Manohar, M.S. 1970. Seed development and germination studies on sem (*Dolichos lab lab* L.). *Indian J. Hort*. 27: 86-92.

Manohar, M.S. and Sachan, S.C. P. 1974. Pod development and germination studies in pea (*Pisum sativum* L.). *Veg. Sci*. 1: 22-30.

Martin, R.D., Ballard, W.M. and Simpson, M. 1923. Growth of fruiting parts in cotton plants. *J. Agric. Res*. 25(4): 195- 208.

Mc Alister, D.F. 1943. The effects of maturity on the viability and longevity of the seeds of western range and pasture grasses. *J. Amer. Soc. Agron*. 35: 442-453.

McDonald, M.B. 1975. A review and evaluation of seed vigour tests. *Proceedings of the Association of official Seed Analysis*. 65: 109- 139.

Menaka, C., Balamurugan, P., Raja, K. and Natarajan, K. 2002. Position of seeds in the inflorescence on seed quality in amaranth. *Seed Tech. News.* 32(1):29.

Metha, V.A. 1983. Study of seed maturation and storage in chilli. M.Sc. (Ag.) thesis, Tamil Nadu Agricultural Univversity, Coimbatore.

Metha, V.A. and Ramakrishnan, 1986. Effect of different pickings on the storability of chilli seeds. *Madras Agric. J.* 73(12): 661-667.

Mini, C., Meagle J. P. and Rajan, S. 2000. Effect of fruit size on seed quality of ash gourd (*Benincasa hispida*). *Seed Res.* 28(2): 215-216.

Mistry, K.K. and Hossain, T. 2008. Determination of physiological maturity in okra [*Abelmoschus esculentus* (L) Moench] seed. *International J. Sustainable Agric. Tech.* 4(2): 25-30.

Mohan, N. 2005. Seed invigoration and dormancy studies in snakegourd. M.Sc. (Ag) thesis, Kerala Agricultural University. Vellanikkara, Thrissur.

Muthuraj, R. and Kant, K. 2006. Evaluation of soybean genotypes for seed storability. In: Abstract. *XII National seed seminar on prosperity through quality seed.* p96.

Naik, L.B., Hebbar, S.S. and Doijode, S.D. 1996. Effect of fruit maturity on seed quality in capsicum (*Capsicum annuum* L.). *Seed Res.* 24: 154-155.

Nandeesh, Javaregowda, S. and Ramegowda, G. 1995. Studies on the stage of harvest and post harvest ripening on seed quality in cucumber (*Cucumis sativus* L.). *Seed Res.* 23: 113-115.

Nautiyal, P.C., Ravindra, V. and Mishra, J.B. 1997. Response of dormant and non-dormant seeds of groundnut (*Arachis hypogea* L.) genotype to accelerated aging. *Indian J. Agric. Sci.* 67(2): 67-70.

Nath, P. and Vashistha, R.N. 1969. Studies on vegetative growth, flowering pattern, fruit set and fruit development (*Citrullus lanatus* Thumb.). *Indian J. Hort.* 26: 51- 58.

Nerson, H. And Paris, H.S. 1988. Effect of fruit age, fermentation and storage on germination of cucurbit seeds. *Sci. Hortic.* 35: 15- 26.

Nkang, A. 1988. Some aspects of biochemical basis of viability of loss in stored qukfaylla seeds. *Seed Sci. Tech.* 16:247-260.

Nirmaladevi, S., Sadankumar, P.G. and Mathew, S.K. 2009. Effect of maturity stages on seed recovery and quality in bitter gourd. *Veg. Sci.* 36(1): 96-97.

Noggle, G.R. and Fritz, G.J. 1989. *Introductory Plant Physiology* (2nd ed.), Prentice Hall of India Pvt. Ltd., New Delhi. 627p.

Novikov, B.N. 1983. Effect of harvesting dates on the seed quality of tomato cultivars suitable for mechanical harvesting. *Trudypo Prikaladaoi Botanike Genetikei Selektsii*. 77: 7-10.

Nowsielska, B. 1979. The quality of differently ripened seeds of vegetable crop. *Nauk Relniczych*. 25: 23-24.

Odland, M.L. 1937. Observations on dormancy in vegetable seed. *Proc. Amer. Soc. Hort. Sci*. 35: 562-565.

Palanisamy, V. and Karivaratharaju, T.V. 1990. Influence of picking wise seeds and their grades on seed quality in tomato genotypes. *Prog. Hortic.* 22(1-4): 198-203.

Pandian, P., Jayaraj, T., Karivartharaju, T.V., Gopalswamy, A. and Subramanyam, A. 1994. Evaluation of storage potential of rice genotypes following accelerated aging. *Seed Tech. News.* 24(4): 25.

Pandita, M.L. and Nagarajan, C. 2001. The quality of differently ripened seeds in chilli crop. *Haryana J. Hortic. Sci*. 30: 94-96.

Pandita, V.K. and Randhawa, K.S. 1996. Influence of seed size grading on seed quality of some tomato cultivars. *Seed Res.* 23(1): 31-33.

Passam, H.C., Theodoropoulou, S., Karanissa, T. and Karapanos, I.C. 2010. Influence of harvest time and after-ripening on the seed quality of eggplant. *Sci. Hortic.* 125(3): 518-520.

Perez, M.A. and Arguello, J.A. 1995. Deterioration in peanut (*Arachis hypogea* L. cv. Flarmen) seeds under natural and accelerated aging. *Seed Sci. Tech.* 23(2): 439-445

Pearl, M., Luria, I. and Gelmond, H. 1978, Biochemical changes in sorghum seeds affected by accelerated ageing. *J. Expert. Bot.* 29 (109): 479-509.

Pet, V.G. and Garretson, F. 1983, Genetical and environmental factors influencing seed size of tomato (*Lycopersicon exculentum* Mill.) and the effect of seed size on growth and development of tomato plants. *Euphytica*, 32: 711-718.

Pokojska, H. 1999. Physiological maturity of faba bean seed (*Vicia faba* L. var. minor) and relationship between its maturity and germinability, vigour, protein and tannin content. *Biuletyn Instytutu Hodowli-i-Aklimatyzacji Roslin.* 212: 227-236.

Potapova, N.F. 1972. Changes in the biochemical composition of cucumber seeds during ripening. Doklady Timirya Zevskoi "Sel" skokhozyaithennoi, Akadmii; Plodorodstioi (1912) No. 173, 133- 135 (RN) Timiryaze-vevkaya sel' skohoozyais tvennya Akadenizer Moscov USSR (*Hort. Abstr.* 45: 1975, 1022).

Pratt, H.K., Goeschi, J.D. and Martin, F.W. 1977. Fruit growth and development. Ripening and the role of ethylene in the "Honeydew" muskmelon. *J. Amer. Soc. Hort. Sci.* 102(2): 203- 210.

Presley, J.T. 1958. Relation of protoplast permeability to cotton viability and pre disposition to seedling disease. *Pl. Dis. Rep*. 42: p852.

Prokhorov, I.A. and Dikareva, N.S. 1976. Tomato stages of harvesting and physiological changes. *Hortic. Abstr.* 47: p5677.

Quagliotti, L. 1977. Effects of ripening stages of berries and of storage within the fruits on viability of seeds in two varieties of pepper. *lnstitut de la Rech. Agron.* 17: 293-301.

Radheshyam, A.S.K., Pandita, M.L. and Singh, J. 1996. Effect of stage of fruit maturity at harvest on seed quality of chilli (*Capsicum annuum* L.) cultivars. *Haryana Univ. J. Res.* 26: 195-198.

Rajan, N. 1989. Influence of date of planting on seed yield and quality under low fertiliser levels in tomato. M.Sc. (Hort.) thesis, Kerala Agricultural University. Vellanikkara, Thrissur.

Raman, K.R. 1956. A note on seed production in bittergourd. *South Indian Hortic.* 4:26- 27.

Rana, S.C., Pandita, V.K. Rajkumar and Yadav, R. N. 2006. Effect of fruit size on seed yield and quality in bitter gourd. In: Abstract. *XII National seed seminar on prosperity through quality seed*. p115.

Rao, G.R. 2001. Studies on pod maturation in pigeon pea (*Cajanus cajan* L. Millsp). *Madras Agric. J.* 88(1/3): 147-148.

Reddy, P.J.R., Rao, G.R., Rao, K.L.N., Rao, D.V.S. and Mahalakshmi, B.K. 2001. Studies on physiological maturity in chilli (*Capsicum annuum* L.). *Seed Res.* 29(1): 93-94.

Renugadevi, J., Natarajan, N. and Srimathi, P. 2009. Influence of Seed Size on Seed and Seedling Quality Characteristics of Cluster Bean [*Cyamopsis tetragonoloba* (L.) Taub.]. *Legume Res.* 32(4): 301-303.

Robinson, R.W. and Decker, W.D.S. 1997. *Cucurbits*. University Press, Cambridge, London, 226p.

Roberts, E.H., 1972, Storage environment and control of viability. In: *Viability of Seeds* (ed.) Roberts, E.H. Chapman and Hall Ltd., London, pp. 14-18.

Roopa, V. 2006. Influence of post harvest handling techniques on seed quality and storability of Muskmelon (*Cucumis melo* L.). M.Sc. (Ag.) thesis, University of Agricultural Science, Dharwad.

Sajjan, A.S. and Vyakarnahal, B.S. 2005. Seed quality as influenced by harvesting stages and drying methods in Okra. *Seed Res.* 33(2): 179-181.

Sakar, S.M. and Farouk, E.E.M. 1953. Viability of seeds harvested from fruits at different stages of maturity. In: *Proc.Amer. Soc. Hortic. Sci*. 6: 327-329.

Sarkar, M., Sharma, R.R. and Deshmukh, P.S. 2003. Physiological studies on pod and seed characters in relation to productivity in garden pea. *Annu. Agric. Res.* 24: 289-293.

Saxena, O.P., Arya, V., Pandey, N. and Maheswar, D.C. 1988. Performance of aged seeds under the influence of bio-regulants. *Proc. Pl. Gr. Regulator Sco.* Pp.194-204.

Seaton, H.L. 1938. Relation of number of seed to fruit size and shape in cucumbers. Proc. *Amer. Soc. Hort. Sci*. 35: 654-658.

Seth, R., Padmavati, C. and Misra, L.P. 1999. Seed quality in relation to degree of seed maturity in fodder cowpea (*Vigna unguiculata* L. Walp.). *Seed Res.* 27(1): 66-70.

Seth, R., Padmavathi, C.H. and Singh, S.N. 2002. Seed quality in relation to seed development and maturation in fodder clusterbean (*Cyamopsis tetragonoloba* (L.) Taub.) genotypes. *National J. Pl. Improvement.* 4(1): 22-26.

Shamsheer, A. 2007. Effect of growth regulators and stages of fruit harvest on seed yield and quality in paprika chilli (*Capsicum annuum* L.) cv. Kt-Pl-19. M.Sc. (Ag.) thesis, University of Agricultural Science, Dharwad.

Shanmugaraj, K. 1978. Seed maturation and storage studies in lablab. (Lablab purpureus (L.) Sweet). M.Sc. (Ag.) thesis, Tamil Nadu Agricultural University, Coimbatore.

Shanmugavel, S., Varier, A. and Dadlani, M. 1996. Physiological attributes associated with seed aging in soybean (*Glycine max* (L) Merrill) cultivars. *Seed Res.* 23(2): 61-66.

Shantappa, T., Shekhargouda, M., Meharwade, M.N. and Mugle, R. 2006. Effects of stages of harvest and drying methods on seed quality in bitter gourd. *Seed Res.* 34 (2): 146-149.

Shaw, R.H. and Loomis, W.E. 1950. Basis for the prediction of corn yield. *Pl. Physiol*., 25: 225-244.

Showlter, R.K. 1961. Specific gravity, weight and solids relationship in watermelons. Proc. Flo. Stat. Hort. Sci. 74: 268- 271.

Simpson, K.G., Lopes, H.M. and Rossetto, C.A.V. 2001. Physiological maturity and storage of *Dolichos lablab* L. seeds. *Agronomia.* 35(1/2): 5-9.

Singh, G., Singh, H. and Dillon, T.S. 1985. Some aspects of seed extraction in tomato. *Seed Res.* 13: 67-72.

Singh, H. and Sidhu, A.S. 1985. Effect of fruits maturity and water soaking of cut fruit on seed germination of brinjal. *J. Res. Punjab Agric. Univ.* 22: 449-452.

Sinnot, E.W. 1945. The relation of growth to size in cucurbit fruits. *Amer. J. Bot*. 32: 439- 446.

Slobodjani, K.N. L. 1958. Variation in the quality of vegetable seeds in relation to cleaning and grading. *Agrobiologija*. 5: 134- 137.

Sreemathi, P. and Ramaswamy, K.R. 1992. Quality of seed in relation to position of seed in the pods of cowpea. *Madras Agric. J*. 79(8): 448- 450.

Supe, V.S. and Lawande, K.E. 1990. Effect of fruit weight and size on seed yield in bittergourd cv. CO-2 White Long. *South Indian Hortic.* 38(3): 158.

Sureshbabu, T., Kurdikeri, M.B., Shekhargouda, M., Shashidhara, S.D. and Dharmatti, P.R. 2003. Influence of fruit maturity stages and post harvest ripening on seed yield and quality in brinjal. *Seed Res.* 31 (2): 204-208.

Suryawanshi, Y.B., Patil, R.B. and Dhadage, S.M. 1994. Seed development and maturation studies in pigeon pea. *J. Maharashtra Agric. Uni.* 19(3): 467-468.

Suryawanshi, Y.B. and Patil, R.B. 1995. Effect of fruit size and method of seed drying on seed quality of watermelon. *Seed Tech. News*. 25(2): 1.

Taylor, A.G., Lee, S.S., Wicz, B.M.M. and Paine, D.H. 1995. Amino acid leakage from aged vegetable seeds. *Seed Sci. Tech.* 23(1): 113-122.

Taung, U. and McDonald, M.B. 1995. Changes in esterase activity associated with peanut (*Arachis hypogaea* L.) seed deterioration. *Seed Sci. Tech*. 23:101-111.

Thamburaj, S. 1973. Correlation studies in ribbed gourd (*Luffa acutangula* L.). *Madras Agric. J.* 60: 61-64.

Urbaniak, Z. 1984. Usefulness of EC for estimating quality of damaged and undamaged seeds of frenchbean. *Biuletyu instytutu Hodowli Akilmathzagi Reaslin*. 152: 103-108.

Vadivelu, K.K. 1983. Seed quality in relation to maturity of tomato fruits. In: *Proceedings of National Seminar on the Production Technology of Tomato and Chillies*. Tamil Nadu Agricultural University, Coimbatore, India. pp.98-99.

Vanangamudi, K. and Palanisamy, V. 1989. Effects of fruit grading on seed quality characteristics in bittergourd. *Veg. Sci.* 16(1): 96-98.

Varatharaj, A. 1979. Studies on seed maturation and quality of seeds on ribbed gourd and bitter gourd. M.Sc. (Ag.) thesis Tamil Nadu Agricultural University. Coimbatore.

Velumani, N.P. and Ramaswamy, K.R. 1980. Effect of picking fruits on plant height and seed yield in okra. *Seed Res.* 8: 52-58.

Verma, S.S., Verma, U., Tomer, R.P.S. 2003. Studies on seed quality parameters in deteriorating seeds in Brassica (*Brassica campestris*). *Seed Sci.Tech.* 31(2): 389-396.

Vijayakumar, A., Geetharani, P. and Thangaraj, T. 2002. Developmental position of seed in the fruit on seed quality in bittergourd. *Seed Tech. News*. 32(1): 41.

Vijaykumar, A., Suthanthirapandian, I.R. and Dharmalingam, C. 1994. Effect of fruit weight and development position on seed quality in bittergourd cv. MDU 1. *Seed Tech. News*. 24(4): 63.

Vinodkumar, Shashidhar, S.D., Kurdikeri, M.B., Channaveerswami, A.S. and Hosmani, R.M. 2002. Influence of harvesting stages on seed yield and quality in paprika (*Capsicum annuum* L.). *Seed Res.* 30 (1): 99-103.

Wold, E.K., Grennel, M.G. and Miller, R.D. 1972. Laboratory techniques to predict relative emergence potential of sorghum seed. *Agron*. Abstr. 60: 258.

Worku, Z., Herner, R.C. and Carolus, R.L. 1975. Effect of ripening and ethephan treatment on colour content of paprika pepper. *Sci. Horti.* 3: 239-245.

Wilson, D.O. and McDonald, M.B. 1986. The lipid peroxidation model of seed ageing. *Seed Sci. Tech.* 14:269-300.

Young, R.E. 1949. The effect of maturity and storage on germination of butternut squash seeds. Proc. *Amer. Soc. Hort. Sci*. 53: 845.

Yureva, N.A. and Polumordvinova, I.V. 1974. Morphogenesis of tomato seeds in relation to fruit growth and development. *Hortic. Abstr.* 45: p6642.

APPENDICES

Appendix I. Mean monthly meteorological data from January 2011 to April 2012
Source: Department of Agricultural Meteorology, KAU, Vellanikkara

Months → Weather parameters↓		Jan 2011	Feb 2011	Mar 2011	April 2011	May 2011	Jun 2011	Jul 2011	Aug 2011	Sept 2011	Oct 2011	Nov 2011	Dec 2011	Jan 2012	Feb 2012	Mar 2012	April 2012
Temperature	Maximum °C	32.69	33.69	34.79	34.31	33.03	29.27	29.06	29.37	30.02	32.10	31.39	31.86	32.75	35.10	35.16	34.82
	Minimum °C	22.23	21.96	23.87	24.54	24.94	23.60	22.90	22.85	23.10	23.46	22.85	22.58	21.33	22.13	24.17	24.81
Relative humidity (%)	I	76.19	75.25	84.97	88.13	90.65	95.53	94.84	95.61	94.17	90.68	79.43	75.48	75.19	74.66	86.35	88.53
	II	40.58	37.54	43.23	57.73	63.03	82.45	80.84	78.48	74.67	65.06	56.77	48.55	39.90	33.34	49.39	55.00
Sun shine (hrs)		8.48	8.54	8.67	6.64	6.83	2.47	1.64	2.22	4.40	6.14	6.30	7.31	9.48	9.15	7.57	6.64
Rainfall (mm)		0.00	2.77	0.32	6.90	6.40	26.65	18.97	23.03	14.51	6.13	8.00	0.08	0.00	0.00	0.15	0.55

ABSTRACT

SEED MATURITY AND SEED LONGEVITY STUDIES IN SNAKE GOURD (*Trichosanthes anguina* L.) VARIETIES

By

ROHIT KUMAR DHOBI
(2010-12-117)

ABSTRACT OF THE THESIS

Submitted in partial fulfillment of the requirement for the degree of

Master of Science in Horticulture

Faculty of Agriculture
Kerala Agricultural University, Thrissur

Department of Olericulture

COLLEGE OF HORTICULTURE

VELLANIKKARA, THRISSUR - 680 656

KERALA, INDIA

2012

ABSTRACT

The present investigation on "Seed maturity and seed longevity studies in snake gourd (*Trichosanthes anguina* L.) varieties" was carried out in the Department of Olericulture, College of Horticulture, Vellanikkara during the year 2010-2012 with the objective of standardising the physiological maturity of snake gourd varieties for better seed quality, understanding the influence of fruit size and position of seeds within the fruit on seed quality and studying the effect of storage conditions on seed quality and longevity.

Investigation on physiological maturity indicated that fruits attained maximum weight and length when harvested at 36 days after anthesis in Baby and 39 days after anthesis in Kaumudi. Seed quality parameters viz., number of seeds per fruit, fresh and dry weight of seeds, 100 seed weight, germination percent, speed of germination, seedling length and vigour index were maximum in fruits harvested at 36 and 39 days after anthesis in Baby and Kaumudi respectively. Morphological characters of the fruit at this stage included change in fruit colour turning red at the tip portion and the placenta colour changing to red. Seeds got detached from the mucilaginous placenta and seed coat became hard with well developed ring on the seed surface.

Large sized fruits recorded maximum values for length and weight of fruits, and number and weight of seeds. Seed quality parameters viz., germination percent, seedling length and vigour index were found to be high in seeds obtained from medium sized fruits when compared to large and small sized fruits in both the varieties.

Among the different portions of the fruit (pedicel, middle and stylar regions), middle portion recorded higher fruit weight, number and weight of seeds, germination percent and vigour index in small, medium and large sized fruits compared to pedicel and stylar regions in both the varieties.

The effect of storage conditions influenced seed quality parameters in both varieties of snake gourd. Maximum germination, seedling length and vigour were obtained at 3rd month in ambient storage condition and 4th month in A/C storage condition and a decline in these parameters was observed in later months of storage. Lowest values for germination, seedling length and vigour were recorded at 12th month in both the conditions of storage (ambient and A/C) in both varieties. Seeds stored under A/C condition exhibited higher quality compared to those stored under ambient condition and Kaumudi recorded higher values for seed quality than Baby. Activity of the enzyme dehydrogenase was found to decrease over storage period in both the varieties studied. Generally values were higher under A/C storage condition than open condition and among varieties, values were slightly higher in Kaumudi than Baby. Electrical conductivity values of the seed leachate were found to increase with increase in storage period under ambient and A/C conditions of storage in both the varieties namely Baby and Kaumudi and the increase was more in seeds stored in open condition than A/C condition.