

STUDIES ON PERFORMANCE OF MUSKMELON
(*Cucumis melo* L.) HYBRIDS UNDER NORTHERN DRY
ZONE OF KARNATAKA

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JULY, 2013

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ZONE OF KARNATAKA

Thesis submitted to the
University of Horticultural Sciences, Bagalakot
in fulfillment of the requirements for the
Degree of

Master Of Science (Horticulture)

In

Vegetable Science

BY

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CERTIFICATE

This is to certify that the thesis entitled "STUDIES ON PERFORMANCE OF MUSKMELON (*CUCUMIS MELO* L.) HYBRIDS UNDER NORTHERN DRY ZONE OF KARNATAKA" submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE (HORTICULTURE) in VEGETABLE SCIENCE to the University of Horticultural Sciences, Bagalkot, is a record of research work carried out by SHIVAPRASAD M. K. under my guidance and supervision and that no part of the thesis has been submitted for the award of any degree, diploma, associateship, fellowship or other similar titles.

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ACKNOWLEDGEMENT

It is always a nostalgic feeling whenever one glance back to the days of hard work, tension and the need of the hour to excel. One would achieve whatever he is now, without all the help, encouragement and the wishes of near and dear part ones. Parents, Brothers, Sisters, teachers, friends and well wishers are an integral task of this. I owe them a lot and it is always a difficult task expressing and putting into words the sense of gratitude I feel towards them.

It was indeed an immense pleasure to express my deep sense of gratitude and indebtedness to the Chairman of my Advisory Committee Dr. V. M. GANIGER, *Associate professor*, College of Horticulture, Bagalkot for excellent guidance, inspiring, unique and compassionate steering of the challenging task and affection showing throughout the course of the investigation. Hard it is not been for his personal interest and preservice, this venture of mine would not have reached the form it is today. I am incapable of quantifying feeling of my gratitude.

I wish to express my profound indebtedness and heartfelt thanks to Dr. M.B. MADALAGERI, *Registrar, UHS, Bagalakot*, Dr. P.S. AJJAPPALAVAR, Assistant professor, Vegetable Science, HRS Devihosur (Haveri), Dr. BHUVANESWARI G., Assistant Professor (Department of Food Science and Nutrition) Dr. MANJUNATH G., Assistant Professor (Department of Plant Pathology, UHS, Bagalkot), Dr. Y.K KOTIKAL, Dean Student Welfare UHS, Bagalkot, for serving as members of my Advisory Committee, under whose edifying counsels and salutary advices my efforts assumed newer shape and strength. I must confess that, it had been a privilege for me to be associated with them during my master's degree programme.

I express my deep sense of gratitude and affection to my parents Sri. Kampli Raj M., and Smt. Vimala, Sister Nandini brother Adarsha grandmother Gowramm and my beloved grandfather Late. Basappa. To all my relatives for their boundless love, unflagging interest and constant encouragement, put confidence in me to reach this level.

I avail myself of this opportunity to express my sincere thanks to all Professors Dr. Chidanad P Mansur, Dean, College of Horticulture, Bagalkot, Dr. Basavaraja. N., Dean, College of Horticulture, Sirsi, Dr. H.B Patil, ADR, UHS, Bagalkot, Mr. Anand N, Dr. Revanappa, Dr. H. P. Hadimani, Dr. Raghavendra, Dr. Ganghadhar, N, Dr. Satish. D, Dr. Laxmanreddy, Dr. Suma. R, Dr. Kiranakumar.K. C, Dr. Shivapriya, College of Horticulture, Bagalkot, for their constant suggestions, support and help during my research work.

I am thankful to Mrs. Girija, Yandigeri, Asst. Librarian, Mr. Shashidhara, Goudara, Library Asst. Girish Hebbal, Shankramma, Muttu, Kumar, Laxmanna Basrigidada, Siddibavi, Shankragouda C Biradar for their support and help.

Colourful blossoms would not have bloomed without the company of my friends, Prasanna, S.C, Lakshmipathy M, Chetan Raj, Nandan C P, Santhosh G B, Murali, Yatindra H A, Satish Kale, Vikram, Manjunath gowda, Soma, Papu, Bharath, Manu, Prashanth, Jeevan,

Praveen, Subba, Kumar, Hemanth, Sampath, Karthik, Swamy, Charan, Harish, Samrat, Sharath, Jainag, Kiran, Sachin, Kiran Shankar, Vijaya Kumar, Sridar K S, Tyaga raj, Harika, Shivanand Malshetty, Kempa, Ganga, Kishore, Shambhu, Kiran, Ragavendra, Prajna, Mamatha, Pallavi, Rachana, Kalpana, Divya, Savitha, Mahesh mat, Poornachandra gowda, Manoj, Deepika, Rinchan Dolker, Sheela, Jogi, Amith Patil, Anand C Patil, Sharan and all my UG and PG senior, junior friends for their moral support, guidance and help during my study.

I am extremely thankful to Raju. Anand, Suresh Bisali, Gasti, Alam, Gous, Dilawar, Suresh, Somanna, Prakash, Santosh, Mantesh, Chavan, Banajiger, and Gitamma, for their constant support and help during the course of my investigation.

I extend my sincere thanks to the Department of Vegetable Science, College of Horticulture, UHS, Bagalkot for giving me an opportunity to complete my higher education M. Sc. (Horticulture) in Vegetable Science.

The presentation that follows is the work assisted by many seen and unseen hands and minds, I am thankful to all of them. Finally, I thank Dr. V.M. GANIGER Associate professor, Vegetable Science, College of Horticultural Bagalkot for their encouragement in completing my degree not only as my guide also as an Enlighter.

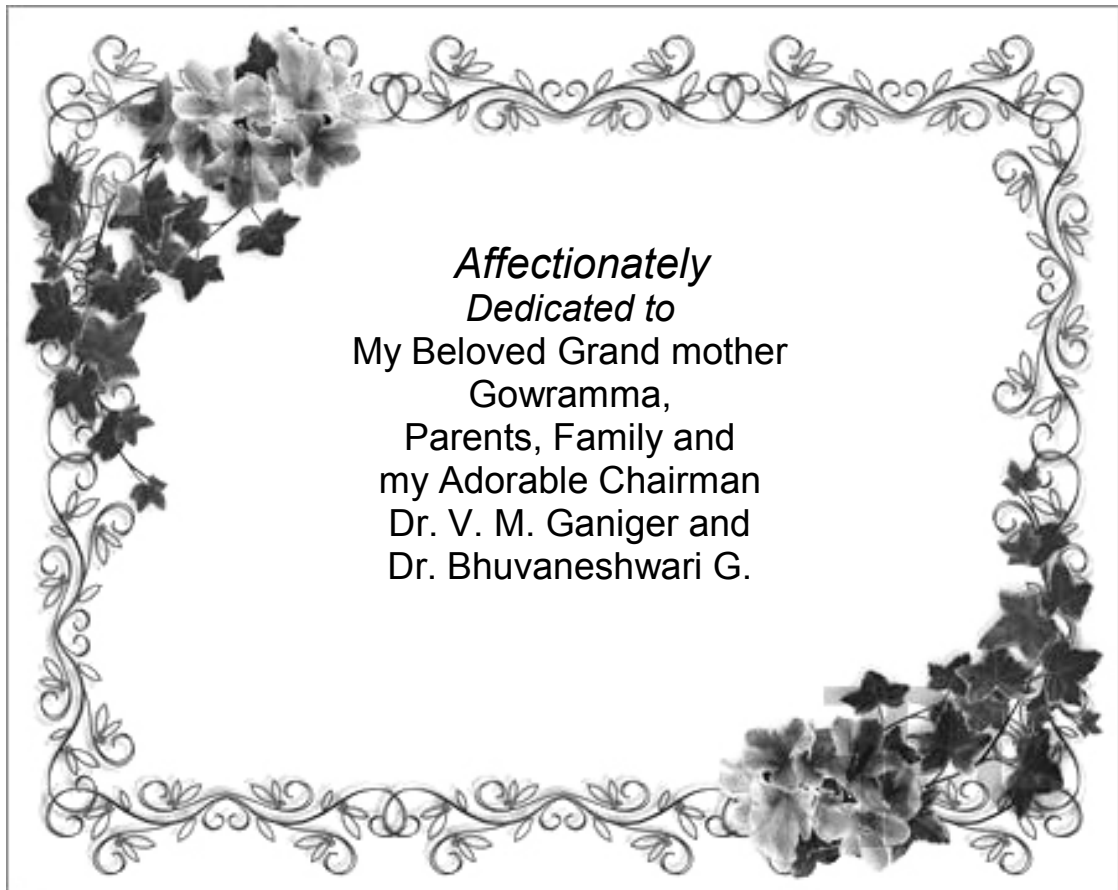
I am thankful to Mr. Arjun and Mr. Kalmesh of "Arjun Computers, Dharwad" for their co-operation during preparation of this manuscript.

End is inevitable for any kind of work. Though acknowledging is an endless task, I end by saying infinite thanks to all those whom I am able to recall here and also to those whom I might have left unknowingly.

BAGALKOT

JULY, 2013

(SHIVAPRASAD M .K.)



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1. INTRODUCTION

Cucumis melo L. (Reticulatus group) commonly called as cantaloupe or muskmelon is a member of the family *Cucurbitaceae* (Bailey and Bailey, 1976). It is known by various names viz., Bachang, Melonegurke, Chiral, Sweet melon, Kalinga, Chira, Kharbooj, Khurmuj, Kharbuja, Kasturi tarabuja, Velapandu, Velapalam, Thai Kumbalom Kharbuj, Sakkartoti, Kekkarike and Kharbujza in different parts of India. Though muskmelon is a tropical old-world species, its geographical origin is still unclear. Africa is considered to be the centre of origin of melon, though the recent data supports the view that the origin of genus *Cucumis* may be in Asia (Renner *et al.*, 2007; Schaefer *et al.*, 2009). Melon was first domesticated in Egypt and Iran during the second and third millennium BC, (Pangalo 1929). The main centre of diversity is located in Asia, from the Mediterranean basin (Turkey) to Central Asia (Iran, Uzbekistan) to India to East Asia (China, Korea) (Robinson and Decker-Walters 1997).

Plants bear fruit with a variety of shapes and flesh colour. The ripe fruits are edible and green fruits are used as vegetable. The ripe fruits are very wholesome and healthful and are used for table as well as for juice purpose, highly relished by rich and poor irrespective of young and old generation. The fruits are extensively used as dessert fruits and are highly popular in summer months. Melons grown in dry regions are sweeter and tastier than those of wet situation. Consumer preference for this fruit is determined largely by its sweetness (sugar content), flavour or aroma, texture and more recently as a rich source of phytonutrients (Lester, 2008). Ripe fruits and immature ones are very much useful in curing human diseases like kidney problem, in chronic and acute eczema as well as tan freckles and internally in case of dyspepsia. It possesses cooling, flattening, tonic, laxative, aphrodisiac and biliousness curative properties. Seed oil is useful in relieving painful discharge and suppression of urine. The seeds are diuretic, cooling, nutritive, and beneficial to the enlargement to prostate gland.

Muskmelon is a rich source of vitamin C, β -carotene (vitamin A), carbohydrates, sugars, protein and also traces of vitamin B₆, vitamin K, niacin, vitamin B₂ and vitamin B₁. In addition, fruits contain more than 90 per cent water (Anon., 2002), folic acid and potassium as well as a number of other human health-bioactive compounds (Lester and Hodges, 2008).

Muskmelon is gaining lot of importance due to its short duration, high production potential with high nutritive value, taste, delicacy and also its suitability for cultivation under rainfed and irrigated conditions almost throughout the year. In India, it is extensively cultivated in hot and dry areas of Uttar Pradesh, Punjab, Rajasthan, Madhya Pradesh, Bihar and Karnataka. Though muskmelon is most nutritious, its productivity is very low as compared to other vegetable fruits in India. This may be due to pre-mature flower drop, lack of initiation of more female flowers in proportion to male flowers, inadequate source-sink relationship and poor translocation of photo-assimilates at later stages of crop growth. Although, the average

potential yield of melons is 60 t/ha, the actual yield of muskmelon ranges from 12.5–20.0 t/ha depending on the management practices (Nempalsingh *et al.*, 2004). This gap certainly indicates that there is a great scope for improving the productivity by using suitable varieties and hybrids.

In Karnataka, the crop is cultivated under limited area with mostly local varieties which are low in productivity. However, of late several public and private hybrids are being popularised but they must be evaluated for different desirable characters like earliness; yield, quality, disease and pest in the crops. The information about crop suitability to the Northern dry zone of Karnataka is rather scanty. Hence, investigation to identify suitable hybrids for Northern dry zone of Karnataka was planned with the following objectives.

- 1) To identify most suitable muskmelon hybrids for Northern dry zone
- 2) To study the growth performance of popular hybrids
- 3) To study the yield and quality of popular hybrids
- 4) To study the economics of cultivation of muskmelon hybrids

2. REVIEW OF LITERATURE

Muskmelon is one of the important nutritious and highly remunerative crop of cucurbit vegetable group known for its taste and delicacy. It is difficult to obtain higher yields of excellent quality with open pollinated varieties in most part of India. Possible improvement in yield and quality through use of F₁ hybrids, improved open pollinated varieties and modified cultural practices have been well established in foreign countries. F₁ hybrids greatly vary for the horticultural traits and growing environment. Evaluation of F₁ hybrids under different regions with different horticultural traits is essential to identify superior F₁ hybrids for commercial cultivation.

Many scientists opined that recent hybrids performed better compared to existing traditional varieties. However, more comprehensive and analytical approaches, based on the performance of hybrids trial data, are essential to examine comparative adoptability in the existing hybrids or varieties.

In this chapter an attempt has been made to review the literature concerning evaluation of F₁ hybrids in muskmelon and other cucurbits for various growth, yield and quality attributes along with economics of crop cultivation

The review is presented under the following heads.

- 2.1 Growth parameters
- 2.2 Yield parameters

- 2.3 Fruit characteristics
- 2.4 Quality parameters
- 2.5 Pest and disease reaction
- 2.6 Economics

2.1 Growth parameters

2.1.1 Vine length (cm)

More and Seshadri (1980) observed that only one hybrid exceeded in vine length over the longer parent. None of the hybrids produced vine shorter than the shorter parent, which would be desirable. Kvasnikov and Biryukova (1982) reported that F_1 hybrids of cucumber with a main stem reaching 2 to 2.5 m length. Nandpuri *et al.* (1984) observed highest vigour in the F_1 hybrids of muskmelon over parents (65.2%) for vine length. As compared with 'Hara Madu' the standard and longest growing variety, the vine length was invariably less and with a significant margin in 13 F_1 hybrids.

Cools and Jansen (1987) reported that the greatest vigour was manifested in cucumber cultivar E 5507 followed by Mustang and least was with Salara. Sirohi *et al.* (1988) reported variation in vine length ranging from 4.02m in S.52-3-2 and 7.05m in S.49-2-1 in a trial which comprises 66 genotypes of bottle gourd. Vijaykumari *et al.* (1991) reported hybrid with a maximum vine length reaching 165 cm length in 304 A x RKS 295 however, minimum vine length of 101 cm was recorded in SR 551 F x JPL. However minimum vine length of 1.1 m in IHR5.1.2 and maximum of 2.0 m in F_1 hybrid 6.7 was reported by Satyanarayana (1991).

Bokashi *et al.* (1992) conducted experiment on performance of muskmelon hybrids, results revealed that the length of vine of different hybrids ranged from 76.33 to 147.33 cm. SM 7 hybrid produced maximum length (147.33 cm) and minimum noticed in SM 17. Mandlinger and Fossen (1993) observed that Galia produced fruits with maximum vine length (144 cm). Patil *et al.* (1996) noted the maximum vine length of 563.7cm in Samrat and a minimum of 343.01cm in Arka Bahar.

Badgujar and More (1999) conducted a study on performance of selected tropical gynoecious cucumber hybrids. It was observed that the five hybrids namely H-27H-312, H-41, H-42 and H-210 expressed significant differences for vine length (188 to 192 cm).

The maximum and minimum vine length of 3.37m and 3.10m was reported in NDBG-10 X NDBG-1C cross and NDBG-15 X NDBG-1C cross, respectively in bottle gourd (Kumar *et al.* 1999). Glala *et al.* (2002) reported that the maximum vine length (115.63 cm) produced in Fal -6 of muskmelon. The studies on the performance of bottle gourd genotypes under hot

arid environment and noticed that the F₁ of Banswara Local-1 X Gujarat Local-1 produced the longest vine (3.87 m) followed by 3.80 m in F₁ of Banswara Local-1 X Pusa Naveen. Whereas, minimum vine length of 2.32 m was observed in genotype IC42361 (Samadia, 2002).

Ahmed *et al.* (2004) conducted an experiment on cucumber cultivars for their growth and yield performance and observed vine length of the cultivar Punjab Local and Electron attained maximum vine length (200 cm and 181 cm, respectively). Market More cultivar obtained plant height of 160 cm and all these cultivars behaved statistically alike. On other hand, minimum plant height of 108 cm was noticed in Yadenctva. A maximum vine length of 3.75m was reported in bottle gourd variety SKBG-27 and a minimum of 3.21m was recorded in NDBG-123 under temperate conditions of Kashmir (Ahmed *et al.*, 2005). Maharana *et al.* (2005) studied on productivity and quality of different accession of pumpkin and revealed that accession -3 had longest vine length (396.17 cm).

Ram *et al.* (2006) evaluated 24 genotypes of *Luffa* sp. and obtained a maximum vine length of 7.20 m in DR/Y-8 and DR/Y-11 genotypes. The minimum was noticed in RAULA-2 (4.13m). Forty eight indigenous germplasm / lines of sponge gourd were evaluated by Pandey and Singh (2007) and noticed a maximum vine length of 7.08m in PSG-206 and minimum of 4.33m in PSG-174 genotypes during summer. Whereas, a maximum vine length of 11.33 m was reported in PSG-85 and minimum of 5.72m in PSG-50 genotypes during rainy season.

Gichimu *et al.* (2008) conducted agronomic performance of five cultivated watermelon accessions and concluded that Kakamega land race had longest main vine (448 cm) on the other hand, 'Crimson Sweet' had shortest main vine (201 cm). 'Sugarbaby', 'Charleston Gray' and 'Yellow Crimson' recorded main vine length of 228 cm, 233 cm and 244 cm, respectively. Variations in vine length have been reported in 28 bitter gourd genotypes by Yadav *et al.* (2008). The maximum vine length was recorded in IC-85635A (5.65 m) and lowest in TZA₁ (1.12 m).

Harika *et al.* (2010) evaluated bottle gourd genotypes for growth, earliness and yield parameters. The results showed the Anand Bottle gourd-1 recorded higher vine length (748.33 cm) which differed significantly from other genotypes Gaja (658.33 cm), INDAM-320 (655.00 cm), INDAM-204 (616.67 cm) and NBOH-1 (613.33 cm) which were next in order of merit. Whereas, the minimum vine length noticed in Louki (391.67), Kaveri (391.67) and NS-443 (393.33 cm) respectively. Okonmah *et al.* (2011) evaluated four varieties of watermelon and the results showed that Sugar baby variety performed best in vine length when compared to values obtained for other varieties (Green Gold, Charsleton gray and Crimson sweet).

2.1.2 Number of leaves

Ahmed *et al.* (2004) conducted an experiment on cucumber cultivars for their growth and yield performance. They observed that Punjab Local cultivar produced maximum number

of leaves per plant (72.11) followed by the Market More (61.46) . The cultivar Yadenctva occupied lowest position with minimum number of leaves (30.80) per plant. Maximum number of leaves in bottle gourd was recorded in BCBG-15 (180.60) and the minimum in B.G.No.36 (93.17) (Munshi and Acharya, 2005).

2.1.3 Leaf area

Maharana *et al.* (2005) studied on productivity and quality of different accessions of pumpkin and the results showed that the accession -3 had highest leaf area (292.50 cm²).

2.1.4 Number of branches

Mandlinger and Fossen (1993) reported the highest number of branches per vine in Topmark and lowest number of branches per vine in BG-84-3. Samadia (2002) evaluated the performance on growth and plant vigour of bottle gourd genotypes and concluded that the number of branches per plant ranged from 2.85 in IC42361 and 7.55 noticed in a hybrid obtained by crossing Banswara Local-1 X Pusa Naveen.

Aravindakumar *et al.* (2005) evaluated 49 crosses in muskmelon, among the crosses, Kajiri x IHR-616-23 got maximum numbers of branches per vine and minimum number in Kajiri x IHR-675. Maximum number of primary branches was observed in VRBT-100 (10.37) followed by DARA-1 (10.33) and Chidambaram Small (9.60) and minimum was observed in VRBT-21(6.53). Bairagi *et al.* (2005) reported variation in number of primary branches per plant ranging from 3.9 to 8.5 in a trial comprising of 28 F₁ hybrids of cucumber. Maharana *et al.* (2005) studied on growth productivity and quality of different accession of pumpkin and the results showed that the accession -3 had highest number of branches (4). Average number of primary branches per plant ranged from 6.53 to 10.37 in different genotypes with mean of 8.79 (Vijaykumar 2007).

Gichimu *et al.* (2008) conducted a study on agronomic performance of five cultivated watermelon accessions and concluded that Kakamega landrace is most branched (11 branches). On the other hand, 'Crimson Sweet' was least branched (5 branches). However, 'Sugarbaby', 'Charleston Gray', and 'Yellow Crimson' recorded 7, 7 and 9 branches, respectively. Yadav *et al.* (2008) observed maximum number of laterals of 37.67 in IC-85639 and minimum of 10.67 in DVBT-G-5 in a study comprising of 28 germplasm lines of bitter gourd. Harika *et al.* (2010) evaluated bottle gourd genotypes for growth, earliness and yield parameters found that the genotype Sarika recorded higher number of branches per vine (12.67) followed by Anand Bottle gourd-1 (11.83) and NS-421 (11.83).

Fergany *et al.* (2011) studied the variation in melon for adoption purpose and the results revealed the range of branches per vine to be 2.0 – 7.5. The highest number of branches was observed in two accessions (AM 5 and AM 7).

2.2 Yield parameters

2.2.1 Days to first flowering

Sirohi *et al.* (1988) noted the line S.52-32-2 was very early (64.00) in first male flower production and S.49-2-1 is late of all (77.00) among 12 bottle gourd germplasm lines. Bokashi *et al.* (1992) conducted an experiment on performance of muskmelon hybrids and the results showed that the hybrids SM 14, SM 12 and SM 13 produced male flower at 28.33 to 28.67 days. On the contrary, SM 9 required maximum (44.33) days to produce male flower.

Gichimu *et al.* (2008) conducted agronomic performance of five cultivated watermelon accessions and concluded that flowering was found to start from the sixth week after planting and the first flower to open was always a male flower. 'Sugarbaby' took the shortest time (45 days) to produce first male flower while Kaka mega landrace took the longest time (63 days) while 'Crimson Sweet', 'Yellow Crimson' and 'Charleston Grey' took 55, 58 and 59 days, respectively. Yadav *et al.* (2008) recorded 27 days in varieties MC-84 and TZA₁, 40 days in CO-1 for opening of first male flower in bitter gourd.

According to Harika *et al.* (2010) bottle gourd variety NBBL-12 was the earliest (43.83) with regard to the opening of first male flower followed by Thar Samridhi (45.17), Gaja (47.33) and INDAM-320 (48.17) while, NBOH-1 took maximum number of days (58.83). Dhanwate *et al.* (2011) noticed that the improved variety of Preethi required the minimum days (34.33) for appearance of first flower.

2.2.2 Node to first flowering

Doijode (1978) studied that performance of seven pumpkin parents and their crosses and observed that among parents, CM-37/9 produced first male flower on highest node (6.9) and IHR-83 produced on lowest node number (2.7). In the case of hybrids CM-12 X CM-37/9 produced highest nodes (5.4) followed by 4.8 in CM-12 X IHR-6 and Arka Chandan X CM-37/9 produced on lowest node number (2.4). Badgujar and More (1999) observed the node number of first female flower in the best five desirable gynoeocious cucumber hybrids *viz.*, H-13(2.60), H.37 (2.70), H.27 (3.00), H-312 (3.00) and H-211 (3.10).

Samadia (2007) reported on variation in node to first male flower ranging from 2.24 in DPY-125, 4.08 in PDVR-48 and KPT-3 in a trial which comprised 18 land races of round melon. Harika *et al.*(2010) evaluated bottle gourd genotypes for growth, earliness and yield parameters and the results revealed that both male and female flower found at earliest node (5.83 and 6.83 respectively) in genotype Louki.

2.2.3 Days to first female flower

Gopalakrishnan *et al.* (1990) noticed a range of 43.33 to 57.00 days to production of first female flower in pumpkin. Vijaykumari *et al.* (1991) evaluated 41 hybrids in muskmelon during rainy season. Among the hybrids Gyn. JPL x 12911 took maximum number of days for opening of first female flower while, 322-11 x Balan took minimum number of days for first female flower opening. Vijayakumari *et al.* (1991) observed that anthesis of first female flower in cucumber hybrids ranged from 55.23 days in WI-2757 X EC-129110 and 70.73 days in SR-551F X Improved Long Green cross during summer season. Whereas, the cross 322-11 X Balsam took only 34.53 days to flower and flowering continued up to 50.16 days in Gyn. JPL x EC-129110 cross during rainy season. Bokashi *et al.* (1992) showed that hermaphrodite flowers opened first in 34 days after sowing in SM 5 followed by SM 8 (38.67days).

Ryugu was earliest in female flower production (54.53) followed by Sugar Baby (55.03) and Nantomidori (55.96) whereas, Black Big Seeded (61.6), Jaunpuri (59.66) and Indian Sweet Heart (59.46) were late of 14 exotic and Indian watermelon varieties studied (Vashistha *et al.*, 1993). Lal and Dhaliwal (1996) reported that genotypes of muskmelon took 27.69 (MHL-10) and 41.92 (M-4) days to first female flowering Days to first female flower of bottle gourd genotypes varied between 61.09 in Banswara Local-1 X Pusa Naveen cross and 89.84 days in IC-92353A (Samadia, 2002).

Pandey and Singh (2007) recorded 53.33 days for production of first female flower in PSG-192 and PSG-193, 57.67 days in PSG-208 genotype. Whereas, PSG-89 genotype proved for late flower (88.33 days) for flowering. While, Samadia (2007) recorded 48.11 days for production of first female flower in DPY-136, 47.44 days in KCM/BKP-08 and 40.55 in Arka Tinda days in a trial comprising of 18 phenotypically diverse round melon genotypes.

The genotype Chidambaram Small responded earliest to open first female flower (49.44 days) followed by VRBT-83 (52.47 days) and VRBT-41 (52.70 days) and the genotype Nanjangood Local took maximum number of days (70.10 days) for female flower appearance. The range for this attribute being 49.4 to 70.1 days with mean of 59.01 days (Vijaykumar, 2007). Gichimu *et al.* (2008) conducted a study on agronomic performance of five cultivated watermelon accessions and found that the opening of the first female flower occurred 6 to 13 days after the opening of the first male flower. 'Sugarbaby' recorded the shortest time to anthesis of its first female flower (51 days) while, the Kakamega landrace recorded significantly the longest time (74 days). 'Yellow Crimson' recorded 66 days while, 'Charleston Gray' and 'Crimson Sweet' took 68 days to open their first female flower.

Among twenty diverse accessions of snake gourd under humid tropics, earliest to flower was in TA (43 days), whereas, TA 21 (49.85 days) was late to flower (Celine *et al.*, 2010). The results of Harika *et al.* (2010) showed that the days to first female flower was least

in NBBL-12 (45.83) followed by INDAM-320 (46.67), Thar Samridhi (47.33) and Sharada (50.33). Whereas, NBOH-1 (60.67) and Sarika (60.67) took maximum days.

Dhanwate *et al.* (2011) carried out studies on flowering in varieties of bitter gourd and results revealed that PBIG-1 and RHRBG-5 required minimum days (38 days) for female flower appearance. Rakha *et al.* (2012) observed that the number of days to the first female flower ranged between 35.0 for Eskandarani and 54.3 days for Strain 2.

2.2.4 Sex ratio

Observed that the male to female ratio ranged from 8.32 to 11.75 in four pumpkin cultivars. 8.2 to 55.3 for in sponge gourd (Ali and Siddique 1983, Arora *et al.*, 1993).

Pillai *et al.* (1998) obtained the staminate to pistillate flower ratio ranging from 20:1 in MO18 variety to 50:1 in MO48 variety in bitter gourd. Cultivation of cucumber recorded maximum sex ratio (3.15) and the minimum was in Market More (1.82). (Ahmed *et al.* 2004).

Rakha *et al.* (2012) evaluated and observed the lowest and highest sex ratios for Strains 5 (0.9) and Strain 7 (1.6). Whereas, Eskandarani cv. produced nearly equal number of male and female flowers per plant in cucurbita interspecific hybrids.

2.2.5 Number of fruits per plant

Nandpuri *et al.* (1974) observed that the number of fruits per vine in 14 F₁ hybrids was slightly in excess of the number of fruits by the parent. Eight F₁ hybrids yielded a slightly larger number of fruits per vine than the better parent. In none of the crosses, the number of fruits per vine was significantly higher than that of parent in muskmelon. Chadha and Nandpuri (1980) witnessed the number of fruits per plant of the parents and the hybrids ranging from 1.19 to 3.53 and 1.2 to 3.44 respectively in muskmelon. More and Seshadri (1980) reported that 11 muskmelon hybrids produced greater number of fruits per plant compared to the parents but were not statistically significant. In the next year 16 hybrids exhibited significantly more number of fruits over parent out of 30 hybrids and maximum vigour observed was 29.55 per cent. Patil *et al.* (1991) reported that the number of fruits per plant in cucumber varied from 3.7 in Gopuri Local to 28.3 in Poona Khira.

Vijaykumari *et al.* (1991) evaluated certain hybrids of muskmelon during rainy season. Among the hybrids, 304 x JPL got more number of fruits per vine. Bokashi *et al.* (1992) showed that there was wide range of variation in fruit bearing (3.44 to 12.19 fruit /plant) in different hybrids, the plants of SM 7 produced maximum fruit bearing (12.19 fruits/plant) but the fruits were small. The SM 12 had minimum fruit bearing (3.44 fruits / plant).

Prasad *et al.* (1993) noticed maximum number of fruits per plant (4.6) in SKBG-104 and minimum in SKBG-101 (2.8) variety of bottle gourd. Pal *et al.* (1994) noted maximum

number of fruits per plant (5.00) in NDBG-20 X Pusa Naveen cross and minimum in NDBG-55 X NDBG-1C cross (4.28) in bottle gourd.

Evaluation of muskmelon by Dhiman *et al.* (1995) revealed that the number of fruits per vine was recorded highest in Punjab Hybrid (1.8), MR-12 (1.8) and Punjab Sunehri (2.0) did not differ from one other but Hara Madhu had significantly less fruits per vine (1.3).

Reddy *et al.* (1995) evaluated the bitter gourd genotypes and found that the number of fruits per vine ranged from 1.60 to 10.53 in Chitradurga Local-II and Bellary Local respectively. Dogra *et al.* (1997) noted 13.33 fruits per plant in K-90 X Gyn. 1 cross and lowest number of fruits per plant (6.67) in LC-11 variety of cucumber.

Sharma *et al.* (1997) reported that the number of fruits per plant in bottle gourd varied from 3.90 in S.52-8-4 to 7.31 in S.9-1-5. Badgajar and More (1999) evaluated the performance of selected tropical gynoecious cucumber hybrids and observed the significant differences for number of fruits per plant in top five hybrids viz., H-210 (18.10), H-211 (18.20), H-42(18.20), H-41(18.10), H-41(18.10) and H36(17.60).

Sharma and Dhankar (1999) evaluated the performance of bottle gourd genotypes and noticed a range of variation from 1.39 to 8.55 for number of fruits per plant. Greenhouse melon cultivars recorded 2.2 to 3.6 fruits per plant (Shaw *et al.*, 2001).

Glala *et al.* (2002) observed maximum number of fruits per plant in Chidambaram Small (61.51) followed by VRBT-100 (28.43) and Panruthy (27.84). Minimum number of fruits per plant was obtained in IC-065782 (14.8).

Ahmed *et al.* (2004) conducted an experiment on cucumber cultivars for their growth and yield performance and observed the greater number of fruits per plant (13) in the cultivar Market More as compared to other cultivars followed by the cultivar Poinsett-76 (12.5). The cultivar Yadenctva gave 6.3 fruits per plant while, Konkurent produced only 4.8 fruits per plant resulting in poor performance.

Mitchell *et al.* (2006) evaluated eighteen speciality melon cultivars for their fruit yield, fruit-quality characteristics and concluded that the number of marketable fruit per plant was similar among all cultivars. Ram *et al.* (2006). Witnessed 96.33 to 185.33 fruits per plant in *Luffa* sp. The number of fruits per plant ranged from 14.8 to 61.5 (Vijaykumar, 2007) in bitter gourd.

Gichimu *et al.* (2008) conducted a study on agronomic performance of five cultivated watermelon accessions and concluded that all accessions were different in number of fruits per plant. The Kaka mega landrace emerged significantly the best yielder with 5.67 fruits/plant (1814 fruits/ha), 'Yellow Crimson' produced an average of 3.45 fruits/plant (1104 fruits/ha). 'Sugarbaby' recorded an average fruit yield of 2.39 fruits/plant (765 fruits/ha) while

'Charleston Gray' produced an average of 1.5 fruits/plant (480 fruits/ha). 'Crimson Sweet' recorded the lowest yields of 0.89 fruits/plant (285 fruits/ha).

Ijoyah and Koutatouka (2008) evaluated five newly introduced muskmelon varieties, 'Jowel F₁', 'Caly F₁', 'Joker F₁', 'Ludo F₁' and 'Citrin F₁' including the commonly grown variety 'Hales Best' under field conditions. The results showed that cv. 'Joker F₁' had the highest number and big sized fruits.

Nirmal *et al.* (2008) recorded the maximum (5.8) and minimum (4.1) number fruits per vine in Arka Jeeth and NDM-5, respectively. Balkaya *et al.* (2009) conducted a study on evaluation of suitable pumpkin types for the black sea region and reported that the number of fruits ranged from 1.20 to 4.28. The maximum number of fruits was found in G19 and minimum number of fruits was found in G10.

Dey *et al.* (2010) reported the highest number of fruits per vine (23.7) in DVBTG-5-5 and lowest number of fruits per vine (12.01) in Nakhara. Harika *et al.* (2010) evaluated bottle gourd genotypes. Gaja ranked first for number of fruits per vine (14.50).

Fergany *et al.* (2011) studied on the variation in melon for adoption purpose and the results revealed that the average number of fruits /vine ranged between 2.5 and 9.0.

Rakha *et al.* (2012) evaluated and obtained the highest number of fruits in terms of early yield (308.4) and total yield (911.2 g) per plot from strain 6. However, two regenerated strains proved superior to the local cultivar 'Eskandarani' in number of fruits (early and total yield/plot) as well as total fruit yield per plot.

2.2.6 Fruit weight (g)

More and Seshadri (1980) stated that, 14 hybrids in muskmelon exhibited significant fruit weight as compared to their parents. The highest estimate of vigour over parent observed was 82.69 per cent.

Kaloo *et al.* (1989) recorded maximum weight per fruit in variety 78#9 (845 g) followed by Sardar Melon (796 g) and minimum weight per fruit was observed in Jaunpuri (330 g) and 78#2 (324 g) varieties of muskmelon. Sheetal yielded 42.1 tons/ha in *Kharif* and 20-30 tons/ha in summer with fruits having an average weight of 350 g (Rajput *et al.* 1991).

Vijaykumari *et al.* (1991) recorded an average fruit weight of 180 g in Poinsett x RKS 302 during rainy season. Dhiman *et al.* (1995) evaluated four muskmelon genotype MR-12, Hara Madhu, Punjab Sunheri and Punjab Hybrid and results revealed that among the hybrids Punjab hybrid produced fruits with maximum weight.

Srinivasa and Srivastava (1996) reported variation in fruit weight of bitter gourd, from 22.40 g to 96.83 g. Sharma *et al.* (1997) recorded maximum fruit weight (1383.52 g) in bottle gourd germplasm line S.1-3-6 and minimum of 712.73 g in S.17-8-3.

Sharma and Dhankar (1999) found the outstanding fruit weight of 1180.02 g in Udaipur Local-1 and least fruit weight in IC-92353A variety of bottle gourd. Badgujar and More (1999) studied the performance of selected tropical gynoeocious cucumber hybrids and observed the significant differences for average fruit weight during both the seasons. Nevertheless, the top five hybrids were H-27(114.11), H-26 (133.00), H-37(112.37), H-13(11.83) and H41 (111.14).

Glala *et al.* (2002) reported that the maximum (986.0g) and minimum (429.11g) fruit weight in Fal-6 and Kyo-4, respectively during winter season. Mean fruit weight was maximum in Panruthy (105.51 g) followed by CO-1 (102.60 g) and Naduthittu (84.53 g) and minimum was observed Chidambaram Small (7.7 g) in Egyptian melon.

Sharma and Lal (2004) conducted a study on the varietal differences in physicochemical characteristics of muskmelon and results revealed that the fruit weight ranged from 322 g (PSDPM-1-7-50) to 865 g (MHY-3). Yadav and Asati (2005) conducted a correlation study among fruit characters in indigenous germplasm lines of watermelon and the data showed that fruit weight ranged from 300 g (Wm99-11) to 9800 g (Wm99-21).

Mitchell *et al.* (2006) evaluated eighteen speciality melon cultivars for mean fruit weight per plant which ranged from 0.7kg ('Charentais') to 1.9kg ('Girlie').

Mean fruit weight ranged from 7.7g to 105.5g with the mean value of 58.58g (Vijaykumar 2007) in bitter gourd. Erdinc *et al.*(2008) compared the local and improved melon cultivars for their growth and quality characters and found that the Rambo F₁ registered maximum fruit weight (1375 g) in the first year and in second year (1032 g). While, 65 ER 02 had recorded the lowest one (787 g).

Gichimu *et al.* (2008) conducted a study on agronomic performance of five cultivated watermelon accessions and concluded that all accessions were different in number of fruits per plant. The Kaka mega landrace emerged significantly the best yielder with 5.67 fruits/plant, but its fruits were lighter in weight (averaging 1.99 kg) compared to those of 'Yellow Crimson' (averaged 3.01 kg). 'Yellow Crimson' produced an average of 3.45 fruits/plant (1104 fruits/ha). 'Sugarbaby' recorded an average of 2.05 kg in weight while, 'Charleston Gray' produced an average of 1.77 kg in weight followed by 'Crimson Sweet' weighing an average of 1.44 kg.

Ijoyah and Koutatouka (2008) evaluated the yield performance of five newly introduced muskmelon varieties. The results showed that cultivar Joker F₁'s fruit length, width, weight, yield and fruit set were significantly ($P \leq 0.05$) higher by 34.3, 31.2, 14.7, 72.6 and 54.2

per cent respectively in 2005; and 34.8, 16.1, 25.2, 64.8 and 47.4 per cent respectively in 2006, when compared to cv. 'Hales Best'. Ohashi *et al.* (2009) compared 32 muskmelon cultivars (cvs.) with one Omani cultivar for average fruit weight and found all cultivars were 25 per cent lighter than control. Celine *et al.* (2010) observed the highest fruit weight of 1198.20 g in TA 10 and lowest in TA 20.

Harika *et al.* (2010) evaluated bottle gourd genotypes for growth, earliness and yield parameters and the results showed that the maximum fruit weight was observed in INDAM-320 (1443.09g) followed by INDAM-204 (1439.78 g) and Anand Bottle gourd-1 (1312.91 g).

Fergany *et al.* (2011) conducted variation studies in melon for adoption purpose and the results revealed that average accession fruit weight ranged between 0.175 and 1.735 kg.

Hossein *et al.* (2012) recorded the highest weight for Jafarabadi cultivar. The lowest fruit weights were recorded in the Zin Abad cultivar (2.30 kg). Rakha *et al.* (2012) evaluated and observed for fruit characteristics, the highest fruit weight (127 g) was obtained from Eskandarani cv. While, Strain 3 had the lowest values.

2.2.7 Fruit yield

Bokashi *et al.* (1992) conducted experiment on performance of muskmelon hybrids and the results showed that there was wide range of variation in fruit yield of the plants of SM 7 produced maximum yield (2.74 kg/plant and 13.72 t/ha, respectively) and the second highest yield (2.39 kg/plant and 11.93 t/ha respectively) was recorded in SM 12. However, the lowest fruit yield both per plant and per hectare (0.91 kg/plant and 4.57 t/ha respectively) was produced by the plants of SM 11. The performance of 11 F₁ hybrids indicated that SM7, SM12 and SM14 could be grouped as high yielder as their yield ranged from 11.58 to 13.72 t/ha. While, SM17 and SM19 can be classified as medium yielder (9.18 to 9.73 t/ha respectively).

Dhiman *et al.* (1995) revealed that MR-12 produced the highest fruit yield (19.22 t/ha) followed by Punjab Hybrid (18.57 t/ha) and Hara Madhu (15.20 t/ha) of muskmelon.

Rajput *et al.* (1995) recorded 5.15 to 20.65 tonnes per hectare, in an evaluation trial of ten bitter gourd varieties. The genotype Coimbatore Long recorded the highest yield of 20.65 tonnes per hectare followed by CO-2 (17.20 t/ha) and DPL-BG-2 (Konkan Tara 16.2 t/ha).

Reddy *et al.* (1995) observed highest yield of 5430.04 kg per hectare in Bellary Local followed by 4763.37 kg in Siddavanahalli Local and lowest per hectare yield of 400.20 kg in Chitradurga Local-II in a trial comprising with 13 varieties of bitter gourd.

Rodriguez *et al.* (2002) evaluated high tunnel cantaloupe and specialty melon cultivars and obtained results that the cultivar 'Galia 152' produced the highest yield per plot where as 'Passport' had relatively good yield.

Ahmed *et al.* (2004) conducted an experiment on cucumber cultivars for their growth and yield performance and observed that the cultivar Market More (32.47 t/ha) gave the highest fruit yield per hectare followed by the cultivar Poinsett-76 (29.12 t/ha), and these two cultivars were statistically similar. The cultivars Konkurent (9.50 t/ha) and Yadenctva (12.05 t/ha) gave minimum fruit yield per hectare.

Maharana *et al.* (2005) studied on productivity and quality of different accession of pumpkin and the results showed that the accession -3 had highest yield, highest number of fruits and high average fruit weight.

Mitchell *et al.* (2006) evaluated eighteen specialty melon cultivars for their fruit yield, fruit-quality characteristics and concluded that several cultivars, 'Angel', 'Vedrantais', 'GVS 206', 'Nestor', 'Gala' and 'Charantais', had significantly lower yields (less than 40 t / ha) than 'Galileo,' Elario, 'Kamila' and 'Girle' (more than 70 t / ha).

Erdinc *et al.* (2008) compared the local and improved melon cultivars for their growth and quality characters and found that the Makdimon F₁ had the highest total yield (31.41 t / ha) in the first year which was followed by the selected local genotypes, 65ER04 and 65ER02 (24.12 and 22.30 t / ha of yields, respectively). Makdimon F₁ had also the highest total yield (29.65 t / ha) in the second year, and was followed by the selected local genotype, 65 ER 02 with 22.99 t / ha of yield of muskmelon.

Singh and Kumar (2009) evaluated five varieties of summer squash and witnessed the highest total fruit yield of 696.0 quintals per ha in Australian Green and lowest of 540.75 quintals per ha in Adlika. Harika *et al.* (2010) evaluated bottle gourd genotypes for growth, earliness and yield parameters and the results showed that the genotype Gaja ranked first for fruit yield (41.68 t/ha) and lowest fruit yield was obtained in Champion (10.29 t/ha) .

Rakha *et al.* (2012) evaluated different cultivars of muskmelon and observed that an early yield (23.9 Kg) per plot were obtained from Eskandarani cv. Strain 5 recorded the highest total yield per plot (45.1 kg). The lowest values of early and total yield per plot were obtained from strain 1 and 2. However, two regenerated strains proved superior to the local cultivar 'Eskandarani' in number of fruits (early and total yield/plot) and total fruit yield per plot in cucurbita interspecific hybrids.

2.3 Fruit characteristics

2.3.1 Fruit shape

Most hybrids have fruits either round with pressed poles or simply round and had oblong fruits but SM 4 had oval fruits (Bokashi *et al.* 1992).

Maharana *et al.* (2005) studied different accessions of pumpkin. Fruit shape of accession -1 was round being flat in both the sides, accession -2 was slightly pointed in distal side and in accession -3 the distal end was more tapering, accession -4 was almost flat in both the sides and accession -5 was roundish.

Yadav and Asati (2005) conducted a study on correlation among fruit characters in indigenous germplasm lines of watermelon and revealed that the fruit shape varied from round to flat cylindrical. The most desirable fruit shape (round shape) was recorded in 11 germplasm/accessions.

Fergany *et al.* (2011) observed four types of fruit shapes in the germplasm *viz.*, elongated, oblate, elliptical and pyriform, the majority of landraces belonged either to the elongated (42%) or oblate (40%) category, the types elliptical pyriform were represented by 10 and 6 % respectively.

2.3.2 Predominant fruit colour

Bokashi *et al.* (1992) opined that rinds of the fruits were cream (SM 11 and SM 12), green (SM 4, SM 5, SM 8, SM 13, SM 13, SM 14, SM 17 and SM 19), orange (SM 9) and yellow (SM 7) in colour among the hybrids.

Yadav and Asati (2005) indicated that lines of watermelon had the rind colours were green, whitish, pale green, bluish black and dark green. Fergany *et al.* (2011) studied on the variation in melon for adoption purpose and the results revealed that the majority of landraces (60%) had yellow primary skin colour, the other accessions were orange (14 %) light green (18 %) or green (4 %).

2.3.3 Flesh main colour

Bokashi *et al.* (1992) remarked that the flesh colour of muskmelon hybrids was variable *viz.*, cream, white, light green and green.

Yadav and Asati (2005) categorised water melon lines by their flesh colour as pink, bright crimson, yellowish, dark red and light pink.

Fergany *et al.* (2011) studied on the variation in melon for adoption purpose and the results revealed that yellow orange with 44 percent and orange 56 percent fruit flesh was observed amongst the accessions.

2.3.4 Fruit surface

Rodriguez *et al.* (2002) opined that cultivar 'Galia 152' had an excellent external appearance, a tight seed cavity and a very floral smell. The flesh was light green. and the cv. 'Passport' did not seem to possess the uniformity in size and shape characteristic of 'Galia

152'. In addition, the external fruit appearance was not as attractive as either 'Galia 152' or 'Elario'.

2.3.5 Flesh thickness (mm)

Munger (1942) stated that the muskmelon hybrids produce a high proportion of flesh than the parent. However, Lippert and Legg (1972a) reported that vigour was non significant and unfavorable for per cent flesh.

More and Seshadri (1980) observed significant vigour only in two hybrids. The highest estimate of vigour for flesh proportion was 17.57 per cent. Kalloo (1989) recorded 2.0 to 3.9 cm range of variation for flesh thickness in Jaunpuri and Aroma F₁ varieties respectively in muskmelon.

Mohamedien *et al.* (1991) evaluated ten cantaloupes and found that a genera mean of flesh thickness was highest (3.41 cm) in Radar and lowest (2.41 cm) in Elora.

According to Bokashi *et al.* (1992), mesocarp thickness differed in descending order among SM 14 (2 cm), SM 4 (1.88 cm) SM 12 (1.72 cm), SM 13 (1.72 cm), SM 17 (1.69 cm) and the fruits of SM 9(0.96 cm) had the minimum mesocarp thickness.

Sharma and Lal (2004) conducted study on the varietal differences in physicochemical characteristics of muskmelon and results revealed that F₁ hybrid MH-10 had thickest flesh (3.2 cm). Maharana *et al.* (2005) studied on productivity and quality of different accession of pumpkin and the results showed that the accession -3 had the highest flesh thickness (25 mm).

Yadav and Asati (2005) conducted a study on correlation among fruit characters in indigenous germplasm lines of watermelon and the data showed that the flesh thickness is an important trait and ranged from 9.6 to 34.5 cm. Mitchell *et al.* (2006) evaluated eighteen specialty melon cultivars and observed that the flesh thickness was highest for 'Tlario' (41 mm) and lowest for 'Charentais' (24 mm).

Pandey and Singh (2007) recorded a maximum flesh thickness of 5.00 cm in PSG-186 and minimum of 2.83 cm in PSG-178 during summer season in sponge gourd. Whereas, the trial during rainy season, the variety PSG-189 recorded a maximum flesh thickness of 3.73 cm and minimum of 2.47 cm in PSG-40.

Erdinc *et al.* (2008) compared the local and improved melon cultivars for their growth and quality characters and found that the Rambo F₁ and Makdimon F₁ had the thickest flesh (29.31 and 28.36 mm, respectively) in the first year, while 65 ER 02 had the thinnest one (22.79 mm). The results obtained in the second year of the study also recorded that

Makdimon F₁ and Rambo F₁ had the thickest flesh (34.8 and 30.83 mm, respectively), while 65 ER 02 had the thinnest one (22.58 mm). Overall, 65 ER 04 and Ananas beside 65 ER 02 were also thinner flesh than others. Nirmal *et al.* (2008) evaluated 7 muskmelon genotypes among them NDM-5 got highest (2.9 cm) flesh thickness and lowest (1.8 cm) in Punjab Madhuras.

Balkaya *et al.* (2009) reported fruit flesh thickness ranging from 11.37mm to 39.95mm. The highest fruit flesh thicknesses was found in G11 and lowest fruit flesh thickness was found in G8. Joseph John and Antony (2009) observed a maximum flesh thickness in Andaman Local and minimum in I C 467669.

2.3.6 Cavity size (cm)

Sharma and Lal (2004) evaluated 5 open pollinated varieties and 5 F₁ hybrids in muskmelon. Among the F₁ hybrids Punjab hybrid had smallest (26.4cm²) cavity size. Among the varieties KPPM-2-31 had the smallest (22.8cm²) cavity size.

Singh and Lal (2005) evaluated 24 genotypes of muskmelon. Among the genotypes maximum cavity polar diameter was in PSPPM-1-7-50 (10.53 cm) and minimum in IC-320173 (3.2 cm) and maximum and minimum cavity equatorial diameter in Planters Jumbo and EC-399937.

Maharana *et al.* (2005) studied the productivity and quality of different accession of pumpkin and the results showed that the Accession -3 had the shortest cavity diameter (13.93 cm). Joseph John and Antony (2009) reported the maximum fruit cavity size (3.0 cm) in I C 467671 and minimum fruit cavity size (1.5 cm) in I C 467686.

2.3.7 Seeds per fruit and seed to pulp ratio

Edelstein and Nerson (2002) studied the effect of genotype and plant density on watermelon grown for seed production and the results showed that the breeding line 203 (186) produced significantly fewer seeds per fruit than 239-4 (232) or Malali (323).

According to Okonmah *et al.* (2011) Sugarbaby had 203.3 seeds/pod at harvest and differed significantly ($P \leq 0.05$) from Crimson sweet (174.3), Green gold (165.0) and Charleton gray (145.3).

Kortse and Oladiran (2012) opined that in 'Egusi-itoo' melon, big sized fruits had significantly more seeds compared to small fruits and medium sized fruits.

Amali *et al.* (2013) conducted an experiment on *Citrullus lanatus* and observed that the number of seeds per fruit showed significant difference with the first harvest (20 Days

After Anthesis). Further succeeding harvest recorded no significant differences among themselves, in contrast to the greater seed number produced by serewe, bara produced a greater seed weight per fruit.

2.3.8 Net type

Davis *et al.* (1964) reported that in muskmelon fruit surface netting is a distinguishing feature, since netting as quality feature per se is not an important variant so long as it covers the fruit surface uniformly.

Bokashi *et al.* (1992) indicated that fruit of two hybrids (SM 8 and SM 9) were sparsely netted whereas four hybrids had smooth fruits.

2.4 Quality parameters

2.4.1 Total sugars (mg/100g)

Hussain and Zafar (1979) observed that in melon, crosses between varieties having high but variable sugar content normally gave progenies lower in sugar than parent varieties, whereas crosses between varieties less variable in sugar inherited the high sugar content of the initial varieties or exceeded these. In crosses with large fruited varieties it is recommended to use these high sugar varieties as the maternal parent.

2.4.2 Vitamin C (mg/100g)

Dhiman *et al.* (1995) conducted a study on evaluation of muskmelon and results revealed that the genotype MR-12 consistently had the highest vitamin C and significantly higher mean (32.49) content than the other three genotypes.

Fergany *et al.* (2011) studied on the variation in melon for adoption purpose and the results revealed that the ascorbic acid of mature fruits ranged between 1.4 and 9.0 mg/ 100gm of fresh weight. Accessions AM 84 and AM 70 contained significantly more ascorbic acid than other accessions (9.0 and 8.4 mg/ 100g of fruit weight, respectively).

2.4.3 β -Carotene content (IU)

Fergany *et al.* (2011) studied on the variation in melon for adoption purpose and the results revealed that the total carotenoids contents ranged between 30.8 and 146.3 μ g/ 100g of fresh fruit weight.

2.4.4 TSS of fruit (%)

Munger (1942) stated that muskmelon hybrids produced much more sugar in the flesh than the parent. Vigour for TSS in muskmelon has also been reported by many workers (Bhattacharya *et al.* 1970, Sivakami and Choudhury 1974., Chadha and Nandpuri 1977).

Bokashi *et al.* (1992) conducted an experiment on performance of muskmelon hybrids and the results showed that the TSS widely varied from 9.47 (SM 4) to 14.77 per cent (SM 11). SM 11 and SM 13 were alike while, SM 7, SM 8, SM 9, SM 12 and SM 17 had the statistically similar TSS values.

The study conducted on evaluation of four muskmelon genotype revealed that mean TSS content was 10.80 per cent (Dhiman *et al.* 1995). Pitchaimuthu and Dutta, (1996) recorded the highest TSS in two lines, viz., Prodatur Local-7 and Rajvarpet Local-15 (16%) out of 32 muskmelon varieties tested.

Dogra *et al.* (1997) studied the mean performance of cucumber parents and hybrids and the results revealed that the cross LC-11 X K-75 recorded maximum total soluble solids of 3.23⁰B followed by EC-173934 (3.12⁰B) and minimum total soluble solids was recorded in a cross K-75 X Gyn. 1 (2.89⁰B).

Gala *et al.* (2002) reported that the maximum (13.97%) and minimum (12.0) TSS in GW-4 and Ano-4, respectively. Rodriguez *et al.* (2002) evaluated high tunnel cantaloupe and specialty melon cultivars and obtained results that the cultivar 'Galia 152' had excellent TSS (Total Soluble Solids) or sugar content averaged 14 per cent . 'The sugar content of 'Passport' was equal to 'Galia 152'.

Charentais melons may reach 14 to 16°Brix (Rangarajan and Ingall, 2003), whereas in this study they were below this, 8.4°Brix ('Vedrantais') and 11.0°Brix ('Charentais').

Sharma and Lal (2004) conducted a study on the varietal differences in physicochemical characteristics of muskmelon and results revealed that the mean TSS content ranged from 7.8 per cent to 10.3 per cent among the open-pollinated varieties Punjab Rasila, Punjab Sunehri and Hara Madhu were found to have acceptable, TSS content coupled with high vitamin C content. Abhijeet had acceptable TSS content (9.2%) and was comparable with the check Punjab Hybrid.

Maharana *et al.* (2005) studied on productivity and quality of different accession of pumpkin and the results showed that the TSS was highest in accession-4 (6.02⁰brix).

Yadav and Asati (2005) Studied fruit characters in indigenous germplasm lines of watermelon and the data showed that the TSS, one of the most important characteristics of the fruit, ranged from 5 (Wm 99-11) to 13 (Sugarbaby). TSS content 10 percent or more then

10 was found in 4 genotypes namely Wm 99-7, Wm99-13, Arka Manik and Sugarbaby and all the flour genotypes were found sweet or very sweet.

Mitchell *et al.* (2006) evaluated eighteen speciality melon cultivars for their fruit yield, fruit-quality characteristics and concluded the cultivars with the highest SSC were 'Angel' (16.3°Brix) and 'Kamila' (15°Brix). However, the lowest SSC was found for 'Vedrantais' (8.4°Brix, 100 DSR), 'Elario' (8.8°Brix, 14 DSR), and 'Melon 6004' (8.9°Brix, 28 DSR).

Erdinc *et al.* (2008) compared the local and improved melon cultivars for their growth and quality characters and found that the Rambo F₁ had the highest SSC (8.74 brix) in the first year, while 65 ER 02 had the lowest one (6.17 brix). One of the interesting points was the field grown 13 TAT 05 had higher SSC value than the field grown Ananas though it was insignificant. Rambo F₁ had also the highest SSC (11.30 brix) in the second year. The commercial cultivars had higher SSC values than the locally selected ones in both years. 13 TAT 05 had higher SSC values among the locally selected genotypes.

Nirmal *et al.*, (2008) compared seven muskmelon genotypes and recorded that the highest total soluble solids (TSS) content (10.1%) in Arka Jeeth and lowest (6.8%) in NDM-5. Sudhakar *et al.* (2008) reported that the cultivar Kashi Madhu showed high TSS content (13.24%) than those of the other cultivars followed by RM 49 (10.53 %) and least by Punjab Sunehari (8.73%).

Ohashi *et al.* (2009) evaluated 32 muskmelon cultivars (cvs.) compared with one Omani cultivar for different quality attributes like total soluble solids (TSS), fruit length and weight etc. in spring. TSS was highest in Andersen (15%) followed by Smash melon, Aristo seika and Rock star (12%). Lewis had a TSS of 11 per cent and cultivar Picaso melon, Bonus 2gou and Monami red showed 10 per cent along with control.

Balkaya *et al.* (2009) studied of suitability of pumpkin types for the black sea region and reported TSS ranging from 3.0 per cent to 11.0 per cent. The highest TSS was in G17 and lowest in G3.

Fergany *et al.* (2011) studied on the variation in melon for adoption purpose and the results revealed that all the accessions were non sweet and their TSS ranged between 2.1 and 6.4⁰ brix. Hossein *et al.* (2012) observed the highest sugar content in Jafarabadi cultivar.

2.5 Resistance to pest and disease

2.5.1 Powdery mildew incidence (%)

Markarian *et al.* (1966) developed an F₁ hybrid derived from Iroquois x PMR 45 and is a mid season firm fleshed and mildew resistant variety. An F₁ hybrid of muskmelon viz., Campo x Dessert 5 with good fruit qualities (ascorbic acid 58.6 mg/100g and dry matter

17.8%) high yield (170 q/ha) and resistant to powdery mildew has been developed by Frolov (1981). Malinina (1974) reported that among the 100 melon collections of Indian origin tested, K 6205, K 6206, K5692 and K 5519 were resistant or relatively resistant to *Erysiphe cichoraciarum* and *Sphaerotheca fuliginea* under field conditions and are recommended for breeding.

Varieties bred in the U.S.A for resistance to *Erysiphe cichoraciarum* retained their resistance in Japan. Promising for resistance and fruit quality were Gorgia 47, PMR-5, PMR-6, C398A and their F₁ hybrids of several crosses, the most promising was Hirako-1 later named as Sunrise (Takada *et al.*, 1974). Sowell and Corley (1974) reported that PI 234607, Gorgia 47 and PMR-6 were highly resistant to race 2 of *Sphaerotheca fuliginea*.

Yuko and Igarashi (1974) bred a Line Kurume No. 2 of muskmelon from a back cross of BC₅ x Sel 108 with BC₅ which was highly resistant to powdery mildew and Fusarium wilt but the flesh was poor and recommended only for breeding or as rootstock.

Waraitch *et al.* (1977) studied the reactions of melon cultivars to *Sphaerotheca fuliginea* under field conditions and on inoculation in the glass house. The cultivars Arka Rajhans, Jacumba, Dulce, PMR-5 Gulf Stream and Golden Perfection had field resistance and all but Golden Perfection remained free from symptoms on inoculation.

Frolov (1981) crossed varieties resistant to *Sphaerotheca fuliginea* viz., Ttabolinka, Cuurme and Campop with recommended varieties. The most resistant hybrid was Campop x Desertnaya 5 with yield of 170 quintals/ha and an ascorbic acid content of 58.6 mg/100g.

Zatkyo (1982) reported that lira a mid early maturing variety was resistant to *Erysiphe cichoraciarum* and *Sphaerotheca fuliginea*. Gomez-Guillamon and Tares (1989) reported that PI 124112B was resistant to race 1, 2 and 3 of *Sphaerotheca fuliginea* while PMR-6 was resistant to race 1 and 2.

2.5.2 Fruit fly infestation (%)

The fruit fly (*Dacus cucurbitae* (Coquillet)) is one among the most serious pests attacking cucurbits in India. The fly prefers green and tender fruits in cucurbits. The attack by fly on fruit not only reduces yield but also affects quality. It is estimated that more than 50 per cent of the cucurbit fruits are partially or fully damaged by the fruit fly (Lall and Sinha, 1959).

Among all cucurbits bitter melon is the most preferred host (Srinivasan, 1959). There is only a partial success in the management of this pest through systematic insecticides (Agarwal *et al.*, 1987). Moreover the use of pesticide also leads to environmental pollution. Hence, development of resistant varieties is the most desirable method of controlling this pest. The environmental factors like temperature and relative humidity also affect the infestation by fruit fly (Shivarkar and Dumbre 1985).

Four strains of bitter gourd, Green Rough, Green Smooth, White Rough and White Smooth genotypes were found resistant to melon fruit fly (Fernando and Udurawana, 1941). Lall and Sinha (1974) evaluated six bitter gourd cultivars for resistance to pest and found cultivar Short Green Kareli as resistant to fruit fly. Gupta and Verma (1978) observed 41.08 per cent, fruit damage and 56.98 per cent of unconsumable portion in an infested fruit.

Variety Phule BG-4 was reported comparatively resistant to fruit fly (Anon., 1990). Twenty eight genotypes were screened and none of them were found free from attack of the pest. Lowest attack was found in Acc28 and highest in 22-D-10 (Thakur *et al.*, 1992). Tewatia and Dhankhar (1996) recorded maximum (86.4%) fruit infestation in Arka Harit followed by Pusa Do Mausami (85.75%), which are too high susceptible genotypes in bitter gourd. Out of the 10 varieties of bitter gourd studied 'Priya' was most susceptible with 45.46 per cent fruit damage.

Productivity of bitter gourd is reduced due to fruit fly infestation and resistance/tolerant to fruit fly infestation could be due to non attraction of pests and their harboring in those genotypes. Minimum fruit fly infestation was observed in Panruthy (20.95 %) followed by VRBT-100 (27.16 %) and VRBT-83 (31.50 %) whereas, maximum fruit fly infestation was observed in Arka Harit (71.5 %). A great range of variation from 20.9 per cent (Panruthy) to 71.5 per cent (Arka Harit) with mean of 42.20 per cent was reported by Vijaykumar (2007).

2.6 Economics (B:C)

According to Sait (2002) net return per square meter was determined to be 0.98 dollars for organic green house cucumber production. Net return per kg was calculated to be 0.07 dollars.

Engindeniz and Tuzel (2003) opined that net profit per square and net profit per kg were determined to be \$ 1.5 and \$ 0.2 for organic greenhouse tomatoes. However, net profit per square and net profit per kg were determined to be \$ 1.3 and \$ 0.1 for organic greenhouse cucumbers.

Total cost estimated for producing cucumber on per acre basis was Rs. 55.906 - of this, 60 per cent accounted for production cost, 28 per cent for marketing cost and 12 per cent rent of land the gross income froth raising one acre of cucumber was Rs. 1.28210 - with production of 14.822 Kgs and net revenue were Rs. 79.102 - and Rs. 72.302 - excluding and including rent of land respectively. The benefit cost ratio showed that investing one rupee in off-season cucumber, production would generate Rs. 1.29 (Ishaq *et al.*, 2003)

Sait (2004) studied on the economic analysis of growing greenhouse cucumber with soilless culture system. Net return obtained from greenhouse cucumbers was determined to be \$1.81 m⁻² and \$0.07 kg⁻¹.

Mathieu *et al.* (2006) investigated about changes in pickling cucumber yield and economic value in response to planting density. The highest yield was observed at the highest density did not translate into the highest economic value. This was mainly due to the added cost of the seed under high densities. Optimum density required to maximize economic value, was between 220000 and 245000 plants / ha and depended on the selling price of the fruits.

Singh *et al.* (2007) opined that the cost-benefit ratio of cucumber cultivation under greenhouse was worked out as 1:2.29 under Delhi conditions of India. It was concluded that the low-cost naturally ventilated greenhouses are more suitable and economical for year-round cucumber cultivation for Northern plains of India.

Cantliffe *et al.* (2008) studies revealed that greenhouse cucumber production requires a significantly larger capital investment (total cost: \$391,922 / acre) compared to field production (total costs: \$5,620 / acre), potential profits have been determined to be as much as 1,206 times greater for greenhouse produced cucumbers than in the field (profits: \$72,775 compared to \$60 / acre, respectively).

Kanade and Patil (2009) observed that in summer cucumber production, the maximum benefit cost (B:C) ratio of 4.57 was obtained with sugarcane trash mulch coupled with 75% ET irrigation level with net income of Rs.35,1919/- per hectare. The minimum B: C ratio of 2.07 was obtained due to no mulch with 50% ET irrigation level.

Silvio *et al.* (2010) opined that growing of peppers and salad cucumbers in the protected space was more profitable than growing them in the open land. The growing of salad cucumbers in the protected space has proven to be more reasonable than growing peppers, as the coefficient of economics (Ce) of growing salad cucumbers reached the value $C_e = 1.4$, while the value in growing peppers was $C_e = 1.1$.

2.7 Correlation studies

Singh *et al.* (1986) reported that the fruit weight had positive significant correlation with number of fruits per plant ($r = 0.502^*$), weight of fruit per plant ($r = 0.504^*$) and yield of fruit ton per hectare ($r = 0.697^{**}$). Correlation studies revealed that, fruit breadth had negative significant correlation with pulp seed ratio (-0.404^*) in water melon. On the other hand number of nodes at first harvest had negative correlation with fruit length and weight of fruits per plant were noticed by Sarkar *et al.* (1990).

Saha *et al.* (1992) also reported similar results in respect of fruit length in pumpkin. Number of fruits per plant had positive significant correlation with weight of fruits per plant (0.915^{**}) and yield of fruit (0.813^{**}) which indicates that yield per plant will be increased with the increase in fruit number.

Taha *et al.* (2003) observed positive and significant associations between the number of fruits per vine with the number of primary branches (+0.82), netting development with number of primary branches (+0.69), netting development with total soluble solids (+0.67), number of primary branches with number of secondary branches (+0.63), fruit weight with plant length (+0.59), earliness with flavor (+0.42), and netting development with flesh thickness (+0.39), whereas, earliness with netting development (-0.82), total soluble solids with earliness (-0.71) and the number of primary branches with stem length (-0.55) were found to be negatively associated in melon.

Khan *et al.* (2009) reported that number of node at first harvest had positive association with single fruit weight, pulp to seed ratio, number of fruits per plant and yield of fruits per hectare. Days to first flowering had positive association with fruit breadth, number of fruits per plant, weight of fruit per plant and yield of fruit. Fruit length had positive correlation with single fruit weight, pulp to seed ratio, number of fruits per plant and yield of fruit per hectare. On the other hand, negative correlation existed with weight of fruit per plant in pointed gourd.

Naroui Rad *et al.* (2010) observed simple correlation coefficient among characters and indicated a significant and positive relation between yield and fruit weight, flesh diameter in melon. Fayeun *et al.* (2012) observed significant correlations between number of branches on one hand and, internode length and vine girth on the other. All other relationships between the characters under study were very highly significant. In addition, all correlation coefficients were positive in fluted pumpkin

Tamil selvi *et al.* (2012) revealed that fruit yield per vine was significantly and positively correlated with fruit number per vine, flesh thickness and total carotenoids content. However negative association was observed with days to first female flower appearance, node number for first female flower appearance, sex ratio, days to first harvest and fruit weight in pumpkin.

Kumar *et al.* (2013) observed the total yield per vine exhibited significant and positive correlation with number of fruit per vine, average weight of fruit, number of seeds per fruit and total soluble solids. Further, average weight of fruit was significantly and positively correlated with number of seeds per fruit, total yield per vine, average length of fruit, number of fruits per vine, suggesting thereby, the increase in either of one will ensure the increase in fruit weight in sponge gourd.

3. MATERIAL AND METHODS

The present investigation was carried out at the Research Block, Department of Vegetable Science, College of Horticulture, Bagalkot during *rabi* 2012-13 with the object to find out the suitable F₁ hybrids of muskmelon for Northern dry zone of Karnataka. The details of material used and methods adopted during the course of investigation are outlined in this chapter.

3.1 Location

The research block, Department of Vegetable Science, College of Horticulture Bagalkot, is located in Northern dry zone (Zone-3) of Karnataka state at 16° 46' North latitude, 74° 59' East longitudes and at an altitude of 534.0 m above the mean sea level.

3.2 Climate

Bagalkot classified under zone-3 of region-2 among the agro climatic zones of Karnataka has benefits of both South-West and North-East monsoons. The average rainfall of South-West monsoon is about 360 mm, distributed over a period of four month (June to September) with 25 rainy days. The average rainfall of North-East monsoon is about 136 mm with 8 rainy days. During the experimental period, the meteorological data recorded at the meteorological observatory of the Agricultural Research Station, Bagalkot is presented in Appendix-II

3.3 Experimental details

Studies on performance of muskmelon hybrids under Northern zone of Karnataka was laid out in Randomized block design with following treatments (Eight muskmelon hybrids and one variety as a check).

Number of treatments: 9

Number of replication: 3

Plot size: 7.5 m X 5.0 m

Spacing: 2.5 m X 1.0 m

Hybrids	Source
T ₁ - Tamanna	East West
T ₂ - Kundan	Known-you

T ₃ - NS-7455	Namdhari
T ₄ - Golden Glory	Green field
T ₅ - Natalya	Nunhems
T ₆ - NUN-0001	Nunhems
T ₇ - NS-910	Namdhari
T ₈ - NUN-1002	Nunhems
T ₉ - Arka Jeet	IIHR, Bengaluru

3.4 Cultural practices

3.4.1 Land preparation

The area of experimental plot was brought to a fine tilth by repeated ploughing and harrowing. The land was levelled and the entire plot was divided into 3 blocks (Replications). The treatments were assigned to different plots in each replication by using random table. The main and sub irrigation channels were prepared taking into account of gradient of the site.

3.4.2 Application of manures / fertilizers

The recommended dose of farm yard manure (20 t/ha) was applied to the site and incorporated in to the soil. Out of the recommended dose of fertilizers (100:75:50 kg NPK/ha) half dose of nitrogen and full dose of phosphorus and potassium were applied as a basal dose to the plots and incorporated in the soil. Remaining 50 per cent of nitrogenous fertilizer was applied after 30 days of sowing as a top dress.

3.4.3 Irrigation

The plots were irrigated uniformly at an interval of 5 days depending on soil and climate conditions so as to maintain adequate moisture in the plot.

3.4.4 Sowing of seeds and after care

The seeds of eight F₁ hybrids from different government and private sector with Arka Jeet (IIHR, Bangalore) as a standard check were sown on 22nd January, 2013. In each hill 3 to 4 seeds were sown at spacing of 2.5 m 1.0 m apart from plant to plant in a row. The row to

row spacing was 2.5 m. The thinning operation and gap filling operations were carried out at 10 days after sowing to maintain uniform population of one seedling per hill. Whenever the seeds were not germinated, gaps were filled by resowing within a week. All other recommended horticultural package of practices of University of Horticultural Sciences, Bagalkot, (Anon, 2012) were followed to raise muskmelon crop.

3.4.5 Weeding and plant protection measures

All necessary care was taken to establish a healthy muskmelon crop. However, diseases and pests were managed by chemicals like karathane at 1.5 gm/l for powdery mildew management sprayed at 15 days interval and for downy mildew control spray of metalaxyl at 1.5 ml/l were used and for management of fruit fly and red pumpkin beetle cabaryl at 4 gm/l was sprayed at the time of flowering.

3.5 Observations recorded

3.5.1 Growth parameters

Five randomly selected plants were tagged in each treatment plot for recording growth parameters and the mean of the observations on these five plants was computed and recorded.

3.5.1.1 Vine length (cm)

The vine length was measured from soil surface to the growing tip of the longest branch after the final harvest and expressed in centimeters.

3.5.1.2 Number of leaves

The number of leaves per plant was counted at the time of harvesting and recorded.

3.5.1.3 Leaf area (cm²)

Measured by graphical method by laying the leaves to be measured on centimeter grid tracing their outline and contains the number of square centimeters covered. The area of the partial squares was estimated and added to the number of full square centimeters.

3.5.1.4 Number of branches

Number of branches arising from the main stem of vine was counted at the final harvest and same was recorded.

3.5.1.5 Days to first flowering

The date on which the first staminate flower appeared on one of the three randomly tagged vines was considered as the days to first flowering. The days were calculated from the date of sowing and expressed in days.

3.5.1.6 Node to first flowering

The node number at which first flower appeared was noted by counting its position from the base of the vine excluding the cotyledonary node.

3.5.1.7 Days to first female flower

Number of days taken from the day of sowing to the onset of first female flower on any one of the tagged vine in each treatment was recorded.

3.5.1.8 Sex ratio (ratio of male to female flowers)

The number of male and female flowers arising on the vines was recorded until the crop showed the signs of termination of flowering and ratio of male to female flowers was calculated.

3.5.2 Yield parameters

Five randomly selected plants were tagged in each treatment plot for recording yield parameters and the mean of the observations of these five plants was computed and recorded.

3.5.2.1 Number of fruits per plant

Total number of fruits per plant of the tagged plants over all the harvests was counted and recorded.

3.5.2.2 Fruit weight (g)

The ratio of total weight of fruits harvested at the edible stage to total number of fruits per vine was recorded as the average fruit weight and was expressed in grams.

3.5.2.3 Total fruit yield per plot (kg)

The weight of fruits from each harvest on all plants in a plot was recorded and total fruit yield per plot was worked out by adding yields of all harvests and expressed in kilograms per plot.

3.5.2.4 Fruit yield per hectare (t/ha)

The fruit yield per hectare was calculated by multiplying the yield per plot. Plot size (7.5 m x 5 m) with a multiplication factor and expressed in tonnes.

3.5.2.5 Fruit characteristics

The fruit characteristics like fruit shape, predominant fruit colour, flesh main colour, fruit surface and net types were recorded by visual observation.

3.5.2.6 Cavity size (cm)

Fruits were cut in the middle at vertical axis and length and breadth were measured and multiplied to estimate the cavity size and expressed in centimeter.

3.5.2.7 Fruit flesh thickness (mm)

Fruits were cut in the middle at vertical axis and the flesh thickness was measured at the middle and expressed in milimeter.

3.5.2.8 Seeds per fruit

The seeds extracted from each fruit in each replication were counted and the average was computed and recorded.

3.5.2.9 Seed to pulp ratio

The seed to pulp ratio was calculated by taking the ratio of seed weight of fruit (g) to pulp weight of fruit (g).

$$\text{Seed to pulp ratio} = \frac{\text{Seed weight of fruit (g)}}{\text{Pulp weight of fruit (g)}}$$

3.5.3 Quality parameters

3.5.3.1 Total soluble solids (TSS ⁰Brix)

The total soluble solids from five randomly selected fruits of F₁ hybrids by squeezing the juice on Erma hand refractometer (0-32 Brix) at room temperature and the values were recorded.

3.5.3.2 Ascorbic acid content (Vitamin C)

Samples of the fruits were analysed for their ascorbic acid content using 2, 6-dichlorophenol visual method (Anon., 1975). The two gram fruit sample was blended with 0.4 per cent oxalic acid and filtered through muslin cloth. To an aliquot of the extract (2 ml) of the sample, 3 ml acid mixture was added and titrated against the standard dye; the end point is the appearance of pink colour (V₂). Similar procedure was followed against acid mixture to get blank titre value and against standard solution made in 0.4 per cent oxalic acid to get standard titre value (V₁) the ascorbic acid content was computed by using following formula.

$$\text{Ascorbic acid (mg/100 g)} = \frac{\text{Ascorbic acid (mg)}}{\text{ml of aliquot}} \times \frac{V_2}{V_1} \times \frac{\text{Total sample volume (ml)}}{\text{Weight of the sample (g)}} \times 100$$

3.5.3.3 β -carotene content of fruit

Beta-carotene content of fruits was estimated by adopting procedure suggested by Srivastava and Sanjeev Kumar (2006). Reagents like acetone, anhydrous sodium sulphate and petroleum ether were used for the estimation. Five gram of fresh sample was taken and crushed in 10-15ml acetone, adding a few crystals of anhydrous sodium sulphate with the help of pestle and mortar. Supernatant was decanted into a beaker. The process was repeated twice and the combined supernatant transferred to a separatory funnel, 10-15 ml of petroleum ether added and mixed thoroughly. Two layers separated out on standing. Lower layer was discarded and the upper layer collected in a 100 ml volumetric flask. Made up the volume to 100 ml using petroleum ether and optical density at 452nm of wave length was recorded using petroleum ether as blank using spectrophotometer.

$$\beta\text{-carotene } (\mu\text{g}/100\text{g}) = \frac{\text{O.D} \times 13.9 \times 10^4 \times 100}{\text{Weight of sample (g)} \times 560 \text{ nm} \times 1000}$$

3.5.3.4 Estimation of total sugars

Preparation of sample

Five gram of sample was taken in a 250 ml of beaker and 50 ml of water was added and heated to boiling, cooled and transferred to a 250 ml volumetric flask. Two ml of lead acetate solution was added, shaken and allowed to stand for 10 minutes. Excess lead was precipitated by adding 2 ml of potassium oxalate solution and volume was make up with water and filtered.

Reducing sugars

Five ml of filter was taken in a test tube 5 ml of Shaffer-Somogyi reagent was added and mixed well. Simultaneously, blank was prepared using 5 ml of water and 5 ml of reagent. Two tubes were placed in a water bath for 15 minutes and tubes were removed carefully without disturbing the contents and cooled in running water for 4 minutes. Along the sides of each tube, 2 ml of iodide-oxalate solution was added and then 3 ml of 2 N sulphuric acid and allowed both tubes to stand in cold water for 5 minutes and then titrated against 0.005 N thiosulphate solution using starch as an indicator.

Total sugars

Twenty five ml of filtrate was taken in a 50 ml volumetric flask and 5 ml of HCL (1:1) was added then allowed to stand for 24 hour at room temperature and neutralized exactly with NaOH using phenolphthalein as indicator and volume was made up with water. An aliquot was taken and total invert sugars were determined as in the case of reducing sugars.

Reducing and total sugars were calculated by using the following formulas.

$$\% \text{ reducing sugars} = \frac{\text{mg of Dextrose} \times \text{Volume made up} \times 100}{5 \times \text{weight of sample taken} \times 1000}$$

$$\% \text{ Total sugars as invert sugar} = \frac{\text{mg of Dextrose} \times \text{Volume made up} \times 100}{\text{Titre} \times \text{weight or volume of sample taken} \times 100}$$

$$\% \text{ Sucrose} = (\% \text{ Total invert sugars} - \% \text{ Reducing sugar originally present}) \times 0.95$$

$$\% \text{ Total sugars} = \% \text{ Reducing sugars} + \% \text{ Sucrose.}$$

3.6 Disease and pest incidence

3.6.1 Powdery mildew incidence (%)

The per cent powdery mildew incidence was recorded as per cent leaf area infected for all the F₁ hybrids, which were scored following zero to five disease rating scale (Girisha, 1989) as given below.

Sl. No.	Per cent leaf area infected	score	Reaction category
1	0	0	Immune
2	1-10	1	Resistant
3	11-25	2	Moderately resistant
4	26-50	3	Moderately susceptible
5	51-75	4	Susceptible
6	76-100	5	Highly susceptible

3.6.2 Fruit fly infestation (%)

The number of fruits infested by fruit fly were counted and expressed as percentage of total fruits. Further, the F₁ hybrids were grouped in to different categories based on per cent fruit infestation (Babu, 2002) as given below.

Per cent fruit infestation	Reaction category
0-10	Resistant
11-25	Moderately resistant
26-50	Moderately susceptible
51-75	Susceptible
>75	Highly susceptible

3.7 Economics

3.7.1 Cost of cultivation

The prices of all the inputs and the labor cost that were prevailing at the time of their use were considered to work out the cost of cultivation. It is furnished in Appendix-III

3.7.2 Gross income

The gross income was worked out based on the prevailing market price when the produce was ready to be marketed.

3.7.3 Net income

Net income per hectare was calculated on the basis of gross income and cost of cultivation per hectare.

3.7.4 Benefit: cost ratio

The benefit cost ratio was worked out by using the following formula.

$$\text{Benefit: Cost ratio} = \frac{\text{Net income (Rs / ha)}}{\text{Cost of cultivation (Rs / ha)}}$$

3.8 Statistical Analysis

The data on various observations such as growth, yield and quality parameters were tabulated and subjected to statistical analysis as described by Sunder Raj *et al.*, (1972).

4. EXPERIMENTAL RESULTS

The present investigation on performance of muskmelon hybrids under Northern dry zone of Karnataka was carried out during *rabi* 2012-13, the results obtained from study are presented in this chapter.

4.1 Growth parameters

4.1.1 Vine length (cm)

Significant differences were observed among the hybrids for vine length (Table 1). It varied from 74.40 cm (NUN-0001) to 160.20 cm (Tamanna). The maximum vine length was recorded in Tamanna (160.20 cm) followed by Kundan (159.06 cm) and NS-910 (156.80 cm) while, Natalya (96.33 cm), Golden Glory (74.86 cm) and NUN-0001 (74.40 cm) had recorded the minimum vine length. Among the 8 F₁ hybrids, 3 hybrids registered significantly maximum vine length over standard check Arka Jeet (123.73 cm).

4.1.2 Number of leaves

The data given in table-1 indicates significant differences among hybrids for number of leaves. The values varied from 70.00 (NUN-0001) to 158.46 (Tamanna). The highest number was recorded in Tamanna (158.46) followed by Kundan (153.80) and NS-910 (147.60) while, NUN-0001 (70.00), NUN-1002 (73.26) and Natalya (75.60) had recorded the least number of leaves and on par with each other. Among eight F₁ hybrids, four hybrids registered significantly highest number of leaves over standard check Arka Jeet (126.80).

4.1.3 Leaf area (cm²)

The values for leaf area ranged from 44.57 cm² (Golden Glory) to 119.10 cm² (Kundan) with a significant difference among the hybrids (Table 1). The highest leaf area was recorded in Kundan (119.10 cm²) followed by Tamanna (118.88 cm²) and NS-7455 (117.90 cm²) while, Golden Glory (44.56 cm²), NUN-0001 (46.65 cm²) and NUN-1002 (52.01 cm²) recorded the lesser leaf area. Among eight F₁ hybrids, four hybrids registered significantly highest leaf area over standard check Arka Jeet (99.13 cm²).

4.1.4 Number of branches

The number of branches per vine was significant among the hybrids and varied from 4.23 to 7.80 with a mean of 6.14 (Table 1). Highest number of branches was recorded in Kundan (7.80) and followed by NS-7455 (7.56), NS-910 (7.36) and Tamanna (6.93). The least number of branches per vine was recorded in NUN-0001 (4.23). Only 4 hybrids registered

significantly higher number of branches over standard check Arka Jeet (6.43) out of 8 F₁ hybrids studied.

4.2 Yield parameters

4.2.1 Days to first flowering

There was significant difference observed among the F₁ hybrids for days to first flowering (Table 2). Days to first flowering ranged from 27.66 to 33.86 with a mean of 30.04 days. The hybrid NS-910 was earliest (27.66 days) to flower followed by Tamanna (27.93) and Kundan (28.33). However, NS-910, Tamanna, Kundan, NUN-0001 and NS-7455 were on par with each other. The standard check Arka Jeet was late (33.86 days) with respect to first flower appearance followed by Golden Glory (31.80 days).

4.2.2 Node to first flowering

Significant difference was noticed for node to first flowering in F₁ hybrids (Table 2). Node to first flowering ranged from 2.53 to 3.66 with a mean of 3.11. The least number of node for first flower was observed in the hybrid NUN-1002 (2.53) followed by Natalya (2.66) and NUN-0001 (2.86) on the contrary, the highest node to first flowering recorded in hybrid Tamanna (3.46) which was on par with Arka Jeet (3.40).

4.2.3 Days to first female flower

There was significant difference among the F₁ hybrid for days taken to first female flower initiation (Table 2). The values ranged from 32.20 to 38.46 with a mean of 35.16 days. The hybrid Tamanna was earliest (32.20 days) to first female flower production followed by NS-910 (32.53 days), NS-7455 (32.73 days). Golden Glory was late (38.46 days) with respect to occurrence of first female flower followed by NUN-1002 (38.13 days) and Arka Jeet (35.53 days).

4.2.4 Sex ratio (M:F)

The hybrids showed significant difference with respect to sex ratio. The values varied from 1.55 to 3.57 with a mean of 2.56 (Table 2). The highest sex ratio was recorded in NUN-1002 (3.57) followed by NATALYA (2.92). Whereas, least sex ratio was found in NUN-0001 (2.08), TAMANNA (1.97) and KUNDAN (1.55). Two hybrids recorded significantly lower sex ratio than standard check Arka Jeet (2.89) among 8 F₁ hybrids studied.

4.2.5 Number of fruits per plant

There was a significant difference observed among the hybrids with respect to number of fruits per vine (Table 3). Number of fruits per vine varied from 2.66 to 4.86 with a mean of 3.76. Highest number of fruits was harvested in Kundan (4.86) and it was least in

Golden Glory (2.66). Hybrids Kundan (4.86), NS-910 (4.60), Tamanna (4.06) and NS-7455 (3.86) were on par with check Arka Jeet (4.38). However, among the eight hybrids, two hybrids (Kundan and NS-910) yielded more number of fruits per plant than check Arka Jeet.

4.2.6 Average fruit weight (g)

The clear variation was observed among the hybrids which ranged from 300.80 g to 863.13 g (Table 3). The highest average fruit weight was recorded in NS-910 (863.13 g) followed by Tamanna (809.53 g), Kundan (797.86 g) and Natalya (702.60 g) and also these hybrids were on par with each other. However, all the hybrids recorded significantly higher fruit weight compared to the check Arka Jeet, which recorded lowest fruit weight (300.80 g).

4.2.7 Fruit yield per plot (kg/plot)

All hybrids in the present study recorded a significantly higher fruit yield per plot than the standard check Arka Jeet and it ranged from 4.38 kg per plot to 12.94 kg per plot with a mean of 10.27 kg per plot. The fruit yield per plot was significant among the F_1 hybrids (Table 3). The highest fruit yield per plot was recorded in NS-910 (12.94 kg/plot). However, there was no significant difference observed between the hybrids NS-910 (12.94 kg/plot), Tamanna (12.14 kg/plot), Kundan (11.96 kg/plot) and Natalya (11.08 kg/plot). Whereas, lowest fruit yield was recorded in Arka Jeet (4.38 kg/plot).

4.2.8 Total yield (t/ha)

Significant difference was observed among the hybrids with respect to total yield (t/ha). The highest total yield was recorded in NS-910 (34.52 t/ha) followed by Tamanna (32.37 kg/plot), Kundan (31.91 t/ha) and Natalya (29.56 t/ha). There was no significant difference found among the hybrids. The lowest total yield was noticed in Arka Jeet (12.04 t/ha). All the 8 F_1 hybrids registered significantly higher total yield over the check Arka Jeet (Table 3).

4.3 Qualitative characters

With respect to qualitative observation from table-4, fruit of three hybrids (Tamanna, Golden Glory and Natalya) were netted whereas, other four are finely netted and Arka Jeet is non-netted type. The rinds of fruits were light yellow (NUN-0001, NS-910 and NUN-1002), pale yellow (NS-7455), green (Natalya), cream (Tamanna) and golden orange (Arka Jeet). Most of the fruits were round in shape except Natalya (Pyriform), NS-910 and Golden Glory (Oval). The flesh colour was also variable which includes predominantly orange, pale orange, deep salmon and cream colour.

4.4 Fruit characteristics

4.4.1 Flesh thickness (mm)

Fruit flesh thickness varied significantly among all the hybrids (Table 5) and it ranged between 15.70 mm and 24.93 mm with a mean of 19.88 mm. The hybrid Tamanna recorded highest flesh thickness (24.93 mm) followed by Natalya (22.33 mm) and NS-910 (22.20 mm) and no significant difference was observed among the hybrids. The lowest flesh thickness (15.70 mm) was found in Golden Glory. Five hybrids had significantly higher fruit flesh thickness over standard check Arka Jeet (18.80 mm).

4.4.2 Cavity size (cm)

There was significant difference with respect to cavity size in all hybrids and varied from 4.15 cm to 7.17 cm with a mean of 5.26 cm. The hybrid Kundan recorded the lowest cavity size (4.15 cm) which was closely followed by NS-7455 (4.41 cm) and Tamanna (5.26 cm). However, Natalya (5.31 cm) and NUN-0001 (5.56 cm) were on par with each other. Arka Jeet registered higher fruit cavity size (7.17 cm) followed by NUN-1002 (6.70 cm) and Golden Glory (6.37 cm). All hybrids except NUN-1002 had significantly lesser fruit cavity size over standard check Arka Jeet.

4.4.3 Number of seeds per fruit

All hybrids registered significantly more number of seeds per fruit over standard check Arka Jeet (Table 5). The range varied from 269.73 to 493.40 with a mean of 390.14. Highest number of seeds per fruit was recorded in NUN-1002 (493.40) followed by NUN-0001 (466.66) and Golden Glory (453.33). The lowest number of seeds per fruit was recorded in Arka Jeet (269.73).

4.4.4 Seed to pulp ratio

Seed to pulp ratio varied significantly among the hybrids and it ranged from 0.016 to 0.040 with a mean of 0.029 (Table 5). The highest seed to pulp ratio was noticed in check Arka Jeet (0.044) and the lowest in Kundan (0.016). The hybrids NUN-1002 (0.040) and NUN-0001 (0.039) were on par with Arka Jeet. All other six hybrids registered significantly less seed to pulp ratio over standard check Arka Jeet.

4.5 Quality parameters

4.5.1 Total sugars (mg / 100 g)

Total sugars varied significantly among different hybrids and it ranged from 47.43 to 51.73 mg per 100g with a mean of 49.63 mg per 100g (Table 6). The highest was recorded in NS-7455 (51.73 mg/100g) and the lowest in Golden Glory (47.43 mg/100g). Whereas, significant difference was not observed between the hybrids NS-7455, NS-910, Kundan and

Natalya. They recorded significantly high total sugar content when compared to check Arka Jeet (48.96 mg/100g).

4.5.2 Vitamin C (mg / 100 g)

The data presented in Table 6 revealed that significant difference in vitamin C content which ranged from 20.13 to 24.76 mg per 100g with a mean of 22.76 mg per 100g. The highest vitamin C content was found in check Arka Jeet (24.76 mg/100g) and lowest in NS-910 (20.13 mg/100g). There was no significant difference observed among hybrids NUN-1002 (24.63 mg/100g), NUN-0001(24.46 mg/100g), Golden Glory (24.36 mg/100g) and check Arka Jeet.

4.5.3 β -carotene content

Observation of β -carotene content showed that there was significant difference among hybrids. The range varied from 11.93 to 17.86 mg/100g with a mean of 15.24 mg/100g (Table 6). The highest β -carotene content was in NS-910 (17.86 mg/100g) followed by NS-7455 (17.66 mg/100g) and Tamanna (16.06 mg/100g). The lowest was recorded in Arka Jeet (11.93 mg/100g), Natalya (12.43 mg/100g) and NUN-1002 (14.60 mg/100g). All hybrids registered significantly high carotene content over standard check Arka Jeet.

4.5.4 TSS ($^{\circ}$ Brix)

Total soluble solids (TSS) varied among different hybrids and it ranged from 11.73 $^{\circ}$ Brix to 13.53 $^{\circ}$ Brix with a mean of (12.56 $^{\circ}$ Brix) (Table 6). The highest TSS content was recorded in NS-910 (13.53 $^{\circ}$ Brix) and lowest in NUN-0001 (11.73 $^{\circ}$ Brix). Hybrids NS-910 (13.53 $^{\circ}$ Brix), NS-7455 (13.50 $^{\circ}$ Brix) and Kundan (13.20 $^{\circ}$ Brix) were on par with each other with respect to TSS content. All the hybrids showed non significant difference among themselves except NUN-0001 (11.73 $^{\circ}$ Brix) and three hybrids recorded high TSS content than check Arka Jeet (12.40 $^{\circ}$ Brix).

4.6 Screening of muskmelon for pest and diseases

4.6.1 Powdery mildew incidence (%)

The nine genotypes were subjected for testing for powdery mildew reaction under natural disease pressure condition. Out of 8 F₁ hybrids all were moderately resistant. None of the F₁ hybrids were resistant to this disease; all hybrids registered significantly less incidence over standard check Arka Jeet. The disease intensity recorded as per cent leaf area infected ranged from 17.63 to 38.70 (%) with mean disease severity of 23.84 % (Table 7). The hybrid Tamanna recorded least (17.63 %) intensity and highest (38.70 %) in Arka Jeet.

4.6.2 Fruit fly infestation (%)

Comparative performance of different muskmelon F₁ hybrids to fruit fly infestation is presented in Table 7. The fruit fly infestation recorded as percentage of fruits infested ranged from 10.60 to 25.41 with a mean of 17.24 % infestation. The least (10.60 %) infestation of fruit fly was recorded in NS-910 and highest (25.41%) in Arka Jeet. Out of 8 hybrids, none of them had showed less than 10 per cent infestation, hence none were resistant to fruit fly but, all were moderately resistant. All hybrids registered significantly less infestation of fruit fly over standard check Arka Jeet.

4.7 Economics

The economics of muskmelon production has been worked out by taking into account of all the inputs used and valued at current prices. This has been presented under the following sub headings.

4.7.1 Inputs utilization pattern

The table 9 gives the per hectare utilization of different inputs. The total human labour required was 186 man days and 14 bullock pair days. The quantity of seeds used 1.25 kg/ha. Application of FYM was 20 tonnes and applied fertilizers in terms of nutrients, nitrogen (N), phosphorus (P) and potassium (K) were 100, 75 and 50 kg/ha, respectively.

4.7.2 Cost and returns

The average cost incurred in the production of muskmelon was ₹ 73949.33 of which expenditure on inputs was ₹ 38152.00 and on labour was ₹ 20460.00. The total variable cost was ₹ 58612.00 and total fixed cost was ₹ 15444.00.

The maximum total returns were obtained by the hybrid NS-910 (₹ 586840.00) followed by Tamanna (₹ 550290), Kundan (₹ 510660), NS-7455 (₹ 505800.00) and

NUN-1002 (₹ 453440) with B: C ratio of 7.85, 7.43, 6.88, 6.77, 6.11, respectively and it was minimum in Arka Jeet (₹ 216720) with 2.97 B:C ratio (Table 8).

4.8 Correlation studies

Correlation coefficients worked out among different growth, yield and quality parameters in muskmelon hybrids are presented in Table 9.

Vine length had highly positive significant correlation with number of leaves per plant (0.936) and number of branches per plant (0.913), significant positive relationship with total sugars (0.734) and it was negatively correlated with days to first female flowering (-0.748).

The number of branches per plant had highly significant correlation with number of leaves per plant (0.956), total sugars (0.855), number of fruit per plant (0.821) and TSS (0.811) content but it had significant negative correlation with days to first female flowering (-0.756) and seeds per fruit (-0.675).

Number of leaves per plant showed highly significant correlation with number of fruits per plant (0.842), total sugar content (0.829) and significant correlation with TSS content (0.728). Whereas, there was highly negative correlation with days to first female flowering (-0.833), seeds per fruit (-0.737) and vitamin C content (-0.741).

Significant positive correlation was noticed between days to first female flowering and vitamin C content (0.691) and it has significantly negative association with number of fruits per plant (-0.769) and total sugar content (-0.695).

Total sugar content showed significant positive association with number of fruits per plant (0.670) and significantly negative association with seeds per fruit (-0.749).

Fruit weight had highly positive significant correlation with total yield (0.986). Total yield had significantly high positive correlation with β carotene content (0.692) and negative association with cavity size (-0.863).

The character cavity size showed significant positive correlation with vitamin C content (0.778) and significant negative association with total sugars (-0.698). Total sugar content showed highly positive significant correlation with TSS (0.955) content and highly negative correlation with vitamin C content (-0.939). Vitamin C content showed only high significant of negative correlation with TSS content (-0.931).

5. DISCUSSION

Muskmelon is grown in all parts of the country. Its cultivation is limited to very narrow area and sporadic locations. Yields are less because of low yielding traditional varieties and lack of suitable hybrids. Therefore, the crop has not received much attention of researchers for its improvement. Improvement of muskmelon for growth, yield, and fruit quality traits is the need of the hour in the interest of producers and end-users. Identification of muskmelon requires knowledge on the evaluation of quantitative and qualitative traits and economics.

There is always a need for increased productivity to meet the increased demand and crunching of land resources year after year. One of the first steps in increasing productivity is introduction of hybrids, which are genetically superior, high yielding, and disease free and having other value added traits.

With this background, the present investigation was carried out to evaluate nine popular F_1 hybrids for yield, quality and their reaction to pests and diseases in muskmelon. The results obtained are discussed here under.

5.1 Growth and yield attributing characters

Yield of any crop largely depends on its genetic base of vigour and growth. Better seedling growth which normally reflects in higher yields is governed by the genetic constituent of the F_1 hybrids and environmental conditions under which the crop is raised. When different hybrids are grown under identical conditions, it is the genetic factors that express the morphological and yield differences.

In muskmelon vine length is one of the most important growth parameters. In the present study F_1 hybrid Tamanna recorded maximum (Fig-1) vine length, followed by Kundan, and it was minimum in F_1 hybrid NUN-0001. This variation in vine length may be attributed to presence of strong apical dominance. Similar results were obtained by Rahman *et al.* (2002) in snake gourd, Ahmed *et al.*, (2005) in bottle gourd and Raja *et al.* (2007) in bitter gourd.

Number of leaves per plant is another most important growth parameter. In the present study highest number of leaves was observed in F_1 hybrid Tamanna followed by Kundan and it was least in F_1 hybrid NUN-0001 (Fig-2). The number of leaves depends on the length of plant. The more is vine length, the greater will be leaf number. The more number of leaves was recorded in Tamanna because of greater vine length and similar trend was observed in other hybrids, except NUN-0001 where number of leaves per plant was comparatively less. This might be due to the inherent genetic nature of plants. Similar observations were made by Ahmed *et al.* (2004) in cucumber, Munshi and Alvarez (2005) in bottle gourd.

Similarly leaf area is an important growth parameter which was highest in F₁ hybrid Kundan followed by F₁ hybrid Tamanna and it was least in F₁ hybrid Golden Glory. The leaf area is associated with the length of plant and number of leaves. The more the vine length and the higher number of leaves, the greater will be leaf area. The higher leaf area was in Kundan and less in Golden Glory. It might be due to the genetic nature of plants. Similar results were reported by Maharana *et al.* (2005) in pumpkin.

A comparison of muskmelon hybrids indicated that they differed significantly for number of branches per vine. Kundan ranked first for number of branches per vine. NS-7455, NS-910 and Tamanna were next in order of merit and least number of branches was recorded in NUN-0001 and Golden Glory. Significant difference in the number of branches per plant may be due to variation in vine length among the hybrids. In the present study significant positive correlation was found with the number of branches per plant and vine length. It indicates that as the vine length increases number of branches were also more and also due to the genetic nature of plants under the influence of environmental factors. Similar results were obtained in water melon Gichimu *et al.* (2008).

The F₁ hybrid NS-910 (27.66 days) flowered early followed by F₁ hybrid Tamanna (27.93 days). Such earliness could be due to its higher capacity to make available the assimilates to the apex during the sensitive phase before initiation (Dielmen and Heuvelink, 1992). Standard check Arka Jeet (33.86 days) flowered late in the present study. This may be attributed purely to genetic differences between the hybrids as they were all exposed to same environmental conditions.

Wehner *et al.* (2001) reported that the sequence of flowering follows a set pattern, namely; (i) Male phase: first few nodes bear only the staminate flowers, (ii) Mixed phase: both pistillate and staminate flowers appear in few nodes in the main axis and secondary branches in cycles and (iii) Female phase: few nodes produce mostly the pistillate flowers. Most accessions produced their first female flower in less than a fortnight after producing their first male flower. Similar results were obtained in water melon Gichimu *et al.* (2008) and Dhanwate *et al.* (2011) in bitter gourd.

In the present study, first female flower had appeared on lower node in F₁ hybrid NUN-1002 (2.53) followed by Natalya (2.66), and upper node, first female flower appeared in F₁ hybrid Golden Glory (3.66). Significant variation in nodal position in different F₁ hybrids may be due to their inherent character. Similar results were reported by Vijaykumar (2007) and Dey *et al.* (2010) in bitter gourd.

The F₁ hybrid Tamanna (32.20) took lesser days for first female appearance, followed by F₁ hybrid NS-910 (32.53). Such earliness could be due to its higher capacity to make available assimilates to the apex during the sensitive phase before initiation (Dielmen and Heuvelink, 1992). Standard check Arka Jeet (35.53) flowered late in the present study. Similar

results were obtained by Gichimu *et al.* (2008) in water melon and Rakha *et al.* (2012) in *Cucurbita* spp.

Sex ratio is one of the most important parameter. In the present study it was recorded low in F₁ hybrid Kundan followed by F₁ hybrid Tamanna and it was high in F₁ hybrid NUN-1002 (Fig-3). Sex expression is influenced by environmental conditions like light, moisture, temperature, nutritional requirements etc. (Frankel and Galun, 1977; Heslop and Harrison, 1972 and Singh *et al.*, 1996) apart from the inherent genetic make up of the plants. Generally the plants produce more number of flowers especially male flowers, which may be due to inherent qualitative type of sex expression and staminate flowers are found in majority at all the time and it is possible that the proportion of staminate to pistillate flowers could be materially changed by environmental conditions (Whitaker, 1971). In the present study, the high variation in sex ratio may be due to environmental conditions also. These results are in line with Rakha *et al.* (2012) in *Cucurbita* spp, Ahmed *et al.* (2004) in cucumber.

In present study the F₁ hybrid Kundan produced highest number of fruits and followed by NS-910 while least number of fruits was recorded in Golden Glory. This could be mainly attributed to the genetic makeup of plant. These results are in conformity with the findings of Hussain and Zafar (1979) in muskmelon and Vijaykumari *et al.* (1991) in same crop.

Average fruit weight was highest in NS-910 (863.13) followed by Tamanna which had comparatively less fruits per vine thus resulting in higher accumulation of assimilates, which might be the reason for higher fruit weight, due to inverse relationship existing between fruit weight and number of fruits per vine and also variation in average fruit weight among the hybrid might be due to difference in vine length and number of branches per plant. In the present study it had significant positive relationship with the vine length and number of branches per plant. Similar results were reported by Vijayakumari *et al.* (1991) in cucumber, Kutty and Dharmatti (2004) in bitter gourd and Celine *et al.* (2010) in snake gourd.

Fruit yield per plot is an important character to be considered to select muskmelon F₁ hybrids. The highest total fruit yield was recorded in F₁ hybrid NS-910 followed by Tamanna and Kundan. This significant variation in the hybrids for fruit yield per plot might be due to variation in average fruit weight as in the present study there was a significant positive relationship with the fruit yield per plot and average fruit weight. The difference may also be due to cavity size as the cavity size increases, fruit weight decreases as per the correlation studies in the present investigation. Also which is attributed to higher number of fruits per vine. Least total fruit yield was recorded in commercial variety Arka Jeet which is mainly due to less number of fruits per vine and smaller fruits. These results confirm with the findings of Vijayakumari *et al.* (1991) in cucumber, Narayanankutty *et al.* (2006) in snake gourd, Vijaykumar (2007) in bitter gourd and Celine *et al.* (2010) in snake gourd.

5.2 Fruit characteristics

Flesh colour is an important trait among the consumer point of view. In the present study, the flesh colour varies with predominantly Orange, Pale Orange, Deep Salmon and Cream colour. The expression of colour in the fruit flesh is conditioned by the particular carotenoid type and concentrations which are influenced by genetic and environmental factors. Similar observations were made by Bokashi *et al.* (1992) in muskmelon and Fergany *et al.* (2011) in melon land races.

Higher flesh thickness is a desirable character in cucurbits. In the present investigation, genotypes differed significantly (Fig-6) with regard to flesh thickness. The highest flesh thickness was noticed in Tamanna followed by Natalya , NS-910 and NUN-1002. Least flesh thickness was observed in Golden Glory and NUN-0001. This difference in flesh thickness could be attributed to inherent characteristics of genotype. Fruit flesh thickness increased with increase in size of the fruit i.e. more thick flesh was observed in bigger sized fruits and less in small fruits. These results are in conformity with those of Nirmal *et al.* (2008) in muskmelon genotypes and Maharana *et al.* (2005) in pumpkin

Fruit cavity size is indirectly in proportional to fruit flesh thickness. In the present study fruit cavity size was highest in F₁ hybrid Arka Jeet (Fig-7) and also recorded comparatively less fruit flesh thickness. Similar observations were made by Nirmal *et al.* (2008) in 7 muskmelon genotypes and Balkaya *et al.* (2009) in pumpkin.

NUN-1002 showed significantly higher number of seeds per fruit followed by NUN-0001. The increase in seed number per fruit may be attributed to the pollinating agents which carried a good amount of pollen which led to pollination thereby, increasing seed number and thus contributed for higher seed number. On the other hand, the lower seed number may be because of fluctuating temperatures which resulted in poor fruit set and drying of ovaries and desiccation of tender fruits there by reducing the seed formation and yields as opined by (Samadia, 2002). Okonmah *et al.* (2011) in water melon, Kortse *et al.* (2012) in melon.

5.3 Quality parameters

Total soluble solids (Fig-8) ranged from 11.73 °Brix (NUN-0001) to 13.53 °Brix (NS-910). The variation in TSS constituent of fruit can be attributed to the genetic makeup of the plant. Earlier Dhiman *et al.* (1995) in muskmelon, Glala *et al.* (2002) in Egyptian melon, Nirmal *et al.* (2008) in muskmelon, Balkaya *et al.* (2009) in pumpkin reported a range of 7.2 – 10.8, 12 – 13, 8 -10 and 3-11 ° Brix, respectively. Higher value of TSS in muskmelon is a desirable character because it contribute to sweetness.

Total sugars varied significantly among different hybrids which ranged between 47.43 to 51.73 mg per 100g. The variation in total sugars constituent of fruit can be attributed to the genetic makeup of the plant and the environmental conditions. Similar reports were made by Dhiman *et al.* (1995) in muskmelon, Glala *et al.* (2002) in Egyptian melon, Nirmal *et al.* (2008) in muskmelon and Balkaya *et al.* (2009) in pumpkin. High value of

total sugars is desirable because of consumer preferences. Total sugar content was positively significant with the TSS content of the fruit as per the correlation studies in the present study.

5.4 Reaction of muskmelon hybrids to powdery mildew and fruit fly

The management of disease through host plant resistance has been a preferred choice in all the crop improvement and crop protection programmes. Utilization of resistant hybrids for cultivation is most simple, effective and environmentally safe method in the management of biotic stresses both at the pre and post harvest stages.

Out of eight F₁ hybrids and check evaluated for reaction to powdery mildew and fruit fly under field condition during 2013, the hybrid Tamanna recorded least disease (17.63 %) intensity and the highest intensity (38.70 %) was in Arka Jeet. Most hybrids were found to be moderately resistant to powdery mildew incidence throughout the growth period of the crop. Several workers documented the resistance of muskmelon varieties to powdery mildew incidence (Zatkyo, 1982).

The fruit fly (*Bactocera cucurbitae*) is most serious pest of cucurbits defying chemical control in India (Bose and Som, 1990). Any breeding programme for selection of best genotype involving resistance to pests must begin with extensive screening of varieties and hybrids. In view of this an attempt was made to screen F₁ hybrids for fruit fly incidence.

The percentage of fruit fly infestation was lowest (10.60 %) in NS-910 and highest (25.41%) in Arka Jeet. None of the F₁ hybrids were free from the attack. It was observed that F₁ hybrids were moderately resistant. Resistance to fruit fly infection in melons has also been reported by other scientists like Lall and Sinha (1974), Thakur *et al.* (1992), Tewatia and Dhankhar (1996), Thakur *et al.* (1996) and Tewatia *et al.* (1998).

5.5 Economics of cultivation

Among the inputs used the maximum quantity was noticed for labour followed by chemical fertilizers. In labour utilization pattern the maximum labour utilization was observed for harvesting followed by weeding, irrigation, fertilizer application and sowing. In India availability of labour is a major problem and therefore improved methods are adopted to reduce the labour problem. Among the cost structure labour cost (₹ 20,460.00) accounted major item of cost in the total variable cost (₹ 58,612.00) followed by cost of chemical fertilizers (₹ 10,732.00). These results are in inconformity with the study conducted by Bala *et al.* (2011) in pea and Girish (2011) in cluster bean. Among the genotypes studied the genotype NS-910, Tamanna and Kundan showed more yield and the total returns.

5.6 Correlation studies

Correlation coefficients worked out among different growth, yield and quality parameters in muskmelon are presented in Table 9.

Vine length had highly positive significant correlation with number of branches per plant (0.913), number of leaves per plant (0.936), significant correlation with total sugars (0.734) and it was negatively correlated with days to first female flowering (-0.748). The number of branches per plant had highly significant correlation with number of leaves per plant (0.956), number of fruit per plant (0.821), total sugars (0.855) and TSS (0.811) content. On other hand it had negative correlation with days to first female flowering (-0.756) and seeds per fruit (-0.675). These results are on par with the findings of Taha *et al.* (2003) in melon, Kumar *et al.* (2013) in sponge gourd and Tamil selvi *et al.* (2012) in pumpkin.

Number of leaves showed highly significant correlation with number of fruits per plant (0.842), total sugar content (0.829) and significant correlation with TSS content (0.728). Whereas, highly negative correlation with days to first flowering (-0.833), seeds per fruit (-0.737) and vitamin C content (-0.741). These results are in conformity with the results of Taha *et al.* (2003) in melon, Kumar *et al.* (2013) in sponge gourd, Tamil selvi *et al.* (2012) in pumpkin and Naroui Rad *et al.* (2010) in fluted pumpkin.

The character days to first female flowering shows significant positive correlation with vitamin C content (0.691) and it has significant negative association with number of fruits per plant (-0.769) and total sugar content (-0.695). Total sugar content shows significant positive association with number of fruits per plant (0.670) and significant negative association with seeds per fruit (-0.749). Similar results were obtained by Taha *et al.* (2003) in melon, Kumar *et al.* (2013) in sponge gourd, Tamil selvi *et al.* (2012) in pumpkin and Naroui Rad *et al.* (2010) in fluted pumpkin.

Fruit weight has highly positive significant correlation with total yield (0.986), whereas, total yield has significantly positive correlation with β -carotene content (0.692). Negative association was observed with cavity size (-0.863) and vitamin C content. These results were confirmed with the results of Tamil selvi *et al.* (2012) in pumpkin and Naroui Rad *et al.* (2010) in fluted pumpkin.

The character cavity size shows significant positive correlation with vitamin C content (0.778) and significant negative association with total sugars (-0.698). Similar results were obtained by Taha *et al.* (2003) in melon and Kumar *et al.* (2013) in sponge gourd.

Total sugar content shows highly positive significant correlation with TSS (0.955) content and highly negative correlation with vitamin C content (-0.939). Vitamin C content shows only high significant negative correlation with TSS content (-0.931). These results are in accordance with the results of Taha *et al.* (2003) in melon, Kumar *et al.* (2013) in sponge gourd and Tamil selvi *et al.* (2012) in pumpkin.

Future line of work

- The present investigation provides information about growth, yield and quality attributes of popular muskmelons under Northern zone of Karnataka to choose for cultivation. The results obtained can be further confirmed by putting them on a large scale trails.
- For further improvement of the genotype for various purpose, selection programme may be planned for simultaneous selection for yield, quality and their strong associated characters.
- Among the hybrids NS-910, Tamanna and Kundan were superior and may be recommended for cultivation, after ascertaining their consumer preferences.

6. SUMMARY

A field experiment was carried out at the Research Block, Department of Vegetable Science, College of Horticulture, Bagalkot during *rabi* 2012-13 to evaluate eight muskmelon F₁ hybrids in RCBD design with three replications. Results obtained on growth, yield, quality, pest and diseases incidences are summarized below.

6.1 Growth and yield parameters

Vine length was highest (160.20 cm) in F₁ hybrid Tamanna which was significantly higher than most of the other F₁ hybrids. Whereas NUN-0001 (74.40 cm) had the least vine length.

Number of leaves was highest in F₁ hybrid Tamanna (158.46) closely followed by Kundan (153.80). While it was NUN-0001 (70.00) which had least number of leaves. Among 8 F₁ hybrids, only 4 hybrids registered significantly higher number of leaves over standard check Arka Jeet (126.80).

Maximum leaf area was recorded in Kundan (119.10 cm²) followed by Tamanna (118.88 cm²) while, it was least in Golden Glory (44.56 cm²).

Number of branches was highest in F₁ hybrid Kundan (7.80) closely followed by NS-7455 (7.56). While it was NUN-0001 (4.23) had least number of branches. Among the hybrids tested, only 4 hybrids registered significantly maximum number of branches over standard check Arka Jeet (6.43).

NS-910 (27.66 days) took minimum number of days for first flowering followed by Tamanna (27.93 days) whereas, the check Arka Jeet (33.86 days) took maximum number of days for first flowering.

The lowest number of nodes to first flowering was observed from the hybrid NUN-1002 (2.53) followed by Natalya (2.66). The hybrid Tamanna had first flower at the higher node (3.46) and it was on par with the standard check Arka Jeet (3.40).

Tamanna (32.20 days) took minimum number of days for first female flowering followed by NS-910 (32.53 days). Whereas, the maximum number of days for first female flower was in Golden Glory (38.46 days).

The least sex ratio was observed in the hybrid Kundan (1.55) followed by Tamanna (1.97). Whereas, highest sex ratio noticed in the hybrid NUN-1002 (3.57) and two hybrids recorded significantly lower sex ratio over standard check Arka Jeet (2.89).

Number of fruits per plant was highest in F₁ hybrid Kundan (4.86) closely followed by NS-910 (4.60). While it was Golden Glory (2.66) which had least number of fruits per vine. Among 8 F₁ hybrids, only 2 hybrids registered significantly maximum number of fruits over standard check Arka Jeet (4.38).

Average fruit weight was highest (863.13 g) in F₁ hybrid NS-910 which was followed by Tamanna (809.53). Whereas, all the hybrids were significantly higher in fruit weight compared with Arka Jeet (300.80 g).

The F₁ hybrid NS-910 recorded the highest yield per plot (12.94 kg/plot) which was closely followed by the F₁ hybrid Tamanna (12.14 kg/plot). Whereas, least fruit yield was recorded in standard check Arka Jeet (4.38 kg/plot).

6.2 Fruit characteristics

The highest fruit flesh thickness (23.93 mm) was found in Tamanna followed by Natalya (22.33 mm) where as the least fruit flesh thickness (15.70 mm) was found in CMC Golden Glory. Out of 8 F₁ hybrids, only 5 hybrids registered significantly highest fruit flesh thickness over standard check Arka Jeet (18.80 mm).

The F₁ hybrid Kundan recorded the least fruit cavity size of 4.15 cm closely followed by NS-7455 (4.41 cm), whereas, the highest fruit cavity size was observed in Arka Jeet (7.17 cm). All hybrids had significantly less fruit cavity size over standard check Arka Jeet.

6.3 Quality parameters

Total sugars varied significantly among different hybrids. The highest was recorded in NS-7455 (51.73 mg/100g) and the least in Golden Glory (47.43 mg/100g).Whereas, no significant difference was observed among NS-7455, NS-910, Kundan and Natalya. They recorded significantly higher total sugar content when compared to check Arka Jeet (48.96 mg/100g).

The highest vitamin C content was found in check Arka Jeet (24.76 mg/100g) and least in NS-910 (20.13 mg/100g). There was no significant difference observed among hybrids NUN-1002 (24.63 mg/100g), NUN-0001(24.46 mg/100g), Golden Glory (24.36 mg/100g) and check Arka Jeet.

The highest β -carotene content was in NS-910 (17.86 mg/100g) followed by NS-7455 (17.66 mg/100g) and Tamanna (16.06 mg/100g). The least was recorded in Arka Jeet (11.93 mg/100g), Natalya (12.43 mg/100g) and NUN-1002 (14.60 mg/100g). All hybrids registered significantly high carotene content over standard check Arka Jeet.

The highest TSS was recorded in NS-910 (13.53 ° Brix) followed by NS-7455 (13.50 °Brix) while NUN-0001 (11.73 °Brix) recorded the least TSS. Three hybrids recorded high TSS content than check Arka Jeet (12.40 ° Brix).

6.4 Pest and disease incidence

All hybrids registered significantly less incidence of powdery mildew over standard check Arka Jeet. The hybrid Tamanna recorded least (17.63 %) intensity and highest (38.70 %) was in Arka Jeet.

The least (10.60 %) infestation of fruit fly was recorded in NS-910 and highest (25.41%) in Arka Jeet. Out of 8 hybrids, none of them showed less than 10 per cent infestation, hence none were resistant to fruit fly infection. All were moderately resistant.

6.5 Economics

The maximum total returns were obtained by the hybrid NS-910 (₹ 586840.00) followed by Tamanna (₹ 550290), Kundan (₹ 510660), NS-7455 (₹ 505800.00) and NUN-1002 (₹ 453440) with B: C ratio of 7.85, 7.43, 6.88, 6.77 and 6.11, respectively and it was minimum in Arka Jeet (₹ 216720) with 2.97 B:C ratio.

6.6 Correlation studies

Vine length had highly positive significant correlation with number of leaves per plant (0.936), number of branches per plant (0.913), significant with total sugars (0.734). It was negatively correlated with days to first female flowering (-0.748), cavity size (-0.406) and vitamin C content (-0.662). The number of branches per plant had highly significant relationship with number of leaves per plant (0.956), total sugars (0.855), number of fruit per plant (0.821) and TSS (0.811) content. On other hand it had negative correlation with days to first female flowering (-0.756) and seeds per fruit (-0.675).

A positive significant relationship was observed between days to first female flowering and vitamin C content (0.691), and it has significantly negative association with number of fruits per plant (-0.769) and total sugar content (-0.695). Total sugars (0.670) content had shown significant positive association with number of fruits per plant and significantly negative association with seeds per fruit (-0.749).

Fruit weight had significantly positive relationship with yield (0.986). Yield was significant positive relationship with β -carotene content and negative relationship with cavity size (-0.863).

The character cavity size shows significant positive correlation with vitamin C content (0.778) and significant negative association with total sugars (-0.698).

Total sugar content shows highly positive significant correlation with TSS (0.955) content and highly negative correlation with vitamin C content (-0.939). Whereas, vitamin C content was high significant negative correlation with TSS (0.422) content.

Conclusion

Muskmelon is one of the important member of cucurbits group, consumers preferring for this because of delicacy, sweetness, flavour, aroma and rich nutrient composition. Though muskmelon is more demanding vegetable, productivity is less hence, the study was under taken to evaluate superior hybrids from private and ruling variety of public sector. The results show that all hybrids had recorded maximum yield, among them NS-910, Tamanna and Kundan were observed superior with respect to yield and quality. Hence they are economically highly profitable as compared to local ruling variety Arka Jeet.

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