MOLECULAR, MORPHOLOGICAL AND CHEMICAL CHARACTERIZATION OF TOMATO (Solanum lycopersicum L.) GENOTYPES AND INFLUENCE OF DIFFERENT ORGANIC MANURES ON SEED YIELD, QUALITY IN TOMATO Cv. DMT-2

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IN
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1. INTRODUCTION

Tomato (*Solanum lycopersicum* Mill.) belongs to family solanaceae having chromosome number (2n=24). It is a self pollinated crop and Peru-Equador region is considered to be the centre of origin. Tomato was introduced by the Portuguese to India. Tomato is cultivated in tropics and subtropics of the world and it is being cultivated in kitchen gardens, commercial fields under green house and polyhouse conditions and soil less culture or hydroponic systems. Tomato is one of the popular vegetables of great commercial value and is used in various forms of salad, soup, ketchup, sauce, chutney, pickles, powder, paste, juice, etc whole canned fruits and also forms an important ingredient in the cocktails known as “Bloody Mary”. It is believed that consumption of one tomato per day enhances the health status of individuals and considered to be important in diet as it is quite high in nutritive value. It contains higher quantity of total sugar (2.5- 4.5%), starch (0.6- 1.2 %) and minerals like potassium, calcium, sodium, magnesium, phosphorus, boron, manganese, zinc, copper, iron, etc. Apart from these, it also contains vitamins A,C,K & B6 organic acids such as citric, malic and acetic acids which are known as health acids in fresh tomato fruit. The flavour of tomato fruits is controlled by various volatile compounds like ethanol and acetaldehyde. Tomato juice promotes gastric secretion, acts as a blood purifier and works as intestinal antiseptic.

Its cultivation has spread throughout the world occupying an area of 4.55 million ha with the production of 125.02 million ton. In India, it occupies an area of 0.54 million ha with a production of 7.60 million ton with an average yield of 14.074 t per ha. Karnataka is one of the important tomato growing states covering an area of 0.4 lakh ha with a production of 1.14 million ton and an average yield of 2.85 t per ha (Anon., 2009).

In India, Pusa Ruby, Sinox, Sanmarsano, Roma, Hybrid Karnataka, Delicious and Manipal are popular genotypes of tomato. The University of Agricultural Sciences, Dharwad has released a variety DMT-2 which is high yielding, non staking and bacterial wilt resistant. It bears medium size fruits and is now gaining more popularity among the vegetable growers.

Tomatoes and tomato sauce contain lycopene, which is a bright red carotene and carotenoid pigment. Lycopene has been proven to inhibit the growth of a number of cancer types including brain gliomas and prostate cancer. Lycopene works by stimulating the development of immune cells and helping them to attack cancer cells. Eating tomato sauce at least twice a week has been shown to increase survival rates in men with prostate cancer. In addition to its anticancer properties, lycopene is also one of the most powerful natural antioxidants. Along with neutralizing free radicals, it can help improve your skin’s ability to protect against harmful UV rays and might be protective against neurodegenerative diseases.

Every year the area under tomato in Karnataka is increasing but the farmers are facing the shortage of quality seeds. The main reason for the scarcity of quality seeds of tomato may be accounted to lack of seed production technology such as cultural and seed production practices, lower seed yield, higher cost of seed production etc. Among various cultivation practices, judicious use of plant nutrition enhances seed yield and quality in most of the crops.

The present farming totally depends on use of chemical fertilizers, pesticides and growth regulators for enhancing crop productivity. Gradually culminated in a situation where in need to reconsider the alternative to chemical agriculture as gradually developed in the western world. It is a well documented fact that increased dependence on agro-chemicals including fertilizers has led to several ill effects on the environment.

Organic agriculture cannot be adopted uniformly under all farming situations. The technology has a role to play in the cultivation of high value crops, fruits, vegetables, spices and condiments, medicinal and aromatic plants. The organically cultivated food crops have a vast untapped export potential growing at 10-15 per cent per year. The sustainable agricultural practice can effectively prevent the entry of pesticides and toxicants in the food chain and prevent soil and water pollution vis-à-vis health hazards. If adopted with a blend of ecologically safe modern technology organic agriculture, though not in its orthodox version, has the potential to be accepted by the farmers.
Organic farming is a production system which avoids or largely excludes the use of synthetically produced fertilizers, pesticides, growth regulators and livestock feed additives. To the maximum extent, possible organic farming system relay upon crop rotations, crop residues, animal manures, legumes, green manures, off farm organic wastes, mineral bearing rocks and biofertilizers to maintain soil productivity, tilth and to supply plant nutrients and biological means to control insects, weeds and pests.

Organic farming is both a philosophy and a system of agriculture. The objects of environments, social and economic sustainability lie at the heart of organic farming and are among the major factors determining the acceptability or otherwise of specific production practices.

Generally, solanaceous vegetables require large quantity of major nutrients like nitrogen, phosphorus and potassium, in addition to secondary nutrients such as calcium and sulphur for better growth, fruit and seed yield. The cost of inorganic fertilizers has been enormously increasing to an extent that they are out of reach of the small and marginal farmers. It has become impractical to apply such costly inputs for a crop of marginal returns. The use of organic manures in such situation is, therefore, a practically paying proposal. They are known to improve growth, yield as well as productivity of crops.

Exchange of seeds is essential for plant breeders to improve genetic variability of available germplasm for recombination and selection of desired traits. Characterization and identification of plant genotypes are thus, fundamental to the development, release and popularization of the crop genotypes. Seed is the ‘custodian’ of genetic improvements in crop species that take place from time through research endeavours in plant breeding. For farmers to realize the full benefits of such improvements, availability of good quality seed is a prerequisite in crop production. In this context, varietal description for identification of crop genotypes has attained a critical importance in national and international seed programmes and there is a considerable need for the development of reliable methods and identifiable characters for identification purpose.

The characters for which a variety is distinct from others could be morphological, chemical and biochemical or physiological in nature which aids in varietal identification. The varietal purity is usually tested by heritable characters of seeds, seedlings or growing plants in a field. However, the GOT (grow-out test) is a time consuming process and sometimes requires a complex set-up. Thus, there is a need to develop rapid techniques which help in identifying and testing the genetic purity at seed and seedling level.

Numerous studies have revealed wide variability existing among crop genotypes in grain/seed morphology. However, it is not always feasible to employ variability for characterization of all crop genotypes and the alternative techniques available are reactions of seeds and seedlings to different chemicals. These tests are most widely used due to their rapidity and reproducibility under any given conditions. Individually, these characters and tests have limited application, but when used in conjunction with each other they could offer considerable promises for development of seed keys for identification purpose. There after varietal identification could be made on the basis of seed keys and used in varietal purity determination.

With this background, the present investigation was carried out with the following objectives.

1. To study the effect of organic manures on seed yield and seed quality in tomato Cv.DMT-2
2. Characterization of tomato genotypes through various morphological descriptors, chemical tests and molecular marker in tomato genotypes.
2. REVIEW OF LITERATURE

In this chapter all the available and relevant literature pertaining to the effect of “Effect of organic manures on growth, seed yield and quality in tomato” has been reviewed. However, literature on the organic nutrients in tomato is lacking. So the combined effect of organics (farm yard manure, vermicompost) and on tomato as well as on few of the related crops have been reviewed and presented.

The development of new and improved plant varieties or hybrids is a continuous process. It is of critical importance for sustained increase in agricultural productivity. Under the New Seed Policy Act, 2001, all the new varieties have to be registered based on the criteria of novelty, distinctness, uniformity and stability (DUS).

Hence, there is a need to develop and identify the gene markers of the variety/hybrid and also to standardize the laboratory based techniques for genetic purity testing in support of the grow-out test. The grow-out test is tedious, laborious and time consuming and also the marketing of seeds is hindered due to delay in GOT results. While the differential response of seeds or seedlings to various chemical solutions and bio-chemical test (PCR based markers) can be used as a tool to identify the hybrids/varieties, which is less time consuming, simple and reproducible.

The literature on identification of crops through morphological characteristics, response of seeds and seedlings to various chemicals and PCR based markers (RAPD) has been reviewed here.

2.1 Effect of organic manures on seed yield and quality

2.1.1 Effect of FYM on growth, yield and seed quality parameters

Sharma and Mahendra (1963) stated that additional application of 27 kg nitrogen and 27 kg phosphorus in addition to a basal dose of FYM @ 10 cart loads per acre, recorded significantly highest fruit yield of tomato as compared to the other treatments in sandy loam soil at IARI, New Delhi.

Paulraj et al. (1982) reported that application of 150:100:50 NPK kg/ha along with recommended dose of FYM @ 25 ton/ha registered the highest fruit yield of tomato as compared to the control, in red sandy loam soil of madurai.

Damke et al. (1988) observed enhanced plant height of chilli with application of FYM @ 9 t per ha along with 50 kg each of N, P$_2$O$_5$ and K$_2$O. Similarly, Surlekov and Rankov (1989) reported greater plant height, number of branches and number of leaves per plant in chilli with the application of farmyard manure @ 20 ton per ha along with 100:80:100 kg N, P$_2$O$_5$ and K$_2$O per ha.

Natarajan (1990) noticed higher plant height and number of branches per plant in chilli when FYM was applied @ 25 t per ha as a basal dose along with 75:33:35 kg NPK per ha. According to Mallanagouda et al. (1995) the application of recommended dose of NPK (100:80:80 kg/ha) + FYM (10 ton/ha) improved the growth parameters in chilli.

Lacatus et al. (1994) studied the influence of organic and mineral fertilizers on tomato quality for processing revealed that the best quality for processing was obtained with N, P and K rates of 300, 150 and 75 kg/ha respectively, along with 20 ton FYM/ha.

Thamizh and Nanjam (1998) stated the combined application of *Azospirillum*, phosphobacteria and VAM with 75 per cent of recommended NPK (90:90:90 kg/ha) recorded higher yield (14.96 ton/ha) which was 21 per cent higher than uninoculated control (11.93 ton/ha) in potato.

2.1.2 Effect of Vermicompost on growth, yield and seed quality parameters

Bano and Kale (1987) reported that application of vermicompost along with chemical fertilizers recorded higher seed yield of brinjal.

Savalagi and Savalagi (1991) found increased germination percentage; shoot length and dry matter of hybrid sorghum (CSH-5) upon seed treatment with vermicompost.
Integrated nutrient management on commercial vegetables studied by Patil (1995) revealed that the combination of RDF (100:75:100 NPK kg/ha) + 50 per cent recommended dose of vermicompost (2.5 ton/ha) recorded significantly higher number of tomato fruits per plant and average fruit weight over absolute control, RDF, FYM and vermicompost alone but was on par with combined application of organics and inorganic fertilizers.

Jasvir Singh et al. (1997) registered higher fruit yield per plant in chilli with the application of vermicompost @ 10 ton per ha, whereas Patil (1995) observed that inclusion of vermicompost along with 100 per cent RDF + FYM resulted in additional dry chilli yield of 1.68 q per ha.

Sendur et al. (1998) summarized that application of organic manures (FYM, vermicompost, neem cake) combined with recommended dose of inorganic fertilizers showed superior performance in fruit yield of tomato.

In an experiment conducted by Renuka and Ravishankar (2001), the application of biogas slurry +FYM, vermicompost + FYM, vermicompost alone have recorded maximum fruit size, more number of fruits per plant, while inorganic fertilizers (NPK) recorded the minimum fruit size. It is inferred that tomato crop would respond well to the application of organic manures either in combination with FYM or alone. Further, organic manures application helps to maintain good soil health.

2.1.3 Combination effect of FYM+ Vermicompost on growth, yield and seed quality parameters

The reason for increased mean fruit weight and fruit yield by the application of NPK with FYM and vermicompost was attributed to solubilization effect of plant nutrients by the addition of FYM and vermicompost leading to increased uptake of NPK as reported by Subbaiah et al. (1985) and similar results were also obtained by Nair and Peter (1990) in chilli.

Sendur et al. (1998) summarized that application of organic manures (FYM, vermicompost, neem cake) combined with recommended dose of inorganic fertilizers showed superior performance in respect of growth and fruit yield of tomato.

2.1.4 Effect of NPK on growth, yield and seed quality parameters

Sutapradia (1979) examined the effect of combination of manure and NPK (complex fertilizer, 15:15:15) on the growth of tomatoes. The study revealed that combination of manure at 30 ton/ha and NPK at 100 kg/ha gave highest yield in tomatoes.

George et al (1980) reported that in tomato cv. Money maker, the combination of higher nitrogen and phosphorus increased the seed germination and seedling emergence rate.

Subbaiah et al. (1985) reported that to improve the tomato fruit yield through integrated nutrient management, the best combination was 100:100:100 NPK kg/ha with 30 tonnes of FYM per hectare. The yield recorded in the above treatment was 65 ton/ha under low available soil nitrogen and phosphorous and high in available potassium at TNAU, Coimbatore.

Amrithalingam (1988) observed that soil inoculation of Azospirillum along with 50 per cent of recommended dose of nitrogen increased the seedling length and vigour index in chilli.

Bagal et al. (1989) noticed the highest acidity, TSS and lycopene content in tomato due to combined application of 200:100:100 kg NPK/ha along with recommended dose of FYM (20 ton/ha) over other treatments of Rahuri soil (Maharashtra).

Dharmatti et al. (1989) reported that significant increase in fruit weight, pericarp thickness, fresh weight and dry weight of tomato cv. Megha (L-15) due to the application of 120:100:60 kg NPK/ha along with recommended dose of FYM compared to other NPK rates.
Kropisz (1992) reported that application of different sources of composts and FYM (@ 25 ton/ha) in three year field trails with cabbage, onion and carrot. The combination of FYM + NPK registered the highest yield of all the three crops as compared to the application of either FYM or inorganic fertilizers individually.

Oikeh and Asiegbu (1993) assessed four organic manures and NPK fertilizers, under field conditions for their comparative effects on tomato yield. Fruit yield (47 ton/ha) was the highest with poultry manure applied @ 10 ton/ha over application of other organic manures and NPK fertilizers alone.

The use of various soil conditioners (3 t lime/ha or 20 t organic manures/ha) in the green house cultivation of tomato cv. Ratna increased the fruit yields compared to control. Sub-plots were supplied with inorganic NPK fertilizers @ 0, 0.5, 1.0 or 1.5 ton/ha, The highest yield and quality were obtained from treatment receiving organic fertilizer together with 1.5 t NPK/ha (Sjamsudin et al., 1994).

According to Mallanagouda et al. (1995), the application of recommended dose of NPK (100:80:80 kg/ha) + FYM (10 ton/ha) improved the yield (2099 kg/ha) and yield components of chilli.

Gapsa et al. (1995) reported that due to application of 300:150:200 kg NPK per ha, the seed quality parameters such as test weight, germination percentage and seedling dry weight were more with less electrical conductivity seed leachate in chilli.

Baskar and Sarvanan (1998) reported that among the coir pit containing media, the medium containing 25 per cent coir pit + 75 per cent soil + 100 per cent RDF registered highest titrattable acidity (0.759% citrate), ascorbic acid (22.7 mg/100 g), total soluble solids (5.43%) and total sugars (4.55 g/100 g) in tomato fruits as compared to 100 per cent soil + recommended dose of fertilizers (150:100:50 kg NPK/ha) alone.

Sendur et al. (1998) observed superior performance with respect to growth and fruit yield of tomato due to application of organic manures in combination with recommended dose of inorganic fertilizers over their individual application.

Shashidhara (2000) noticed that Azospirillum + phosphobacteria recorded higher 1000-seed weight (5.93 g) which was significantly superior over 50 per cent RDF (5.40 g) in chilli.

Prabhu et al (2003) reported that increased N and P rates increased the root length when N: P at 200:100 kg per ha was applied in brinjal hybrid COBH-1.

Wange and Kale (2004) reported significant improvement in vegetative characters such as plant height, number of leaves per plant in brinjal when compared to the recommended rate of N-fertilizer, due to inoculation with mixture of Azotobacter + Azospirillum plus application of 75 kg N per ha.

Suthar et al (2005) reported the highest values for seed vigour index and standard germination percentage under 10th June planting and N: P: K: Zn at the rate of 125:62.5:62.5:25 kg per ha, respectively than other treatments in brinjal cv. BR-112.

2.2 Morphological characters

2.2.1 Seedling morphology

Venkat Redcly (1991) reported that soybean shoot length, root length and seedling length were used as criteria for distinguishing genotypes under laboratory condition.

2.1.2 Plant morphology

Koszykowski and Burgoon (1983) tabulated 64 soybean cultivars for plant characters and classified based on the leaflet shape, days taken for flowering, flower colour, plant height, growth habit and maturity days.

Agrawal (1984) classified soybean varieties based on spreading type, presence of pubescence on stem, leaf shape and size, flower colour, pod colour at maturity and days taken for maturity. All these characters were exhibited considerable differences between the varieties.
Tunwar and Singh (1985) recorded salient features of 31 improved soybean varieties based on seed and plant morphological characteristics.

Chakraborty and Agarwal (1989b) developed seed keys for identification of 16 blackgram genotypes using seedling characters like pigmentation (strong, moderate, weak), stemhairiness (glabrous, pubescent), leaflet shape (lanceolate, obovate), hypocotyl and radiclelength.

Agarwal and Pawar (1990) classified 13 soybean genotypes into three groups on the basis of hypocotyls (length: long, medium, short; two groups based on seedling pigmentation: dark, purple and green; and two groups based on seedling pubescence: intense and sparse).

Ravikumar (1999) studied morphological characters of soybean seedlings and reported that root length, shoot length, seedling length is helpful for distinguishing one variety from the other.

Upadhyaya et al. (2002) evaluated 1956 chickpea accessions for flower colour (white, light flower), plant colour, seed colour (orange, yellow orange) and other characteristics.

Yadav and Srivasthava (2002) characterized chickpea varieties based on seed colour (brown, light brown, dark brown, reddish brown, salmon white, green), seed size (bold, medium, small), stem pigmentation (strong, medium, absent), flower colour (white, deep pink, pink, light pink), foliage colour (dark green, green, light green), plant height (tall, medium, dwarf), podding habit (single, double), pod number per plant (low, medium, high), number of locules per pod (one, tow, three) and duration (early, medium and late).

Sankarapandian (2002) reported that four cowpea varieties were grouped based on pod shape, seed colour and leaf shape.

Rajendra Prasad et al. (2003) characterized the 10 sunflower varieties, hybrids and their parental lines based on the leaf petiole pigmentation (absent, present), stem pigmentation (weak, medium, dense), number of leaves per plant (low, medium, high), time to 50 per cent flowering (early, medium, late) and their seed characteristics.

Murlimohan Reddy et al. (2004) characterized the castor genotypes based on the seed colour (white, maroon, brown, dark chocolate, black), 100 seed weight (low, medium, high), capsule dehiscence (non dehiscent, partially dehiscent, dehiscent), number of nodes on main stem (low, medium, high, very high), leaf shape, leaf colour, leaf length (small, medium and large) and other morphological characteristics.

Tarasatyavathi et al. (2004) characterised that 75 released soybean varieties based on leaf shape (lanceolate, pointed ovate, rounded ovate, triangular), leaf colour intensity (light, medium, dark), flower colour (white, violet), pod pubescence (absent, present), plant height (short, medium, tall), days to flowering (early, medium and late) and days to maturity (early, medium, late).

Anon. (2005) reported that, in Jabalpur, 11 niger varieties were characterized based on leaf colour (light green, green), days to 50 per cent flowering (medium early) flower colour (yellow, orange), days to maturity (early, medium, late), plant height (tall, medium) and seed colour (light black, dark black, golden black, black, brown)

Kumar et al. (2005) reported that 27 jute varieties were grouped based on leaf shape (ovate, ovate-lanceolate, elliptical, palmate), pod dehiscence (absent, present), time of 50 per cent flowering (early, medium, late), plant height (short, medium, tall), maturity days (early, medium, late), seed size on 1000 seeds weight basis (small, medium, large) and seed color (blue, steed grey, chocolate brown, black).

Chandrashekhar (2005) indicated that hypocotyl colour expressed in different genotypes were as purple, light green, light purple and pale green

Muhammad Arshad et al. (2006) thirty-three soybean genotypes were evaluated for days to flowering, days to maturity, pod length, number of branches, number of unfilled, filled pods and total pods, 100 seed weight and seed yield (kg/ha).
Muthiah (2006) published important morphological characters for the varietal identification of green gram viz plant growth habit, leaf shape, leaf pubescence, petiole colour, stem colour, mature pod colour, modulation.

Avasthi and Rao (2007) observed genetic variability for the characteristics of 21 cross combinations of linseed. They studied characters viz, days to 50% flowering, days to maturity, plant height, number of primary branches per plant, number of secondary branches per plant, number of seeds per capsule, number of seeds per plant, 100 seed weight and seed yield per plant. They noticed that maximum genetic variability was for number of seeds/plant.

Purnima et al. (2008) categorised three induced mutants of soybean varieties viz, JS-93-05, JS-335 and NAC-37. They studied the quantitative characters like, days to 50% flowering, days to maturity, plant height, number of primary branches, number of pods per plant, no. of seeds per pods, 100 seed weight and yield per plant.

Manjaya and Bapat (2008) grouped 55 soybean genotypes by using quantitative characters viz, days to 50% flowering, days to maturity, plant height, number of branches per plant, number of pods per plant, number of seeds per plant, 100 seed weight, yield per plant.

Cupic et al. (2009) analysed European pea (Pisum sativum L.) germplasm, to determine differences between P. sativum var. arvense and P. sativum ssp. sativum groups, and to estimate genetic variability among and within 18 P. sativum accessions. Sixteen morphological traits (shape of seed, colour of hilum, shape of grain starch, unwrinkled seed and simple starch grain, colour of testa, colour of cotyledons, plant height, colour of foliage, anthocyanin, type of node, stipule length, colour of flower,

2.3 Chemical tests

Studies on characterization of cultivars based on response of seed and seedling to various chemicals viz. phenol, modified phenol, peroxidase, sodium hydroxide, potassium hydroxide, GA₃ and 2, 4-D etc., offer wide variability and can be used in characterization of genotypes.

2.3.1 Phenol and modified phenol

It is one of the rapid chemical test and technique for varietal identification, which is simple to carry out. Phenol colour reaction is highly specific and monogenically controlled response which is localized in seed coat. The reaction involves melanin formation by oxidizing phenol via anthoquinones and hydroxyquinones (Joshi and Banerjee, 1970).

Chakrabarty and Agrawal (1989a) grouped 16 black gram varieties based on seed coat colour reaction at different concentrations of NaOH and KOH and color groups were, red, brown, greenish yellow, light green, green yellow and deep yellow. Also developed seed keys for identification of 16 black gram varieties based on response to phenol colour reaction (green or greenish yellow and brown or light red).

The reaction is controlled by the enzyme ‘trysosinase’ in seed coat and is under genetic control. The reactions is constant for a variety. Hence this can serve as a basis for grouping of varieties and Piper (1920) was the first to elaborate the general technique of phenol testing.

Walls (1965) reported that soaking wheat seeds in distilled water for 10-16 hours, followed by placing them over a filter paper wetted with 0.2 per cent phenol solution gave satisfactory results. Further it was concluded that phenol, in wheat was a chemical reaction involving flavonoids (Elekes, 1930).

The sodium hydroxide chemical test is simple, quick and cheap. Based on the secondary metabolites present in the seed coat, the seed coat produces distinct colour pattern (Vanderburg and Vanzwod, 1991).

Halim et al. (1994) reported that treating pearl millet hybrids and its parents with one per cent aqueous phenol solution could be useful for distinguishing hybrids from their parents.

Ezhilkumar (1999) and Ponnusamy et al. (2003) reported the phenol test could not distinguish different genotypes of cotton.
Kirankumar Reddy (2004) reported that one per cent phenol solution developed black colour in all the cotton genotypes rendering them undistinguishable.

Banerjee and Chandra (1977) grouped wheat cultivars by modifying the phenol test by adding Cu and Na ion for 6 hours.

Gupta and Agrawal (1988) suggested that treating rice seeds with 0.5 per cent ferrous sulphate solution for 18 hours in addition to phenol solution could be used as primary diagnostic character for distinguishing rice varieties. Whereas, Jaiswal and Agrawal (1995) reported that treating rice seeds with one per cent copper sulphate, one per cent ferrous sulphate and one per cent of sodium hydroxide could be used for subgrouping of rice varieties which showed no response to phenol test.

Ponnusamy et al. (2003) reported that modified phenol test could not help to distinguish different genotypes of cotton.

2.3.2 Sodium hydroxide test

Chakrabarty and Agrawal (1990) reported that sodium hydroxide (0.5% and 0.1%) could be used to group the seeds of black gram into five groups as red, brown, greenish yellow, light green and green.

The sodium hydroxide chemical test is simple, quick and cheap. Based on the secondary metabolites present in the seed coat, the seed coat produces distinct colour pattern (Vanderburg and Vanzood, 1991).

At Akola, 10 jute genotypes were classified as black, dark brown, brown and no change in colour when soaked in five per cent sodium hydroxide for six hours (Anon., 2002).

Based on the 22 cotton genotypes response to five per cent sodium hydroxide test, the genotypes were classified as dusky red, dark red, red, reddish yellow, yellow, alive yellow, yellowish red and strong brown types (Ponnuswamy et al., 2003).

At Jabalpur, 18 sesame varieties were categorized into three groups using sodium hydroxide at five per cent as reddish brown, dark brown light brown. (Anon., 2005).

Biradarpatil et al. (2006) grouped 20 genotypes of safflower as light brown, brown and dark brown based on their response to two per cent NaOH.

2.3.2 Potassium hydroxide test

Jawaharlal (1994) reported that, cotton genotypes can be classified based on the colour development in five per cent potassium hydroxide as dark red, red, yellowish brown and brown.

Twelve varieties of pigeon pea could be distinguished based on the colour development in KOH test. Four varieties showed no response, four varieties showed dark tan, while rest were brown in colour (Anon., 1998).

Sambasiva Rao et al. (2002) categorized 37 groundnut genotypes into light brown and dark brown based on seed coat response to KOH solution.

Biradarpatil et al. (2006) grouped 22 safflower genotypes as light brown and brown by using five per cent KOH solution.

2.3.4 Seedling growth response to GA3

Kurdikeri and Kurdikeri (1988) reported that gibberellic acid soaked seeds produce more vigorous seedlings. Further, cotton genotypes showed varied response to gibberellic acid treatment and the cultivars were grouped as high and low response types.

Based on the response of seedlings to GA3 and DDT the mungbean genotypes were categorized into different groups (Agrawal and Sharma, 1989).

Agarwal and Pawar (1990) categorized soybean genotypes into long, medium and short types based on the seedling response to 15ppm GA3 and developed seed key for identification of soybean varieties.
Chakrabarthy and Agrawal (1990) classified 16 black gram varieties based on seedling response to growth hormones and herbicides.

Lee et al. (1992) grouped 15 Korean soybean cultivars based on seedling response to GA3. The seedling length varied with genotypes.

Jawaharlal (1994) studied the effect of gibberellic acid at 100 ppm in cotton and grouped the genotypes based on hypocotyls length as long, medium and short.

Sambasivaraao et al. (2002) classified the 37 groundnut genotypes into three groups as low, moderate and high response in coleoptile length to GA3.

Ponnuswamy et al. (2003) grouped 22 genotype of cotton into high, medium and low response groups based on the seedling response to 100 ppm gibberellic acid.

Kirankumar Reddy (2004) classified cotton genotypes as very high, high, medium and low response varieties based on their response to GA3.

At Jorhat 20 sesamum varieties were grouped based on GA3 growth response test as low, medium and high response (Anon., 2004).

Biradarpatil et al. (2006) classified 20 safflower genotypes based on response to 2,4-D at 5 ppm into three groups namely highly susceptible, susceptible and less susceptible.

2.3.6 Peroxidase enzyme activity test

Buttery and Buzzelli (1968) studied peroxidase enzyme activity of seed coat and classified as reddish brown colour indicates high peroxidase activity while colorlessness indicating low peroxidase activity.

Buzzell and Buttery (1959) analysed for inheritance of peroxidase activity in soybean seed coats. The dominant gene produce high activity and its recessive allele give low activity.

Payne (1976) distinguished the soybean cultivars based on unit peroxidase test. The results of the test are reproducible in the laboratory and indicated by a reddish brown colour (high peroxidase activity) and 13 negative reactions (low peroxidase activity).

Wagner and McDonald (1981) reported varietal differences in 36 soybean cultivars using rapid laboratory tests, based on seed coat peroxidase activity and electrophoresis of β-amalaysase and urease.

Koszykowski and Burgoon (1983) studied soybean cultivar characteristics based on seed coat peroxidase activity and electrophoresis and their results were tabulated for 6 soybean cultivars.

Development of new varietal identification methods with rapid laboratory tests which show potential for distinguish the cultivars are described in detail, including soybean seed coat peroxidase test (McDonald, 1985).

Payne (1986) reported that 44 laboratories were involved in cultivar testing with seed morphology, rapid chemical tests and procedures for soybean and cowpea.
The importance of cultivar identification is discussed and quick cultivar purity testing procedure was given for peroxidase test for differentiating soybean cultivars (Anon., 1988).

Chakrabarty and Agrawal (1989) grouped 16 black gram varieties based on colour reaction of seed coat peroxidase activity (low, moderate and high peroxidase activity).

Agrawal and Anilpawar (1990) Identified 13 soybean varieties on the basis of peroxidase activity of the seed coat.

2.4 RAPD marker

Variation in morphological traits, geographical distribution, cytogenesis relationships, breeding system, cross compatibility and biochemical markers though used extensively to elucidate the relation among the species arc restricted their resolving power mainly because of small number of variables available and some of them are developmental specific. In contrast, molecular approaches provide genetically interpretable variability with extensive genomic coverage and are becoming immensely important in studies on population biology and systematic. Among the PCR based marker techniques, randomly amplified polymorphic DNA (RAPD) technology is widely used, as it is easy and simple. A brief review of literature has been presented regarding RAPD marker technology here under.

RAPD is a PCR based technique developed by Welsch and McClelland (1991). By this method it is possible to detect nucleotide sequence polymorphism in DNA by using a single primer of arbitrary nucleotide sequence. In this reaction a single primer anneals at two different sites on complementary strands of genomic DNA. If these priming sites are within an amplifiable range of each other, a discrete DNA product is formed through thermocyclical amplification. Similarly each one of the primers can amplify different loci of the genome making the assay useful for identifying genomic DNA polymorphism between individuals (Tingey et al., 1993). Arbitrary primers used in RAPD will be usually of 10 base long with a GC content of 50-80 per cent and do not have palindrome sequences. The number of DNA fragments that are to be amplified depends on the length of time and genomic DNA used (Williams et al., 1990). GC content of primers influence the time required for annealing. RAPD patterns obtained from primers with high GC content (70-80%) are affected by short annealing time. The primers with 50-60% GC content showed reduced intensity in banding pattern even with 30 seconds of annealing time (Kang et al., 1998). Hence for reproducible DNA amplification, it is important to optimize the reaction conditions. RAPD markers are dominant in nature and the protocol is also relatively quick and easy to perform (Williams et al., 1993), hence are used to identify markers related to agronomically important traits (Sandhu et al., 2003).

Using RAPD analysis, Lawson (1994) studied a collection of cultivars, breeding lines, wild and distantly related species for assessing the genetic diversity. A considerable amount of polymorphism was revealed. Overall, 33 per cent. Dissimilarity was detected with arm average of 27 per cent among the hybrids arid breeding lines.

Doldi et al. (1997) used RAPD technique to evaluate genetic diversity among 18 soybean genotypes selected for a breeding programme to increase the protein content of varieties adopted for central European growing conditions. Out of 33 random primers used in RAPD locations, only 12 showed polymorphism useful for characterization of these genotypes. The resulting dendograms, from similarity measures and cluster analysis were compared with each other and with the available pedigree information as a control. The dendrogram derived from RAPD data showed some divergence from the pedigree information available for the lines.

An RAPD analysis was carried out by Egashira et al. (2000), to investigate the genetic diversity of the ‘peruvianum-complex’ (PC) species of highly polymorphic wild tomato relatives and the genetic relationship between the PC and the ‘esculentum-complex’ (EC) species including the cultivated. A total of 435 RAPDs were obtained from 50 accessions of all the nine Lycopersicon species using only 10 random primers. Average genetic distances among the L. peruvianum accessions and among L. chilense accessions were larger than in any species of the ‘esculentum-complex’ (EC). In addition, the cluster analysis conducted by using the neighbor joining method showed that all the tested accessions were clearly divided into at least four main clusters consisting of the PC, the self-compatible EC, L. pennelli and L. hirsutum.
This study demonstrated that the PC species had the largest genetic diversity in the *Lycopersicon*, and the genetic background of the PC was clearly different from those of the self-compatible EC species including the cultivated tomato.

Archak et al. (2002) analysed genetic diversity of 27 tomato cultivars grown in India with RAPD markers, generated by 42 random primers. The overall high levels of pairwise similarity and low levels of marker diversity implied the existence of limited genetic variation in the investigated materials. Interestingly, old introductions and locally developed cultivars of the 1970s exhibited significantly greater genetic variation than the ones released during the 1990s. Reduction in the genetic diversity among modern tomato cultivars may be attributed to the recent trend towards breeding for similar plant and fruit characteristics.

RAPD genome analysis of 53 species and cultivars of the genus *Lycopersicon* (Tourn.) Mill. revealed their high genetic polymorphism (Tourn.) Mill., based on which their phylogenetic relationships were inferred(Kochieva et al., 2002). In total, 248 polymorphic DNA fragments were amplified. Intraspecific polymorphism was maximum (79%) in *L. peruvianum* and minimum (9%) in *L. parviflorum*. In general, genome divergence among cross pollinating tomato species was substantially higher than in self-pollinating species.

Gulhanercan et al. (2004) obtained the bands through RAPD technique for all sesamum populations and 78 per cent of which were polymorphic. According to ANOVA and shannon’s index that were performed separately for each region, the highest value of genetic variation was observed among North West region populations and lowest in the South East region populations. Nei and Li’s similarity index was calculated and polygenetic true was established using the neighbour joining algorithm. This phenotypic analysis grouped 35 of 38 accessions in six groups leaving three highly diverse accessions outside. These results indicate that RAPD technique is useful for sesame systematics and valuable for the maintenance of germplasm banks and the efficient choice of parents in breeding programmes.

Encheva et al. (2005) reported that the method of direct organogenesis has been successfully used for overcoming the inability for crossing *Helianthus annuus* (*V. albens*) and *Verbesina helianthoides* (*Genus uerbesicin*). As hybrid materials, fertility restorer lines were produced in the R10 generation. The applied molecular method (RAPD) indicated an introgression of *Verbesina helianthoides*. DNA into some of the hybrid progenies produced and concluded that RAPD could be used for characterization of intergeneric hybrid progenies in sunflower at a later stage of selection (F9) in which an increased genetic variation was discovered.

Deepamala et al. (2005) reported that 14 sunflower cultivars have been fingerprinted by RAPD, ISSR and AFLP markers utilizing 361, 21 and four primer combinations, respectively. On an individual assay basis, AFLP was proven to be the best marker system as compared with the other two markers. To understand genetic relationships among these cultivars, Jaccard’s similarity coefficient and UPGMA clustering algorithm were applied to the 3 marker data sets. However, strong correlation was observed between RAPD and ISSR marker systems.

Silvanacreste et al. (2005) studied the genetic relationships among 15 Brazilian annual accessions from Arachis and Heteranthae using RAPD markers. Twenty seven primers were tested, of which nine produced unique fingerprinting for all the accessions studied. A total of 88 polymorphic fragments were scored and the number of fragments per primer varied from 6 to 17 with a mean of 9.8. Two specific markers were identified for species with 2n=18 chromosomes. The bootstrap analysis divided the genotypes into 2 significant clusters. The first cluster contained all the section Arachis species and the accessions within it were grouped based on the presence or absence of the ‘A’ pair and the number of chromosome. The second cluster grouped all the accessions belonging to section Heteranthae.

Ten tomato genotypes showing distinct variation in morphological and anatomical features were screened by Kulkarni et al. (2006), for Random amplified polymorphic DNA (RAPD). Germplasm under study comprised 3 mutant derivatives, 3 hybrids, their parents and one wild cherry tomato genotype. Twelve random decamer operon primers of OPAB series could generate total 690 bands of which 33.3% were polymorphic. Mutant specific polymorphic markers were detected.
Polymorphy could clearly identify mutant derivatives, cultivated genotypes and wild cherry tomato genotypes. The UPGMA based dendogram divided genotypes into two main clusters. Interestingly, wild cherry tomato was present in cluster of mutant derivatives, affirming its potential for utilization as unique source for tomato breeding. Low level of genetic diversity was noted in cultivated genotypes (mean = 0.138) indicating the existence of narrow genetic base.

Carelli et al. (2006) used random amplified polymorphic DNA markers (RAPD) to estimate the variability of 35 tomato accessions (*Lycopersicon esculentum* Mill.). A total of 257 reproducibly scorable bands were obtained from 20 primers, 78.6% of which were polymorphic. The percentage distribution of RAPD markers showed a bimodal distribution, and the frequency of rare alleles was similar in commercial and landrace accessions. Genetic distances among accessions were calculated and a dendrogram showing the genetic relationships among them was constructed allowing for the separation of four groups. Twenty out of 23 Brazilian landraces fell within one group, whereas commercial cultivars were distributed in the four groups. AMOVA analysis of RAPD data showed that, despite the high within Brazilian landraces and commercial cultivars variation, these two groups were significantly different, indicating that landraces can be a source of variation for breeding programs.

Husain et al. (2009) characterised 28 soybean germplasm lines by using 51 RAPD primers. They mentioned that 53.90% bands were polymorphic while 46.1 per cent bands monomorphic in nature.

Malik et al. (2009) studied 92 soybean germplasm by using 20 RAPD primers, out of which 20 primers, 10 primers produced 5684 RAPD fragments. 10 primers yielded 107 markers, with an average of 10.7 markers per primer.
3. MATERIAL AND METHODS

A field experiment was conducted to study the effect of organic manures on growth, seed yield and quality in tomato Cv.DMT-2 during kharif season 2010-2011 at the Main Agriculture Research Station, University of Agricultural Sciences, Dharwad. Further, the seed quality parameters were determined in the PG Laboratory of the Department of Seed Science and Technology, University of Agricultural Sciences, Dharwad. The details of the experiment and techniques adopted during the course of investigation are presented below.

3.1 General description

3.1.1 Location

The field experiment was conducted under rainfed condition during kharif 2010-2011 at the Main Agriculture Research Station (MARS), University of Agricultural Sciences, Dharwad, plot No. 93 situated at 15° 26' N, latitude of 75° 07' longitude and at an altitude of 678 m above the mean sea level.

3.1.2 Soil

The experimental site consisted of black clayey textured soil and was neutral in reaction. A composite soil sample (to a depth of 0-30 cm) was drawn from the experimental area before sowing and was analyzed for physical and chemical properties. The soil physical and chemical compositions are presented in Appendix-1.

3.1.3 Climate

Dharwad is situated in the transitional tract of Northern Karnataka. The Meteorological data with respect to rainfall, temperature and relative humidity for the crop period of kharif 2010 and average rainfall, temperature, relative humidity for the past 60 years (1950-2010) are furnished in Appendix-2.

The mean annual rainfall for the past 60 years was 810.55 mm and the maximum rainfall was received in the month of August (154.45 mm) followed by July (138.7 mm). The total rainfall during 2010 - April 2011 was 1122.45 mm and a maximum of 190.7 mm was received in August. January did not receive any rainfall during 2011. The mean maximum temperature ranged from 28.41°C (June) to 28.15°C (September) during year 2010-11. The months of October, February and March were hottest. While the mean maximum temperature during past 60 years indicated that, it was maximum in March (35.2°C) followed by April (34.9°C). The minimum temperature ranged from 12.5°C (January) to 21.8°C (June) during the 2010-11. The average of last 60 years indicated that the mean minimum temperature was maximum during June (21.8°C) and minimum during January (12.5°C). The relative humidity ranged from 44 (March) to 84 per cent (July) during 2010-11, the cropping period ranged from June 2010 to April 2011.

3.2 Previous crop of the experimental site

In the experimental plot, previously benalgram was grown during 2008-2009.

3.2.1 Experimental details

The details of the experiment with respect to crop variety, treatment, design, plot size, are given below.

3.2.2 Treatments

The experiment consisted of 11 treatments comprising of organic manures along with RDF. The details are as below.

- $T_1$: FYM (11.5 ton/ha)
- $T_2$: Vermicompost (5.75 ton/ha)
- $T_3$: Sheep manure (16.0 ton/ha)
- $T_4$: Poultry manure (7.0 ton/ha)
T5 – Neem cake (2.2 ton/ha) 
T6-50% FYM (5.75 ton/ha )+ 50% vermicompost (2.87 ton/ha) 
T7- 50% FYM (5.75 ton/ha ) + 50% poultry manure (3.5 ton/ha) 
T8-50% FYM (5.75 ton/ha ) + 50% sheep manure 8.0 ton/ha) 
T9- 50% FYM (5.75 ton/ha ) +50% neem cake (1.1 ton/ha) 
T10- Recommended doses of chemical fertilizer (115:100:60) NPKkg/ha 
T11- RDF (FYM40 ton/ha + 115:100:60 NPKkg/ha 

3.2.4 Replications
The treatments were replicated three times

3.2.5 Design and layout
The experiment was laid out in randomized complete block design the plan of layout of the experiment is given in Fig. 1.

3.2.6 Plot size
Gross plot size: 5 m x 4.5 m

3.2.7 Variety of crop
Tomato variety DMT-2 was used in the experimentation.

3.2.8 Description of tomato cultivar
DMT-2 tomato variety released from the University of Agricultural Sciences, Dharwad. It’s been released after crossing CA-1x20/6 Alcobasa. Fruits are in medium sized, round in shape and having long shelf-life under high temperature condition. DMT-2 has the yielding potentiality on an average of 25-30 tons per hectare. It is staking and is resistant to bacterial wilt disease.

3.3 Cultural practices

3.3.1 Nursery operation
Raised seed beds of 5 m length and 1 m width and 10 cm height with fine tilth were prepared. Three baskets of Farm Yard Manure (FYM) were incorporated thoroughly into the seed bed. Furrows were made at a distance of 10cm across the length of the bed, the seeds of variety DMT-2 were sown and the nursery bed was mulched with dried paddy straw. The seed bed was watered daily during evening hours. The healthy seedlings were transplanted on 35th day in the experimental plot.

3.3.2 Preparation of experimental plot
The land was deep ploughed once was brought to fine tilth by repeated harrowing and leveling. Then layout was made as per the plan given in Fig. 1. The plots were prepared as per the specifications and organic manures (FYM, Vermicompost sheep manures poultry manures and Vermicompost) were applied one week before the transplanting. All the cultural operations were followed as per the package of practices.

3.3.3 Transplanting
Micro plots were made with a length of 5 m and a width of 4.5 m. The seedlings were transplanted with a spacing of 75 cm x 60 cm. Thus the net plot size was 4.5 m x 4m. Gap filling was done after seven days of transplanting.

3.3.4 After care
The experimental plot was kept free of weeds by regular hand weeding. To control the pests and diseases, necessary organic plant protection measures like collection and destruction of Helicoverpa armigera larvae as and when noticed, removal of infected plants, and NSKE 5% spraying was also taken as and when required.
Fig. 1: Plan of layout of the experiment

Fig 1. Plan of layout of the experiment
3.3.5 Harvesting

The fruits were harvested when they were fully matured and turned to red colour.

3.3.6 Extraction of seeds

The fruits were harvested separately according to the treatment and the harvested fruits were kept for fermentation up to four days and fruits were crushed without causing damage to the seed. The seeds were separated manually by repeated hand washing of the pulp. Then, the seeds collected on the sieve are separated and are dried in the shade.

3.4 Collection of experimental data

In each treatment, five plants were randomly selected and tagged for recording various biometric observations as detailed below.

3.4.1 Growth parameters

3.4.1.1 Plant height

On the earlier five randomly selected and tagged plants, the plant height was measured from the base of plant to the terminal growing point of the main stem at 30, 60, 90 days after transplanting. The average plant height was expressed in centimeters.

3.4.1.2 Days to 50% flowering

When the flowering was noticed in the 3rd plant of the five tagged plants, it was considered as 50 percent flowering and days taken to this stage was considered as days to 50 percent flowering and was expressed in number

3.4.1.3 Number of Truss per plant

The number of trusses per plant was recorded when vegetative growth of plant was stopped.

3.4.1.4 Number of cluster per Truss

The number of trusses per plant was recorded when vegetative growth of plant was stopped.

3.4.1.5 Number of clusters per plant

The no. of clusters per plant was recorded of plants which were tagged previously when the lower leaves start drying and also commencement of fruit ripening.
3.4.1.6 Number of fruit per truss

Numbers of fruits per truss of tagged plant were recorded.

3.4.1.7 Number of fruits per plant

The number of fruits harvested from five earlier randomly tagged plants was counted from which total number of fruits per plant was calculated.

3.4.2 Yield and yield parameters

3.4.2.1 Seed yield per fruit

After weighing the five fruits obtained from tagged plants were crushed separately and seeds were extracted, the seeds obtained from each fruits counted manually and the average number of seeds per fruit was expressed as number of seeds per fruit.

3.4.2.2 Seed yield per plant (g)

The seeds were extracted from the ripe fruits and dried under shade for 6-8 days till it reached constant moisture (8%). Seeds obtained from the five tagged plants were weighed and later added and work out to get seed yield per plant and expressed in grams.

3.4.2.3 1000 seed weight (g)

The weight of 1000 seeds was recorded treatment wise as per the procedure given in ISTA Rules. The average 1000 seed weight was recorded in grams.

3.4.2.4 Seed yield per hectare (kg)

Seed yield per hectare was calculated on the basis of seed yield per plot and expressed in kilograms.

3.4.3 Seed quality parameters

3.4.3.1 Germination (%)

Germination test was conducted on 100 seed with four replications by adopting “between paper towel (BP) method” as prescribed by ISTA. The first and final germination counts were made on 5th and 14th day of germination test for normal seedlings and expressed in percentage.

3.4.3.2 Shoot length (cm)

From the germination test, ten normal seedlings were selected randomly from each treatment of all the replications on 14th day. The shoot length was measured from collar region to the base of the first leaf with the help of a scale and the mean shoot length was expressed in centimeters.

3.4.3.3 Root length (cm)

Ten normal seedlings used for shoot length measurement were also used for the measurement of root length. The root length measured from collar region to the tip of primary root with the help of a scale and the mean root length was expressed in centimeters.

3.4.3.4 Seedling dry weight (mg)

The same ten seedlings selected for shoot and root length measurement were kept in butter paper bag and dried in an oven maintained at 85 ± 2°C for 24 hours. After drying, the butter paper bags were removed and kept in a desicator for cooling. The weight of dried seedlings was recorded and means dry weight of seedlings was calculated and was expressed in milligrams.

3.4.3.5 Seedling vigour index (SVI)

The vigour index of seedlings was calculated by adopting the method suggested by Abdul-Baki and Anderson (1973) and expressed in number by using the below formula.

\[ SVI = \text{Germination (\%)} \times [\text{shoots length (cm)} + \text{root length (cm)}] \]
3.4.3.5 Field Emergence (%)

For field emergence the hundred seeds were own in plot and counted the number of germinated seedlings.

3.5 Plant morphological characters under field conditions

3.5.1 Seed material

Genetically pure and fresh seeds of different tomato genotypes viz., DMT-1, DMT-2, DMT-3, DMT-4, DMT-5, DMT-6, DM-4, Line No.C-3, Line No.C4, Important-B(Oblong), Important-B(Round), Important-D(Oblong) were collected from the department of horticulture UAS, Dharwad. The seeds were dried to a safer level of moisture content (9.0%) for further analysis.

3.5.2 Brief cultural practices were followed in the field

The land was prepared well to obtain fine tilth after ploughing and harrowing. The crop was raised as per package of practices given by the University of Agricultural Sciences, Dharwad. The crop was raised during the kharif, 2010-11 with a spacing of 75cm row to row and 60 cm plant to plant distance with a net plot size 4.5x5.00 meters in three replications for twelve genotypes. The experimental design was shown in field map and weather data was enclosed in Appendix – III

Following plant morphological characteristics were recorded under field conditions on ten randomly selected plants in each replication for all the genotypes at different stages as suggested by Agarawal (1984).

1. Plant characteristics

Seedling leaf color
a) Green
b) Greenish white

Stem colour: The colour of the stem was observed for ten genotypes under natural day light and grouping was done.

Plant growth type
a) Dwarf
b) Determinate
c) Semi-determinate
d) Indeterminate
Plant size
   a) Small
   b) Intermediate
   c) Large
Leaf color
   a) Green
   b) Light green
Foliation density
   a) Sparse
   b) Intermediate
   c) Dense
Leaf type
   a) Dwarf
   b) Potato leaf type
   c) Standard
   d) Peruvianum
   e) Pimpinellifolium

2. Flower characteristics (descriptors)
   Flower behavior (Days to 50% flowering)

   The flower initiation was regularly recorded from the earlier tagged ten random plants. The 50 per cent flowering was noted when the flower initiation in five plants has started and days to 50 per cent flowering was worked out from the date of transplanting and expressed in days and grouped as early flowering and late flowering.

   Flower character

   Petal colour and number of petals of the all the ten genotypes was observed at flowering under natural day light and grouping was done.

3. Fruit descriptors
   Per-dominant fruit shape
   a) Flattened
   b) Slight flattened
   c) Rounded
   d) Heart -shaped
   e) Cylindrical
   f) Pyriform
   g) Ellipsoids

   Fruit size
   a) Very small
   b) Small
   c) Intermediate
   d) Large
   e) Very large
Days to maturity

The observations were made on the five tagged plants in each treatment and days to physiological maturity calculated from the date of sowing. The average was computed and expressed in days for fruit maturity and grouped as late and early.

Exterior color of mature fruit

a) Green
b) Yellow
c) Orange
d) Pink
e) Red

Fruit shoulder shape

a) Flat slightly depressed
b) Moderately depressed
c) Strongly depressed

Fruit cross-sectional shape

a) Round
b) Angular
c) Irregular

Number of locules

a) Shape of pistil scar
b) Dot
c) Stellate
d) Linear
e) Irregular
f) Fruit blossom end shape
g) Indented
h) Flat
i) Pointed

Test weight

1000 seed weight was computed by counting 1000 randomly chosen filled seeds from a well-dried composite sample made by mixing the yield of all the ten selected plants in each replication of all the genotypes. The weight in grams was recorded using an electrical balance and genotypes were classified.

3.6 Varietal response to various chemical tests

The chemical tests are spot tests and they are useful in identification by representing seed coat color reaction to chemicals.

3.6.1 Phenol tests

It was studied as per the procedure given by ISTA (1976). Seeds were soaked in distilled water for 24 hours at $20^\circ C$. The soaked seeds were transferred on filter paper soaked in 1% aqueous solution of phenol in Petri-dish. The dish is covered and kept for about 4 hours at $30^\circ C$. The ventral side of the seed should face down on the filter paper. The intensity of color development is evaluated on a 0-9 scale (0=negative or no change of color and gradual intensification color from light brown to deep black graded from 1-9).
3.6.2 Modified phenol tests

Banerjee and Chandra (1977) grouped wheat cultivars by modifying the phenol test by adding Cu and Na ion for 6 hours. Gupta and Agrawal (1988) suggested that treating rice seeds with 0.5 per cent ferrous sulphate solution for 18 hours in addition to phenol solution could be used as primary diagnostic character for distinguishing rice genotypes. Whereas, Jaiswal and Agrawal (1995) reported that treating rice seeds with one per cent copper sulphate, one per cent ferrous sulphate and one per cent of sodium hydroxide could be used for subgrouping of rice genotypes which showed no response to phenol test. Ponnusamy et al. (2003) reported that modified phenol test could not help to distinguish different genotypes of cotton.

3.6.3 Peroxidase enzyme activity test

It was studied as per the procedure given by Butterly and Buzzell (1968). Ten seed coats were removed and placed separately in the test tube, with three replications for all the genotypes and added 10 drops of 0.5 per cent Guaiacol solution into test tube, after ten minutes one drop of 0.1 per cent solution of hydrogen peroxide (H₂O₂) was added and the reactions were noted after sixty seconds. The development of reddish brown colour was indicated as + ve, while colour lessness indicated as –ve.

+ ve  : High peroxidase activity
- ve  : Low peroxidase activity

3.6.4 Potassium hydroxide (KOH) test for colour reaction

Ten seeds were soaked in 20 ml solution at 0.5 per cent concentration in a test tube with three replications for all the genotypes and kept for 24 hours at an ambient temperature, (Chakrabarty and Agrawal, 1989), afterwards the solution was poured off and the seeds were placed over a wet filter paper in a Petridis. The seed coat colour was visually examined and recorded. Based on this genotypes were grouped into the following colour groups.

A. Yellow
B. Light yellow
C. Reddish yellow

3.6.5 Sodium hydroxide (NaOH) test for colour reaction

Ten seeds were soaked in 20 ml solution at 0.5 per cent concentration in a test tube with three replications for all the genotypes and kept for 24 hours at an ambient temperature (Chakrabarty and Agrawal, 1989), afterwards the solution was poured off and the seeds were placed over a wet filter paper in a Petridis for seed coat colour examination and observations were recorded. Based on the colour obtained, the genotypes were categorized into,

A. Yellow
B. Light yellow
C. Reddish yellow

3.6.6 Seedling growth response to GA₃ application

The response of GA₃ on seedlings was followed as per procedure given by Agrawal and Anilpawar (1990). Fifty seedlings were grown in germination towels which were moistened with 100 ppm GA₃ solution in three replications for all the genotypes. The germination towels were kept in upward position in seed germination at 25°C + 1°C for 14 days. The growth response was measured in centimeters, for per cent increase in seedling length over that is seedlings in control. The observations were expressed in per cent as means of 25 seedlings in each replication.
Based on the seedling growth response, the genotypes were classified as follows.

A. High responsive : > 50 per cent increase over control
B. Moderate responsive : 30 to 50 per cent increase over control
C. Least responsive : 30 per cent increase over control

3.6.7 Seedling growth response to 2, 4-D treatment

The response of 2, 4-D on seedlings was studied using the standard procedure given by Chakrabarty and Agrawal (1990.) Fifty seedlings were grown in germination towels which are moistened with 5 ppm 2, 4-D solution with three replications for all the genotypes. The germination towels were kept in upward seedling growth due to exogenous application of 2, 4-D was measured in centimeters, and the observations were expressed in per cent as means of 25 seedlings in each replication and genotypes. Based on the growth response, the genotypes were classified into following groups.

A. High affected : > 30 per cent decrease over control
B. Moderated affected : 10 to 30 per cent decrease over control
C. Least affected : < 10 per cent decrease over control

3.7 Varietal Characterization of tomato genotypes using molecular markers (RAPD)

3.7.1 Materials

Twelve tomato genotypes were analyzed for varietal characterization by using Randomly Amplified Polymorphic DNA (RAPD) analysis.

3.7.2 Methodology

Ten seedlings of each genotype were grown in small plastic pot for 10 days and used for the isolation of DNA by following mini pre-rapid method given by Edwards et al. (1991) with little modifications. The detailed protocol is given bellow.

3.7.3 DNA isolation protocol

1. Grind 2-3 g of young, uninfected leaf samples in extraction buffer (400 µl).
2. Centrifuge for 10 min at 13000 rpm.
3. Transfer the supernatant to fresh tubes.
4. Add equal volume of chloroform: IAA (24:1), shake vigorously and centrifuge at 13000 rpm for 3 min.
5. Take the supernatant and equal volume of isopropanol (around 400 µl).
6. Then centrifuge at 13000 rpm for 5 min.
7. DNA pellets obtained should be washed with 70% alcohol. After removing alcohol keep it at 37°C till the smell of alcohol gone.
8. Add 100 µl of T10E1 and store at 4°C.

3.7.4 DNA quality estimation

To test the quality of DNA, samples were run on 0.80 per cent agarose gel in 1X TAE buffer, stained with ethidium bromide and evaluated by comparing with the standard undigested DNA sample.

3.7.5 DNA purification

Purification of DNA was needed to remove RNA, proteins and polysaccharide which are the major contaminants. RNA was removed by RNase treatment. RNase was added to the DNA sample @100 ug/ml and incubated at 37°C for 1 hour.
3.7.6 DNA quantification
The quantification of DNA was done by using 'Nano drop' technique.

3.7.7 Standardization of DNA concentration
Various dilutions of DNA were tried for standardization of DNA concentration to be used for the PCR reaction. The different dilutions tried were 1:10, 1:20, 1:50, 1:100, 1:150 and 1:200. The one which gave optimal amplification was chosen for actual work.

3.8 Random Amplified Polymorphic DNA (RAPD) analysis

3.8.1 Polymerase chain reaction
1. Template DNA: Genomic DNA extracts from individual tomato genotypes was obtained using young leaves and used as template DNA per reaction.
2. Random primers: A total of 20 decamer DNA primers obtained from Operon Technologies Inc., Alameda, USA were used for study. The sequence details of the primers are presented in Table 1.
3. dNTPs: The four individual dNTPs viz., dATP, dGTP, dCTP and dTTP were obtained from M/S Bangalore Genei Pvt., Ltd. Bangalore.
4. Taq DNA Polymerase: Taq DNA polymerase (3 units per µl) and 10X Taq buffer were obtained from M/S Bangalore Genei Pvt., Ltd. Bangalore.
5. Chemicals: Analytical grade chemicals were obtained locally.
6. Thermocycler: Eppendorf thermal cycler gradient was used for cyclic amplification of DNA.

3.8.2 PCR reaction mixture
The RAPD reaction mixture consisted of 25-50 ng of template DNA, 5 pM of random decamer primer, 25mM MgCl₂, 2.5 mM of dNTPs, 1 unit of Taq polymerase, 10X Taq buffer in a volume of 20µl.

3.8.3 Amplification conditions
Amplification was carried out using Eppendorf Master Thermal Cycler. The amplification profile was as follows:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Steps</th>
<th>Temperature (°C)</th>
<th>Duration (Min)</th>
<th>No. of Cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Initial denaturation temperature</td>
<td>95</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Denaturation</td>
<td>94</td>
<td>2</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Annealing</td>
<td>36</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Primer extension</td>
<td>72</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Final extension</td>
<td>72</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Hold</td>
<td>4</td>
<td>Until removed</td>
<td></td>
</tr>
</tbody>
</table>

3.8.4 Gel electrophoresis
Agarose gel of 1.2 per cent was prepared using electrophoresis agarose in 1X TAE buffer. Ethidium bromide was added at a concentration of 0.5 µg/ml of gel. The gel was allowed to set fully before removing the comb and loading the sample. Two µl of tracking dye was added to 20 µl of PCR products and mixed well before loading into the wells. Care was taken to prevent mixing of samples between the wells. A voltage of 70 volts was given for a period of 3 hours for separation of PCR fragments. After the run, the gel was viewed under UV light and the DNA banding pattern was recorded in UV doc.
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Primers</th>
<th>Sequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>OPA-04</td>
<td>5’-AATCGGGGCTG-3’</td>
</tr>
<tr>
<td>2</td>
<td>OPA-06</td>
<td>5’-GGTCCCTGAC-3’</td>
</tr>
<tr>
<td>3</td>
<td>OPA-11</td>
<td>5’-CAATCGCCGT-3’</td>
</tr>
<tr>
<td>4</td>
<td>OPA-20</td>
<td>5’-GTTGCGATCC-3’</td>
</tr>
<tr>
<td>5</td>
<td>OPB-02</td>
<td>5’-TGATCCCTGG-3;</td>
</tr>
<tr>
<td>6</td>
<td>OPD-01</td>
<td>5’-ACCGCGAAGG-3’</td>
</tr>
<tr>
<td>7</td>
<td>OPD-12</td>
<td>5’-CACCGTATCC-3’</td>
</tr>
<tr>
<td>8</td>
<td>OPD-15</td>
<td>5’-CATCCGTGCT-3’</td>
</tr>
<tr>
<td>9</td>
<td>OPD-16</td>
<td>5’-AGGGCGTAAG-3’</td>
</tr>
<tr>
<td>10</td>
<td>OPE-08</td>
<td>5’-TCACCAGGCTG-3’</td>
</tr>
<tr>
<td>11</td>
<td>OPE-16</td>
<td>5’-GGTGACTGTG-3’</td>
</tr>
<tr>
<td>12</td>
<td>OPE-19</td>
<td>5’-ACGGCGTAT-3’</td>
</tr>
<tr>
<td>13</td>
<td>OPF-05</td>
<td>5’-CCGAATTCCC-3’</td>
</tr>
<tr>
<td>14</td>
<td>OPF-12</td>
<td>5’-ACGGTACCAG-3’</td>
</tr>
<tr>
<td>15</td>
<td>OPF-19</td>
<td>5’-CCTCTAGACC-3’</td>
</tr>
<tr>
<td>16</td>
<td>OPG-06</td>
<td>5’-GTGCCTAACC-3’</td>
</tr>
<tr>
<td>17</td>
<td>OPG-08</td>
<td>5’-TCACGTCAC-3’</td>
</tr>
<tr>
<td>18</td>
<td>OPG-12</td>
<td>5’-CAGCTCACGA-3’</td>
</tr>
<tr>
<td>19</td>
<td>OPW-11</td>
<td>5’-CTGATGCGTG-3’</td>
</tr>
<tr>
<td>20</td>
<td>OPX-07</td>
<td>5’-GAGCGAGGCT-3’</td>
</tr>
</tbody>
</table>
3.8.5 Scoring the amplified fragments

The amplified fragments were scored as ‘1’ for the presence and ‘0’ for absence of a band generating the 0 and 1 matrix for 20 primers used for all genotypes. All 17 genotypes of tomato were analyzed by 20 RAPD primers. The per cent polymorphism was calculated by using the following formula:

\[
\text{Per cent polymorphism} = \frac{\text{Number of polymorphic bands}}{\text{Total number of bands}} \times 100
\]

3.8.6 Analysis of the profile of the amplified fragments

Pair wise genetic similarities (Sij) between genotypes were estimated by DICE similarity coefficient. Clustering was done using the symmetric matrix of similarity coefficient and cluster obtained based on unweighted pair group arithmetic mean (UPGMA) using NTSYS-PC. The similarity measurements were converted to genetic distance measurements as (1-SM) X 100 (Spooner et al. 1996).

3.8.7 Scoring and analysis of the profile of the amplified fragments

Scoring was done as in RAPD i.e. ‘0’ and ‘1’.

3.9 Statistical analysis

The data of the respective field experiment were subjected to appropriate statistical analysis. The analysis of variance and interpretation of data were done as per procedures given by Fisher and Yates (1963), Panse and Sukhatme (1967) and Gomez and Gomez (1984). Level of significance used in ‘F’ test was P=0.05 critical difference (CD) values were calculated only wherever the ‘F’ test was found significant.

The data on percentage germination and field emergence were transformed into arcsine root percentage and transformed data was used for the statistical analysis.

3.9.1 Analysis of variance

The experimental data was statistically analyzed by adopting randomized complete block design. The critical difference values were computed at five per cent level. The model of analysis of variance is as given below.

3.9.2 Model of analysis

<table>
<thead>
<tr>
<th>Sources</th>
<th>Df</th>
<th>SS</th>
<th>MSS</th>
<th>F-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replications</td>
<td>r-1</td>
<td>RSS</td>
<td>$M_r$</td>
<td>$M_r/E$</td>
</tr>
<tr>
<td>Treatments</td>
<td>t-1</td>
<td>TSS</td>
<td>$M_t$</td>
<td>$M_t/E$</td>
</tr>
<tr>
<td>Error</td>
<td>(r-1)(t-1)</td>
<td>ESS</td>
<td>E</td>
<td></td>
</tr>
</tbody>
</table>

Where,

\[ r = \text{number of replications} \]
\[ t = \text{number of genotypes} \]
4. EXPERIMENTAL RESULTS

The field experiment was conducted during kharif 2010 in the Main Agricultural Research Station, University of Agricultural, Dharwad to study the effect of organic manures on growth, seed yield and quality in tomato. The results of the experiment obtained are presented in this chapter.

Effects of different organic manures on seed yield and quality in tomato Cv. DMT-2

4.1 Growth parameters

4.1.1 Plant height (cm)

The data on plant height of tomato at different growth stages as influenced by organic manures are presented in Table 2 and depicted in Fig. 2. The plant height was differed significantly at 30, 60 and 90 days after transplanting (DAT).

At 60 DAT, the plant height was significantly highest (65.20 cm) recorded by T11 (FYM 40 t/ha + 115:100:60 kg of NPK/ha) over the rest of the treatments. However the lowest (33.82 cm) plant height was recorded in T1 (FYM: 11.5 t/ha).

At 90 DAT, the significantly the highest (107.85 cm) plant height was recorded by T11 (FYM 40 t/ha + 115:100:60 kg of NPK/ha). Among the treatments RDF was recorded higher plant height (107.85 cm) as compared to the remaining treatments however significantly the lowest (69.12 cm) plant height was recorded by T1 (FYM :11.5 t/ha).

At 120 DAT, the plant height was significantly highest with T11 (FYM 40 t/ha + 115:100:60 kg of NPK/ha) (164.58 cm) over remaining treatments. While, lower plant height was recorded in FYM application (96.56 cm).

4.1.2 Days to 50% flowering

The data on days to 50% flowering of tomato Cv.DMT-2 as influenced by organic manures is presented in Table 2 and depicted in Fig. 2. The data on days to 50 % revealed the significant difference due to different sources of nutrition. The organic manures (T1 to T9) recorded significantly higher days for 50% flowering. While T11 (FYM: 40t/ha +115:100:60 kg NPK/ha) took less number of days (36.10 days) for 50% flowering.

4.1.3 Number of trusses per plant

The number of trusses per plant found to be statistically significant due to organic manures are presented in Table 3 and depicted in Fig. 3.

Among the treatments number of trusses per plant was significantly highest T11 (FYM 40 t/ha + 115:100:60 kg of NPK/ha) (5.19) followed by T10 (recommended dose of chemical fertilizer ) application (4.84). The lowest number of trusses per plant was recorded by T1 (FYM 11.5 t/ha) (3.33).

4.1.4 Number of clusters per truss

The number of clusters per truss found to be statistically significant due to organic manures are presented in Table 3 and depicted in Fig. 3

Among the treatments number of clusters per truss was significantly highest in T11 (FYM 40 t/ha + 115:100:60 kg of NPK/ha) (4.33) followed by T10 (recommended dose of chemical fertilizer ) application (4.00). The lowest number of clusters per truss was recorded by T1 (FYM 11.5 t/ha) (1.07)

4.1.5 Number of clusters per plant

The number of clusters per plant found to be statistically significant due to organic manures are presented in Table 3 and depicted in Fig. 3

Among the treatments number of clusters per plant was significantly highest in T11 (FYM 40 t/ha + 115:100:60 kg of NPK/ha) (11.27) followed by T10 (recommended dose of chemical fertilizer ) application (9.67). The lowest number of clusters per plant was recorded by T1 (FYM 11.5 t/ha) (2.40).
Table 2. Influence of organic manures on plant height at 60, 90 and 120 days after transplanting and days to 50% flowering in tomato Cv. DMT-2

<table>
<thead>
<tr>
<th>Treatments</th>
<th>60 days after transplanting</th>
<th>90 days after transplanting</th>
<th>120 days after transplanting</th>
<th>Days to 50% flowering</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 - FYM (11.5t/ha)</td>
<td>33.82</td>
<td>69.12</td>
<td>96.56</td>
<td>42.08</td>
</tr>
<tr>
<td>T2 - Vermicompost (5.75t/ha)</td>
<td>40.2</td>
<td>77.66</td>
<td>107.70</td>
<td>41.80</td>
</tr>
<tr>
<td>T3 – Sheep manure (16.0t/ha)</td>
<td>48.61</td>
<td>94.68</td>
<td>141.75</td>
<td>41.18</td>
</tr>
<tr>
<td>T4 - Poultry manure (07.0t/ha)</td>
<td>51.53</td>
<td>94.37</td>
<td>144.10</td>
<td>39.22</td>
</tr>
<tr>
<td>T5 - Neem cake (2.2t/ha)</td>
<td>58.63</td>
<td>101.39</td>
<td>141.06</td>
<td>41.39</td>
</tr>
<tr>
<td>T6 - FYM (5.75 t/ha) + Vermi compost (2.87 t/ha)</td>
<td>47.53</td>
<td>87.59</td>
<td>118.91</td>
<td>41.36</td>
</tr>
<tr>
<td>T7 - FYM (5.75 t/ha) + Poultry manure (3.5 t/ha)</td>
<td>37.8</td>
<td>87.93</td>
<td>122.44</td>
<td>39.52</td>
</tr>
<tr>
<td>T8 - FYM (5.75 t/ha) + Sheep manure (8.0 t/ha)]</td>
<td>37.58</td>
<td>86.07</td>
<td>117.47</td>
<td>37.71</td>
</tr>
<tr>
<td>T9 - FYM (5.75 t/ha) +Neem cake (1.1 t/ha)</td>
<td>36.48</td>
<td>82.98</td>
<td>113.24</td>
<td>38.62</td>
</tr>
<tr>
<td>T10 - Recommended doses of chemical fertilizer (115:100:60 NPK kg/ha)</td>
<td>60.5</td>
<td>104.18</td>
<td>161.44</td>
<td>38.15</td>
</tr>
<tr>
<td>T11 –RDF (FYM:40 t/ha + 115:100:60 NPKkg /ha)</td>
<td>65.2</td>
<td>107.85</td>
<td>164.58</td>
<td>36.10</td>
</tr>
<tr>
<td>Mean</td>
<td>48.08</td>
<td>90.35</td>
<td>129.93</td>
<td>39.74</td>
</tr>
<tr>
<td>SE m±</td>
<td>0.6253</td>
<td>0.60</td>
<td>0.97</td>
<td>0.42</td>
</tr>
<tr>
<td>C.D. at 5%</td>
<td>1.3068</td>
<td>1.7</td>
<td>2.86</td>
<td>1.23</td>
</tr>
</tbody>
</table>
Legend

T₁ - FYM (11.5t/ha)
T₂ - Vermicompost (5.75t/ha)
T₃ - Sheep manure (16.0t/ha)
T₄ - Poultry manure (07.0t/ha)
T₅ - Neem cake (2.2t/ha)
T₆ - FYM (5.75 t/ha) + Vermi compost (2.87 t/ha)
T₇ - FYM (5.75 t/ha) + Poultry manure (3.5 t/ha)
T₈ - FYM (5.75 t/ha) + Sheep manure (8.0 t/ha)
T₉ - FYM (5.75 t/ha) + Neem cake (1.1 t/ha)
T₁₀ - Recommended doses of chemical fertilizer (115:100:60 NPK kg/ha)
T₁₁ - RDF (FYM:40 t/ha + 115:100:60 NPKg /ha)

Fig. 2: Influence of organic manures on plant height at 60, 90 and 120 days after transplanting and days to 50% flowering in tomato Cv. DMT-2
Table 3. Influence of organic manures on number of truss/plant, number of clusters/truss, number of clusters/plant and number of flowers/cluster in tomato Cv. DMT-2

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Number of truss/plant</th>
<th>Number of clusters/truss</th>
<th>Number of clusters/plant</th>
<th>Number of flowers/cluster</th>
</tr>
</thead>
<tbody>
<tr>
<td>T&lt;sub&gt;1&lt;/sub&gt; - FYM (11.5t/ha)</td>
<td>3.33</td>
<td>1.07</td>
<td>2.40</td>
<td>5.40</td>
</tr>
<tr>
<td>T&lt;sub&gt;2&lt;/sub&gt; - Vermicompost (5.75t/ha)</td>
<td>3.44</td>
<td>1.27</td>
<td>3.80</td>
<td>5.07</td>
</tr>
<tr>
<td>T&lt;sub&gt;3&lt;/sub&gt; - Sheep manure (16.0t/ha)</td>
<td>3.52</td>
<td>1.33</td>
<td>3.00</td>
<td>4.20</td>
</tr>
<tr>
<td>T&lt;sub&gt;4&lt;/sub&gt; - Poultry manure (07.0t/ha)</td>
<td>3.72</td>
<td>1.40</td>
<td>3.67</td>
<td>8.40</td>
</tr>
<tr>
<td>T&lt;sub&gt;5&lt;/sub&gt; - Neem cake (2.2t/ha)</td>
<td>4.46</td>
<td>1.80</td>
<td>4.20</td>
<td>8.47</td>
</tr>
<tr>
<td>T&lt;sub&gt;6&lt;/sub&gt; - FYM (5.75 t/ha) + Vermi compost (2.87 t/ha)</td>
<td>3.75</td>
<td>1.87</td>
<td>3.47</td>
<td>5.40</td>
</tr>
<tr>
<td>T&lt;sub&gt;7&lt;/sub&gt; - FYM (5.75 t/ha) + Poultry manure (3.5 t/ha)</td>
<td>4.64</td>
<td>2.00</td>
<td>4.47</td>
<td>6.00</td>
</tr>
<tr>
<td>T&lt;sub&gt;8&lt;/sub&gt; - FYM (5.75 t/ha) + Sheep manure (8.0 t/ha)</td>
<td>3.75</td>
<td>2.20</td>
<td>5.33</td>
<td>7.67</td>
</tr>
<tr>
<td>T&lt;sub&gt;9&lt;/sub&gt; - FYM (5.75 t/ha) + Neem cake (1.1 t/ha)</td>
<td>4.54</td>
<td>2.40</td>
<td>4.07</td>
<td>4.47</td>
</tr>
<tr>
<td>T&lt;sub&gt;10&lt;/sub&gt; - Recommended doses of chemical fertilizer (115:100:60 NPK kg/ha)</td>
<td>4.84</td>
<td>4.00</td>
<td>9.67</td>
<td>11.07</td>
</tr>
<tr>
<td>T&lt;sub&gt;11&lt;/sub&gt; - RDF (FYM:40 t/ha + 115:100:60 NPKkg /ha)</td>
<td>5.19</td>
<td>4.33</td>
<td>11.27</td>
<td>11.80</td>
</tr>
<tr>
<td>Mean</td>
<td>4.11</td>
<td>2.15</td>
<td>5.03</td>
<td>7.09</td>
</tr>
<tr>
<td>SE m±</td>
<td>0.11</td>
<td>0.19</td>
<td>0.22</td>
<td>0.21</td>
</tr>
<tr>
<td>C.D. at 5%</td>
<td>0.32</td>
<td>0.56</td>
<td>0.66</td>
<td>0.62</td>
</tr>
</tbody>
</table>
**Legend**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>FYM (11.5 t/ha)</td>
</tr>
<tr>
<td>T₂</td>
<td>Vermicompost (5.75 t/ha)</td>
</tr>
<tr>
<td>T₃</td>
<td>Sheep manure (16.0 t/ha)</td>
</tr>
<tr>
<td>T₄</td>
<td>Poultry manure (07.0 t/ha)</td>
</tr>
<tr>
<td>T₅</td>
<td>Neem cake (2.2 t/ha)</td>
</tr>
<tr>
<td>T₆</td>
<td>FYM (5.75 t/ha) + Vermicompost (2.87 t/ha)</td>
</tr>
<tr>
<td>T₇</td>
<td>FYM (5.75 t/ha) + Poultry manure (3.5 t/ha)</td>
</tr>
<tr>
<td>T₈</td>
<td>FYM (5.75 t/ha) + Sheep manure (8.0 t/ha)</td>
</tr>
<tr>
<td>T₉</td>
<td>FYM (5.75 t/ha) + Neem cake (1.1 t/ha)</td>
</tr>
<tr>
<td>T₁₀</td>
<td>Recommended doses of chemical fertilizer (115:100:60 NPK kg/ha)</td>
</tr>
<tr>
<td>T₁₁</td>
<td>RDF (FYM:40 t/ha + 115:100:60 NPK kg/ha)</td>
</tr>
</tbody>
</table>

Fig. 3: Influence of organic manures on number of truss/plant, number of clusters/truss, number of clusters/plant and number of flowers/cluster in tomato Cv. DMT-2
4.2 Yield and yield parameters

4.2.1 Number of flowers per cluster

The data on number of flowers per cluster found to be statistically significant due to organic manures are presented in Table 4 and depicted in Fig. 4.

The number of flower per cluster was significantly highest in T_{11} (FYM 40 t/ha + 115:100:60 kg of NPK/ha) (11.80) followed by T_{10} (recommended dose of chemical fertilizer) application (11.07). Among organic manures (T_5) Neem cake (2.2t/ha), (8.47) and (T_4) poultry manure 7.0t/ha (8.40) where as the lowest number of flowers per cluster was recorded by T_1 (FYM 11.5 t/ha) (5.40).

4.2.2 Number of fruits per truss

The numbers of fruits per found to be statistically significant due to organic manures are presented in Table 4 and depicted in Fig. 4. The data showed significant difference due to some of organic nutrition

Among the treatments number of fruits per truss was significantly highest in T_{11} (FYM 40 t/ha + 115:100:60 kg of NPK/ha) (12.75) followed by T_{10} (recommended dose of chemical fertilizer) application (11.61). The lowest number fruits per truss was recorded by T_1 (FYM 11.5 t/ha) (8.54).

4.2.3 Number of fruits per plant

The numbers of fruits per plant found to be statistically significant due to organic manures are presented in Table 4 and depicted in Fig. 4.

Among the treatments number of fruits per plant was significantly highest in T_{11} (FYM 40 t/ha + 115:100:60 kg of NPK/ha) (47.13) followed by T_{10} (recommended dose of chemical fertilizer) application (43.68). The lowest number of fruits per plant was recorded by T_1 (FYM 11.5 t/ha) (31.43).

4.2.4 Number of seeds per fruit

The number of seeds per fruit found to be statistically significant due to organic manures are presented in Table 4 and depicted in Fig. 4.

Among the treatments number of seeds per fruit was significantly highest in T_{11} (FYM 40 t/ha + 115:100:60 kg of NPK/ha) (110.44) followed by T_{10} (recommended dose of chemical fertilizer) application (105.47). The lowest number of seeds per plants per plant was recorded by T_1 (FYM 11.5 t/ha) (80.77).

4.2.5 Seed yield per plant (g)

The seed yield per plant (g) found to be statistically significant due to organic manures are presented in Table 4 and depicted in Fig. 4.

Among the treatments seed yield per plant was significantly highest in T_{11} (FYM 40 t/ha + 115:100:60 kg of NPK/ha) (30.24g) followed by T_{10} (recommended dose of chemical fertilizer) application (28.56g). The lowest seed yield per plant was recorded by T_1 (FYM 11.5 t/ha) (14.65g).

4.2.6 1000 seed weight

The 1000 seed weight was found to be statistically significant due to organic manures are presented in Table 5 and depicted in Fig. 5.

Among the treatments 1000 seed weight was significantly highest in T_{11} (FYM 40 t/ha + 115:100:60 kg of NPK/ha) (2.87g) followed by T_{10} (recommended dose of chemical fertilizer) application (2.84g). The lowest number of 1000 seed weight was recorded by T_1 (FYM 11.5 t/ha) (2.42g).

4.2.7 Seed yield per plot (g)

The seed yield per plot (g) was found to be statistically significant due to organic manures are presented in Table 5 and depicted in Fig. 5.
Table 4. Influence of organic manures on number of fruits/truss, number of fruits/plant, number of seeds/fruit and seed yield/plant (g) in tomato Cv. DMT-2

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Number of fruits/truss</th>
<th>Number of fruits/plant</th>
<th>Number of seeds/fruit</th>
<th>Seed yield/plant (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_1$ - FYM (11.5 t/ha)</td>
<td>8.54</td>
<td>31.43</td>
<td>80.77</td>
<td>14.65</td>
</tr>
<tr>
<td>$T_2$ - Vermicompost (5.75 t/ha)</td>
<td>9.50</td>
<td>35.64</td>
<td>85.01</td>
<td>15.93</td>
</tr>
<tr>
<td>$T_3$ – Sheep manure (16.0 t/ha)</td>
<td>9.66</td>
<td>35.90</td>
<td>98.62</td>
<td>20.7</td>
</tr>
<tr>
<td>$T_4$ - Poultry manure (07.0 t/ha)</td>
<td>9.92</td>
<td>36.69</td>
<td>100.91</td>
<td>22.48</td>
</tr>
<tr>
<td>$T_5$ - Neem cake (2.2 t/ha)</td>
<td>10.54</td>
<td>40.03</td>
<td>100.41</td>
<td>18.89</td>
</tr>
<tr>
<td>$T_6$ - FYM (5.75 t/ha) + Vermicompost (2.87 t/ha)</td>
<td>9.68</td>
<td>37.16</td>
<td>95.43</td>
<td>18.17</td>
</tr>
<tr>
<td>$T_7$ - FYM (5.75 t/ha) + Poultry manure (3.5 t/ha)</td>
<td>10.66</td>
<td>40.66</td>
<td>82.50</td>
<td>16.95</td>
</tr>
<tr>
<td>$T_8$ - FYM (5.75 t/ha) + Sheep manure (8.0 t/ha)]</td>
<td>9.98</td>
<td>39.45</td>
<td>83.64</td>
<td>15.41</td>
</tr>
<tr>
<td>$T_9$ - FYM (5.75 t/ha) + Neem cake (1.1 t/ha)</td>
<td>10.71</td>
<td>40.26</td>
<td>82.51</td>
<td>17.66</td>
</tr>
<tr>
<td>$T_{10}$ - Recommended doses of chemical fertilizer (115:100:60 NPK kg/ha)</td>
<td>11.61</td>
<td>43.68</td>
<td>105.47</td>
<td>28.56</td>
</tr>
<tr>
<td>$T_{11}$ – RDF (FYM:40 t/ha + 115:100:60 NPKkg /ha)</td>
<td>12.75</td>
<td>47.13</td>
<td>110.44</td>
<td>30.24</td>
</tr>
<tr>
<td>Mean</td>
<td>10.32</td>
<td>38.91</td>
<td>93.25</td>
<td>19.97</td>
</tr>
<tr>
<td>SE $m\pm$</td>
<td>0.29</td>
<td>0.43</td>
<td>0.90</td>
<td>0.79</td>
</tr>
<tr>
<td>C.D. at 5%</td>
<td>0.84</td>
<td>1.26</td>
<td>2.66</td>
<td>2.33</td>
</tr>
<tr>
<td>Treatments</td>
<td>1000 seed weight</td>
<td>Seed yield/plot(g)</td>
<td>Seed yield/ha(kg)</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>------------------</td>
<td>-------------------</td>
<td>------------------</td>
<td></td>
</tr>
<tr>
<td>T₁ - FYM (11.5t/ha)</td>
<td>2.42</td>
<td>189.98</td>
<td>87.85</td>
<td></td>
</tr>
<tr>
<td>T₂ - Vermicompost (5.75t/ha)</td>
<td>2.43</td>
<td>212.21</td>
<td>93.97</td>
<td></td>
</tr>
<tr>
<td>T₃ - Sheep manure (16.0t/ha)</td>
<td>2.63</td>
<td>200.82</td>
<td>100.67</td>
<td></td>
</tr>
<tr>
<td>T₄ - Poultry manure (07.0t/ha)</td>
<td>2.63</td>
<td>225.66</td>
<td>101.90</td>
<td></td>
</tr>
<tr>
<td>T₅ - Neem cake (2.2t/ha)</td>
<td>2.59</td>
<td>225.2</td>
<td>101.77</td>
<td></td>
</tr>
<tr>
<td>T₆ - FYM (5.75 t/ha) + Vermi compost (2.87 t/ha)</td>
<td>2.57</td>
<td>201.05</td>
<td>98.51</td>
<td></td>
</tr>
<tr>
<td>T₇ - FYM (5.75 t/ha) + Poultry manure (3.5 t/ha)</td>
<td>2.45</td>
<td>213.72</td>
<td>95.01</td>
<td></td>
</tr>
<tr>
<td>T₈ - FYM (5.75 t/ha) + Sheep manure (8.0 t/ha)</td>
<td>2.63</td>
<td>215.08</td>
<td>94.32</td>
<td></td>
</tr>
<tr>
<td>T₉ - FYM (5.75 t/ha) + Neem cake (1.1 t/ha)</td>
<td>2.49</td>
<td>218.66</td>
<td>93.59</td>
<td></td>
</tr>
<tr>
<td>T₁₀ - Recommended doses of chemical fertilizer (115:100:60 NPK kg/ha)</td>
<td>2.84</td>
<td>239.11</td>
<td>105.98</td>
<td></td>
</tr>
<tr>
<td>T₁₁ - RDF (FYM:40 t/ha + 115:100:60 NPKkg /ha)</td>
<td>2.87</td>
<td>241.72</td>
<td>108.28</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>2.65</td>
<td>216.66</td>
<td>98.35</td>
<td></td>
</tr>
<tr>
<td>SE m±</td>
<td>0.08</td>
<td>10.63</td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td>C.D. at 5%</td>
<td>0.33</td>
<td>31.42</td>
<td>2.07</td>
<td></td>
</tr>
</tbody>
</table>
Legend

T₁ - FYM (11.5 t/ha)

T₂ - Vermicompost (5.75 t/ha)

T₃ - Sheep manure (16.0 t/ha)

T₄ - Poultry manure (07.0 t/ha)

T₅ - Neem cake (2.2 t/ha)

T₆ - FYM (5.75 t/ha) + Vermicompost (2.87 t/ha)

T₇ - FYM (5.75 t/ha) + Poultry manure (3.5 t/ha)

T₈ - FYM (5.75 t/ha) + Sheep manure (8.0 t/ha)

T₉ - FYM (5.75 t/ha) + Neem cake (1.1 t/ha)

T₁₀ - Recommended doses of chemical fertilizer (115:100:60 NPK kg/ha)

T₁₁ - RDF (FYM:40 t/ha + 115:100:60 NPK kg/ha)

Fig. 4: Influence of organic manures on number of fruits/truss, number of fruits/plant, number of seeds/fruit and seed yield/plant (g) in tomato Cv. DMT-2
Legend

T₁ - FYM (11.5 t/ha)

T₂ - Vermicompost (5.75 t/ha)

T₃ - Sheep manure (16.0 t/ha)

T₄ - Poultry manure (07.0 t/ha)

T₅ - Neem cake (2.2 t/ha)

T₆ - FYM (5.75 t/ha) + Vermicompost (2.87 t/ha)

T₇ - FYM (5.75 t/ha) + Poultry manure (3.5 t/ha)

T₈ - FYM (5.75 t/ha) + Sheep manure (8.0 t/ha)

T₉ - FYM (5.75 t/ha) + Neem cake (1.1 t/ha)

T₁₀ - Recommended doses of chemical fertilizer (115:100:60 NPK kg/ha)

T₁₁ - RDF (FYM:40 t/ha + 115:100:60 NPK kg/ha)

Fig. 5: Influence of organic manures on 1000 seed weight, seed yield/plant (g) and seed yield/ha (g) in tomato Cv. DMT-2
Among the treatments seed yield per plot was significantly highest in $T_{11}$ (FYM 40 t/ha + 115:100:60 kg of NPK/ha) (241.72g) followed by $T_{10}$ (recommended dose of chemical fertilizer) application (239.11g). The lowest of seed yield per plot was recorded by $T_1$ (FYM 11.5 t/ha) (189.98g).

4.2.8 Seed yield per ha (kg)

The seed yield per ha (kg) was found to be statistically significant due to organic manures are presented in Table 5 and depicted in Fig. 5.

Among the treatments seed yield per ha (kg) was significantly highest in $T_{11}$ (FYM 40 t/ha + 115:100:60 kg of NPK/ha) (108.28kg) followed by $T_{10}$ (recommended dose of chemical fertilizer) application (105.98kg). The lowest of seed yield per ha (kg) was recorded by $T_1$ (FYM 11.5 t/ha) (87.85kg).

4.3 Quality parameters

4.3.1 Germination percentage

The Germination percentage was found to be statistically significant due to organic manures are presented in Table 6 and depicted in Fig. 6.

Among the treatments Germination percentage was significantly highest in $T_{11}$ (FYM 40 t/ha + 115:100:60 kg of NPK/ha) (95.89%) followed by $T_{10}$ (recommended dose of chemical fertilizer) application (91.50%). The lowest germination percentage was recorded by $T_1$ (FYM 11.5 t/ha) (85.92%).

4.3.2 Shoot length (cm)

The shoot length (cm) was found to be statistically significant due to organic manures are presented in Table 6.

Among the treatments shoot length (cm) was significantly highest in $T_{11}$ (FYM 40 t/ha + 115:100:60 kg of NPK/ha) (12.86cm) followed by $T_{10}$ (recommended dose of chemical fertilizer) application (11.54cm). The lowest shoot length was recorded by $T_1$ (FYM 11.5 t/ha) (7.89cm).

4.3.3 Root length (cm)

The root length (cm) was found to be statistically significant due to organic manures are presented in Table 6.

Among the treatments root length (cm) was significantly highest in $T_{11}$ (FYM 40 t/ha + 115:100:60 kg of NPK/ha) (11.96cm) followed by $T_{10}$ (recommended dose of chemical fertilizer) application (10.82cm). The lowest root length was recorded by $T_1$ (FYM 11.5 t/ha) (7.25 cm).

4.3.4 Seedling vigour index (SVI)

The Seedling vigour index (SVI) was found to be statistically significant due to organic manures are presented in Table 6 and depicted in Fig. 6.

Among the treatments Seedling vigour index (SVI) was significantly highest in $T_{11}$ (FYM 40 t/ha + 115:100:60 kg of NPK/ha) (2349) followed by $T_{10}$ (recommended dose of chemical fertilizer) application (2277). The lowest Seedling vigour index (SVI) was recorded by $T_1$ (FYM 11.5 t/ha) (1228).

4.3.5 Dry weight of seedling (mg)

The Dry weight of seedling (mg) was found to be statistically significant due to organic manures (Table 6).

Among the treatments Dry weight of seedling (mg) was significantly highest in $T_{11}$ (FYM 40 t/ha + 115:100:60 kg of NPK/ha) (26.94mg) followed by $T_{10}$ (recommended dose of chemical fertilizer) application (23.59mg). The lowest Dry weight of seedling (mg) was recorded by $T_1$ (FYM 11.5 t/ha) (17.05mg).
4.3.6 Field Emergence (%)

The Field Emergence (%) was found to be statistically significant due to organic manures are presented in Table 6 and depicted in Fig. 6. Among the treatments Field Emergence (%) was significantly highest in T11 (FYM 40 t/ha + 115:100:60 kg of NPK/ha) (88.33%) followed by T10 (recommended dose of chemical fertilizer) application (86.92%). The lowest Field Emergence (%) was recorded by T1 (FYM 11.5 t/ha) (71.55%).

4.4 Characterization of tomato genotypes through morphological descriptors

The only legally recognized method in our country for varietal identification and genetic purity assessment practices by seed certification is based on field-plot or grow out test, which include the morphological characteristics of a cultivar.

4.4.1 Plant morphological characters

The morphological characters seedling leaf color, days to maturity, stem color, flowering behavior, flower character Foliage density, leaf type, exterior color of immature fruit, fruit shape, exterior color of mature fruit, easiness of fruits to detach from pedicel, fruit shoulder shape, easiness of fruit wall to be peeled, skin color of ripe fruit, flesh color of pericarp, flesh color intensity, fruit cross sectional shape number of locules shape of pistil scar and fruit blossom end shape were studied on this characters, the genotypes were grouped.

4.4.1.1 Seedling leaf color

Seedling leaf color varied among the tomato genotypes. Based on this descriptor tomato genotypes were grouped into green and greenish white (Table 7).

Among 12 genotypes nine genotypes were green foliage viz DMT-1, DMT-2, DMT-3, DMT-4, DMT-5, DMT-6 DM-4, Line No. C3, Line No. C4, IMP-B (oblong) and remaining genotypes were greenish white foliage viz IMP-B (round), IMP-D (round) and DM-4.

4.4.1.2 Plant growth type

Based plant growth type genotypes were not classified or categorized because all the genotypes used in this experiment were determinate type (Table 7).

4.4.1.3 Flowering behavior

The days to 50 per cent flowering varied significantly among the genotypes. The average days taken by the genotypes for fifty per cent flowering were grouped. The genotypes DMT-1, DMT-2, DMT-3, DMT-4, DMT-5, and DMT-6 were early flowering type (22.67-26.67 days after transplanting). However remaining genotypes were grouped as late flowering type (30.67-37.33 days after transplanting) viz Line No. C3, Line No. C4, IMP-B (oblong) IMP-B (round), IMP-D (round) and DM-4 (Table 7).

4.4.1.4 Foliage density

Foliage density largely varied among the tomato genotypes. Based on the foliage density tomato genotypes grouped as sparse, intermediate and dense are presented in Table 7.

Among 12 genotypes 10 genotypes were dense foliage type viz. DMT-1, DMT-2, DMT-4 DMT-6 DM-4, Line No. C3, Line No. C4, IMP-B (oblong) IMP-B (round), IMP-D (round) and DM-4 (Table 7).

4.4.1.5 Leaf type

On the basis of leaf type tomato genotypes were grouped in to hirsutum, dwarf, peruvianum, standard, potato leaf type (Table 7).

Among 12 genotypes five genotypes were standard viz. DMT-1, DM-4 Line No. C4, IMP-B (round), IMP-D (round), three genotypes were potato leaf type viz. DMT-6, DMT-3, DMT-2, one was dwarf type, viz. DMT-4, two were peruvianum viz. DMT-5, IMP-B (oblong), and one was hirsutum type viz. Line No. C3.
Table 6. Influence of organic manures on germination percentage shoot length, root length, SVI and field emergence (%) in tomato Cv. DMT-2

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Germination %</th>
<th>Shoot length (cm)</th>
<th>Root length (cm)</th>
<th>Seedling dry weight (mg)</th>
<th>Seedling vigour index</th>
<th>Field emergence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 – FYM (11.5t/ha)</td>
<td>85.92 (68.00)*</td>
<td>7.89</td>
<td>7.25</td>
<td>17.05</td>
<td>1228</td>
<td>71.55 (57.79)*</td>
</tr>
<tr>
<td>T2 – Vermicompost (5.75t/ha)</td>
<td>88.34 (70.07)*</td>
<td>8.85</td>
<td>7.98</td>
<td>18.21</td>
<td>1479</td>
<td>72.62 (58.48)*</td>
</tr>
<tr>
<td>T3 – Sheep manure (16.0t/ha)</td>
<td>90.16 (71.75)*</td>
<td>10.38</td>
<td>9.89</td>
<td>22.69</td>
<td>1927</td>
<td>72.44 (58.36)*</td>
</tr>
<tr>
<td>T4 – Poultry manure (07.0t/ha)</td>
<td>83.43 (66.01)*</td>
<td>10.54</td>
<td>10.25</td>
<td>22.51</td>
<td>1896</td>
<td>81.29 (64.40)*</td>
</tr>
<tr>
<td>T5 – Neem cake (2.2t/ha)</td>
<td>82.34 (65.18)*</td>
<td>9.72</td>
<td>11.4</td>
<td>18.49</td>
<td>1997</td>
<td>79.10 (62.83)*</td>
</tr>
<tr>
<td>T6 – FYM (5.75 t/ha) + Vermi compost (2.87 t/ha)</td>
<td>80.68 (63.96)*</td>
<td>8.39</td>
<td>8.40</td>
<td>20.55</td>
<td>1779</td>
<td>76.43 (60.99)*</td>
</tr>
<tr>
<td>T7 – FYM (5.75 t/ha) + Poultry manure (3.5 t/ha)</td>
<td>84.91 (67.18)*</td>
<td>8.55</td>
<td>8.09</td>
<td>23.04</td>
<td>1246</td>
<td>72.10 (58.15)*</td>
</tr>
<tr>
<td>T8 – FYM (5.75 t/ha) + Sheep manure (8.0 t/ha)</td>
<td>85.39 (67.56)*</td>
<td>8.62</td>
<td>8.36</td>
<td>19.72</td>
<td>1265</td>
<td>76.09 (60.76)*</td>
</tr>
<tr>
<td>T9 – FYM (5.75 t/ha) + Neem cake (1.1 t/ha)</td>
<td>84.35 (66.73)*</td>
<td>8.89</td>
<td>8.02</td>
<td>18.35</td>
<td>1269</td>
<td>74.57 (59.75)*</td>
</tr>
<tr>
<td>T10 – Recommended doses of chemical fertilizer (115:100:60 NPK kg/ha)</td>
<td>91.50 (73.09)*</td>
<td>11.54</td>
<td>10.82</td>
<td>23.59</td>
<td>2277</td>
<td>86.92 (68.83)*</td>
</tr>
<tr>
<td>T11 – RDF (FYM:40 t/ha + 115:100:60 NPKkg /ha)</td>
<td>95.89 (78.34)*</td>
<td>12.86</td>
<td>11.96</td>
<td>26.94</td>
<td>2349</td>
<td>88.33 (70.06)*</td>
</tr>
<tr>
<td>Mean</td>
<td>86.02 (68.08)*</td>
<td>9.66</td>
<td>9.31</td>
<td>21.01</td>
<td>1701</td>
<td>77.40 (61.65)*</td>
</tr>
<tr>
<td>SE m±</td>
<td>0.92</td>
<td>0.18</td>
<td>0.22</td>
<td>0.23</td>
<td>3.30</td>
<td>0.69</td>
</tr>
<tr>
<td>C.D. at 5%</td>
<td>3.69</td>
<td>0.74</td>
<td>0.87</td>
<td>0.93</td>
<td>13.29</td>
<td>2.78</td>
</tr>
</tbody>
</table>

* - Indicates arc sine transformed values
Legend

T₁ - FYM (11.5t/ha)
T₂ - Vermicompost (5.75t/ha)
T₃ - Sheep manure (16.0t/ha)
T₄ - Poultry manure (07.0t/ha)
T₅ - Neem cake (2.2t/ha)
T₆ - FYM (5.75 t/ha) + Vermi compost (2.87 t/ha)
T₇ - FYM (5.75 t/ha) + Poultry manure (3.5 t/ha)
T₈ - FYM (5.75 t/ha) + Sheep manure (8.0 t/ha)
T₉ - FYM (5.75 t/ha) + Neem cake (1.1 t/ha)
T₁₀ - Recommended doses of chemical fertilizer (115:100:60 NPK kg/ha)
T₁₁ - RDF (FYM:40 t/ha + 115:100:60 NPK kg/ha)

Fig. 6: Influence of organic manures on germination percentage, shoot length, root length, SVI and field emergence in tomato Cv. DMT-2
4.4.1.6 Exterior color of immature fruit

Based on exterior color of immature fruit genotypes were categorized into Greenish white, green and dark green (Table 7).

Greenish white colour genotypes included DMT-1, DMT-2 DMT-3, DMT-4, and DMT-5 DMT-6. Line No. C3 Line No. C4, IMP-D (round), green colour genotypes includes IMP-B (oblong), IMP-B (round), whereas dark green colour genotypes was DM-4.

4.4.1.7 Fruit shape

The fruit shape varied significantly among different tomato genotypes. So based on the shape of fruit genotypes were categorized into flattened, cylindrical, high rounded, rounded and heart shaped based on fruit shape (Table 7).

Among the 12 genotypes, one genotype was grouped into flattened viz. DMT-1. Whereas three genotypes were grouped as cylindrical shaped fruit type viz. DMT-2, DMT-5, IMP-B (oblong) and five genotypes were grouped into high rounded shaped fruit type viz., DMT-3, DMT-6, DM-4, and Line No. C4, IMP-B (round), one genotype grouped in to rounded shaped fruit type viz. DMT-4, Line No. C3 and one genotype grouped into heart shaped fruit type viz. IMP-D (round).

4.4.1.8 Fruit size

The fruit size varied significantly among different tomato genotypes. The genotypes were categorized into small, intermediate and large (Table 7).

Among the 12 genotypes, one genotype was grouped into small viz. Line No. C4. Whereas five genotypes grouped into intermediate viz. DMT-1, DMT-2, IMP-B (oblong), IMP-B (round) and IMP-D (round). The remaining six were grouped into large viz. DMT-3, DMT-4, DMT-5, DMT-6, DM-4 and Line No. C3.

4.4.1.9 Stem color

Based on stem color these tomato genotypes were not categorized because all genotypes showed the greenish white stem color (Table 8).

4.4.1.10 Flower character

Based on flower character these tomato genotypes were not categorized because all genotypes showed the yellow color petals with pentamarous flower (Table 8).

4.4.1.11 Days to maturity

Days to maturity varied significantly among different tomato genotypes. The genotypes were categorized into early and late (Table 8).

The genotypes DMT-1, DMT-2, DMT-3, DMT-4, DMT-5, and DMT-6 were grouped as early matured (38.33-40.67 days after transplanting) however remaining genotypes were grouped as late matured (49.33-53.33 days after transplanting) viz. Line No. C3, Line No. C4, IMP-B (oblong) IMP-B (round), IMP-D (round) and DM-4.

4.4.1.12 Exterior color of mature fruit

The exterior color of mature fruit varied significantly among different tomato genotypes. The genotypes were categorized into yellow and red (Table 8).

Genotypes DMT-1, DMT-2, DMT-3, Line No.C4 and Line No.C3 were grouped into yellow and the genotypes DMT-4, DMT-5, DMT-6, DM-4, IMP-B (oblong), IMP-B (round), IMP-D (round) were grouped into red.

4.4.1.13 Easiness of fruits to detach from pedicel

The easiness of fruits to detach from pedicel varied significantly among different tomato genotypes. Based on this morphological character genotypes were categorized into easy intermediate and difficult detachment of fruits from pedicel (Table 8). Genotypes Line No.C4, Line No.C3, DMT-6, DMT-1, and DMT-2 were grouped as Easy detacher where as the genotypes, IMP-D (round), IMP-B (oblong), IMP-B (round), DMT-4 and DMT-5 and genotypes DMT-3 and DM-4 as intermediate detacher and difficult detacher respectively.
Table 7. Distinguishing morphological characters (descriptors) of tomato genotypes

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Genotypes</th>
<th>Seedling leaf color</th>
<th>Plant growth type</th>
<th>Foliage density</th>
<th>Leaf type</th>
<th>Flowering behavior</th>
<th>Exterior color of immature fruit</th>
<th>Fruit shape</th>
<th>Fruit size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>DMT-1</td>
<td>Green</td>
<td>Determinate</td>
<td>Dense</td>
<td>Standard</td>
<td>26.67</td>
<td>Greenish white</td>
<td>Flattened</td>
<td>Intermediate</td>
</tr>
<tr>
<td>2.</td>
<td>DMT-2</td>
<td>Green</td>
<td>Determinate</td>
<td>Dense</td>
<td>Potato leaf type</td>
<td>25.67</td>
<td>Greenish white</td>
<td>Cylindrical</td>
<td>Intermediate</td>
</tr>
<tr>
<td>3.</td>
<td>DMT-3</td>
<td>Green</td>
<td>Determinate</td>
<td>Sparse</td>
<td>Potato leaf type</td>
<td>24.33</td>
<td>Greenish white</td>
<td>High rounded</td>
<td>Large</td>
</tr>
<tr>
<td>4.</td>
<td>DMT-4</td>
<td>Green</td>
<td>Determinate</td>
<td>Dense</td>
<td>Dwarf</td>
<td>23.00</td>
<td>Greenish white</td>
<td>Rounded</td>
<td>Large</td>
</tr>
<tr>
<td>5.</td>
<td>DMT-5</td>
<td>Green</td>
<td>Determinate</td>
<td>Intermediate</td>
<td>Peruvianum</td>
<td>22.67</td>
<td>Greenish white</td>
<td>Cylindrical</td>
<td>Large</td>
</tr>
<tr>
<td>6.</td>
<td>DMT-6</td>
<td>Green</td>
<td>Determinate</td>
<td>Dense</td>
<td>Potato leaf type</td>
<td>23.00</td>
<td>Greenish white</td>
<td>High rounded</td>
<td>Large</td>
</tr>
<tr>
<td>7.</td>
<td>DM-4</td>
<td>Greenish white</td>
<td>Determinate</td>
<td>Dense</td>
<td>Standard</td>
<td>30.67</td>
<td>Dark green</td>
<td>High rounded</td>
<td>Large</td>
</tr>
<tr>
<td>8.</td>
<td>LINE NO.C3</td>
<td>Green</td>
<td>Determinate</td>
<td>Dense</td>
<td>Hirsutum</td>
<td>34.67</td>
<td>Greenish white</td>
<td>Rounded</td>
<td>Large</td>
</tr>
<tr>
<td>9.</td>
<td>LINE NO.C4</td>
<td>Green</td>
<td>Determinate</td>
<td>Dense</td>
<td>Standard</td>
<td>35.33</td>
<td>Greenish white</td>
<td>High rounded</td>
<td>Small</td>
</tr>
<tr>
<td>10.</td>
<td>IMP-B(oblong)</td>
<td>Green</td>
<td>Determinate</td>
<td>Dense</td>
<td>Peruvianum</td>
<td>36.33</td>
<td>Green</td>
<td>Cylindrical</td>
<td>Intermediate</td>
</tr>
<tr>
<td>11.</td>
<td>IMP-B(round)</td>
<td>Greenish white</td>
<td>Determinate</td>
<td>Dense</td>
<td>Standard</td>
<td>34.67</td>
<td>Green</td>
<td>High rounded</td>
<td>Intermediate</td>
</tr>
<tr>
<td>12.</td>
<td>IMP-D(round)</td>
<td>Greenish white</td>
<td>Determinate</td>
<td>Dense</td>
<td>Standard</td>
<td>37.33</td>
<td>Greenish white</td>
<td>Heart shaped</td>
<td>Intermediate</td>
</tr>
</tbody>
</table>

Mean: 29.53
SE m±: 1.34
C.D. at 5%: 3.94

Large: 6.0x3.0 to 7.0x3.5cm
Intermediate: 4.0x2.5 to 5.9x2.99cm
Small: less than 4.0x2.5cm
Plate 2. Characterization of tomato genotypes by leaf density
Plate 3. Characterization of tomato genotypes based on leaf shape.
Plate 4. Characterization of tomato genotypes based on immature fruit colour

Dark green
Green
Greenish white
Plate 5. Characterization of tomato genotypes based on dominant fruit shape.
Table 8. Distinguishing morphological characters ( descriptors) of tomato genotypes

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Genotypes</th>
<th>Stem color</th>
<th>Flower character</th>
<th>Days to maturity</th>
<th>Exterior color of mature fruit</th>
<th>Easiness of fruits to detach from pedicel</th>
<th>Fruit shoulder shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>DMT-1</td>
<td>Greenish white</td>
<td>Yellow , pentamarous</td>
<td>38.33</td>
<td>Yellow</td>
<td>Easy</td>
<td>Flat</td>
</tr>
<tr>
<td>2.</td>
<td>DMT-2</td>
<td>Greenish white</td>
<td>Yellow ,pentamarous</td>
<td>39.00</td>
<td>Yellow</td>
<td>Easy</td>
<td>Flat</td>
</tr>
<tr>
<td>3.</td>
<td>DMT-3</td>
<td>Greenish white</td>
<td>Yellow ,pentamarous</td>
<td>39.00</td>
<td>Yellow</td>
<td>Difficult</td>
<td>Flat</td>
</tr>
<tr>
<td>4.</td>
<td>DMT-4</td>
<td>Greenish white</td>
<td>Yellow ,pentamarous</td>
<td>38.33</td>
<td>Yellow</td>
<td>Intermediate</td>
<td>Moderately depressed</td>
</tr>
<tr>
<td>5.</td>
<td>DMT-5</td>
<td>Greenish white</td>
<td>Yellow ,pentamarous</td>
<td>38.67</td>
<td>Red</td>
<td>Intermediate</td>
<td>Moderately depressed</td>
</tr>
<tr>
<td>6.</td>
<td>DMT-6</td>
<td>Greenish white</td>
<td>Yellow ,pentamarous</td>
<td>40.67</td>
<td>Red</td>
<td>Easy</td>
<td>Flat</td>
</tr>
<tr>
<td>7.</td>
<td>DM-4</td>
<td>Greenish white</td>
<td>Yellow ,pentamarous</td>
<td>51.33</td>
<td>Red</td>
<td>Difficult</td>
<td>Moderately depressed</td>
</tr>
<tr>
<td>8.</td>
<td>LINE NO.C3</td>
<td>Greenish white</td>
<td>Yellow ,pentamarous</td>
<td>50.00</td>
<td>Yellow</td>
<td>Easy</td>
<td>Flat</td>
</tr>
<tr>
<td>9.</td>
<td>LINE NO.C4</td>
<td>Greenish white</td>
<td>Yellow ,pentamarous</td>
<td>49.33</td>
<td>Yellow</td>
<td>Easy</td>
<td>Moderately depressed</td>
</tr>
<tr>
<td>10.</td>
<td>IMP-B(oblong)</td>
<td>Greenish white</td>
<td>Yellow ,pentamarous</td>
<td>52.67</td>
<td>Red</td>
<td>Intermediate</td>
<td>Moderately depressed</td>
</tr>
<tr>
<td>11.</td>
<td>IMP-B(round)</td>
<td>Greenish white</td>
<td>Yellow ,pentamarous</td>
<td>51.00</td>
<td>Red</td>
<td>Intermediate</td>
<td>Moderately depressed</td>
</tr>
<tr>
<td>12.</td>
<td>IMP-D(round)</td>
<td>Greenish white</td>
<td>Yellow ,pentamarous</td>
<td>53.33</td>
<td>Red</td>
<td>Intermediate</td>
<td>Moderately depressed</td>
</tr>
</tbody>
</table>

Mean: 45.14
SE m±: 1.46
C.D. at 5%: 4.28
Plate 6. Characterization of tomato genotypes based on fruit size
4.4.1.14 Fruit shoulder shape

The fruit shoulder shape varied significantly among different tomato genotypes. Based on this morphological descriptor genotypes were categorized into flat and moderately depressed (Table 8).

The genotypes DMT-1, Line No.C3, DMT-3, DMT-6 and DMT-2 were grouped as flat shoulder shape fruit where as the genotypes DMT-4 IMP-D (round), DM-4, Line No. C4I, MP-B (oblong), IMP-B (round) and DMT-5 were grouped as moderately depressed shoulder shape.

4.4.1.15 Easiness of fruit wall (skin) to be peeled

The easiness of fruit wall (skin) to be peeled varied significantly among different tomato genotypes. Based on this morphological descriptor genotypes were categorized into easy, intermediate and difficult (Table 9).

The variety DM-4 was grouped as Easy (skin could be removed easily). The genotypes Line No.C4, DMT-2, DMT-4, DMT-5, DMT-6, Line No.C3, and DMT-1 were grouped as intermediate. The genotypes DMT-3, IMPB (oblong), IMP-B (round), and IMP-D (round) were grouped as difficult.

4.4.1.16 Flesh color of pericarp

The flesh color of pericarp varied significantly among different tomato genotypes. Based on this character (flesh color of pericarp) genotypes were categorized into yellow and red (Table 9).

The genotypes DMT-1, DMT-2, DMT-3, DMT-4, DMT-5, and DMT-6, were grouped as yellow. The remaining genotypes viz DM-4, IMP-D (round), Line No.C4, IMP-B (oblong), IMP-B (round), and Line No. C3 were grouped as Red.

4.4.1.17 Flesh color intensity

The flesh color intensity varied significantly among different tomato genotypes. Based on this character (flesh color intensity) genotypes were categorized into dark, intermediate and light (Table 9).

The genotypes DMT-1, DMT-2, DMT-5, DMT-6, and Line No.C4 were grouped as intermediate. The genotypes Line No.C-3, DMT-4, and DMT-3 were grouped as light and remaining genotypes were grouped as dark viz, IMP-D (round), IMP-B (oblong), IMP-B (round), Line No.C3, and DM-4.

4.4.1.18 Fruit cross sectional shape

The fruit cross sectional shape varied significantly from genotypes to genotypes. Based on the Fruit cross sectional shape genotypes were categorized into angular, irregular and round (Table 9).

The genotypes DMT-1, DMT-2, DMT-3, DMT-5, Line No.C3 IMP-B (round), and IMP-D (round), were grouped as round. The genotypes DM-4 and DMT-4, were grouped as irregular and remaining genotypes IMP-B (oblong), Line No. C4 and DMT-6 were grouped as angular.

4.4.1.19 Number of locules

The number of locules in a fruit varied among different genotypes of tomato. Based on the number of locules present in a fruit genotypes were categorized into two loculed, three loculed, five loculed and six loculed (Table 9).

The genotypes DMT-1, DMT-2, DMT-3 DMT-5, Line No.C3 IMP-B (round), and IMP-D (round) were grouped as two loculed. The genotypes Line No. C-4, DMT-6, and IMP-B (oblong) three loculed, DMT-4 was grouped as five loculed and the variety DM-4 was grouped as six loculed.

4.4.1.20 Shape of pistil scar

The shape of pistil scar varied significantly among different tomato genotypes. Based on the Shape of pistil scar genotypes were categorized into irregular and stellate (Table 9).
Plate 7. Characterization of tomato genotypes based on skin colour of ripe fruit

Red

Yellow

Plate 8. Characterization of tomato genotypes based on fruit shoulder shape

Depressed

Flat
Plate 9. Characterization of tomato genotypes based on fruit cross sectional shape
The genotypes DMT-1, DMT-2, DMT-3 DMT-5, Line No.C3, IMP-B (round), IMP-D (round), Line No. C-4, DMT-6, and IMP-B (oblong) were grouped as stellate type of pistil scar. The remaining genotypes viz DMT-4 and DM-4 were grouped as irregular type of pistil scar.

4.4.1.21 Fruit blossom end shape

The fruit blossom end shape varied significantly among different tomato genotypes. Based on the fruit blossom end shape genotypes were categorized into flat, intended and pointed (Table 9).

The genotypes DMT-1, DMT-3 and DMT-5 were grouped as pointed. The genotypes IMP-D (round), DMT-6, Line No. C3, Line No.C4, DMT-2 and IMP-B (oblong) were grouped as flat, genotypes IMP-B (round), DM-4, and DMT-4 were grouped as Intended.

4.4.1.22 Test weight

Based on test weight these tomato genotypes were not categorized because non-significant difference in test weight among the tomato genotypes (Table 9).

4.5 Varietal response to various chemical tests

The laboratory experiments were conducted to characterize the tomato genotypes based on, response to various chemicals are presented in this chapter.

The colour pattern of various chemicals soaking of seed for the different genotypes.

4.5.1 Phenol test

The genotypes which were used in this test could not change their color even after 24 hours of soaking because of absence of tyrosinase activity. So all the genotypes were scaled as “0” (negative or no change of color). DMT-1, DMT-2, DMT-3, DMT-4, DMT-5, DMT-6, DM-4, Line No. C3, Line No. C4, IMP-B (oblong), IMP-B (round), and IMP-D (round), all genotypes exhibited colorlessness. It indicated that phenol test is negative test for these tomato genotypes (Table 10).

4.5.2 Modified phenol test

The genotypes which were used in this test could not change their color even after 24 hours of soaking because of absence of tyrosinase activity. So all genotypes were scaled as “0” (negative or no change of color). DMT-1, DMT-2, DMT-3, DMT-4, DMT-5, DMT-6, DM-4, Line No. C3, Line No. C4, IMP-B (oblong), IMP-B (round), and IMP-D (round), all genotypes exhibited colorlessness. It indicated that Modified phenol test is negative test for these tomato genotypes (Table 10).

4.5.3 Peroxidase test

The genotypes which used in this experiment were not showed high peroxidase activity. So all genotypes were grouped as colorlessness (absent)

DMT-1, DMT-2, DMT-3, DMT-4, DMT-5, DMT-6, DM-4, Line No. C3, Line No. C4, IMP-B (oblong), IMP-B (round), and IMP-D (round), all genotypes exhibited colorlessness. It indicated that peroxidase test negative test for these tomato genotypes (Table 10).

4.5.4 Potassium hydroxide (KOH) test

Potassium hydroxide test at 0.5 per cent concentration was used to distinguish and grouped the genotypes based on seed coat colour obtained. There was no change in the color of seed coat. (Table 10)

Genotypes DMT-1, DMT-2, DMT-3, DMT-4, DMT-5, DMT-6, DM-4, Line No. C3, Line No. C4, IMP-B (oblong), IMP-B (round) and IMP-D (round), exhibited colourlessness, it indicated that Potassium hydroxide (KOH) test is a negative test for these tomato genotypes

4.5.5 Sodium hydroxide (NaOH) test

Sodium hydroxide test at 0.5 per cent concentration was used to distinguish the genotypes and were grouped based on their colour pattern. However there was no change in colour of seeds.
Table 9: Distinguishing morphological characters (descriptors) of tomato genotypes

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Genotypes</th>
<th>Easiness of fruit wall(skin) to be peeled</th>
<th>Fruit cross sectional shape</th>
<th>Flesh color of pericarp</th>
<th>Flesh color intensity</th>
<th>Number of locules</th>
<th>Shape of pistil scar</th>
<th>Fruit blossom end shape</th>
<th>Test weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>DMT-1</td>
<td>Intermediate</td>
<td>Round</td>
<td>Yellow</td>
<td>Intermediate</td>
<td>2</td>
<td>Stellate</td>
<td>pointed</td>
<td>2.62</td>
</tr>
<tr>
<td>2.</td>
<td>DMT-2</td>
<td>Intermediate</td>
<td>Round</td>
<td>Yellow</td>
<td>Intermediate</td>
<td>2</td>
<td>Stellate</td>
<td>Flat</td>
<td>2.60</td>
</tr>
<tr>
<td>3.</td>
<td>DMT-3</td>
<td>difficult</td>
<td>Round</td>
<td>Yellow</td>
<td>Light</td>
<td>2</td>
<td>Stellate</td>
<td>Pointed</td>
<td>2.62</td>
</tr>
<tr>
<td>4.</td>
<td>DMT-4</td>
<td>Intermediate</td>
<td>Irregular</td>
<td>Yellow</td>
<td>Light</td>
<td>5</td>
<td>Irregular</td>
<td>Intended</td>
<td>2.61</td>
</tr>
<tr>
<td>5.</td>
<td>DMT-5</td>
<td>Intermediate</td>
<td>Round</td>
<td>Yellow</td>
<td>Intermediate</td>
<td>2</td>
<td>Stellate</td>
<td>Pointed</td>
<td>2.60</td>
</tr>
<tr>
<td>6.</td>
<td>DMT-6</td>
<td>Intermediate</td>
<td>Angular</td>
<td>Yellow</td>
<td>Intermediate</td>
<td>3</td>
<td>Stellate</td>
<td>Flat</td>
<td>2.66</td>
</tr>
<tr>
<td>7.</td>
<td>DM-4</td>
<td>Easy</td>
<td>Irregular</td>
<td>Red</td>
<td>Dark</td>
<td>6</td>
<td>Irregular</td>
<td>Intended</td>
<td>2.62</td>
</tr>
<tr>
<td>8.</td>
<td>LINE NO.C3</td>
<td>Intermediate</td>
<td>Round</td>
<td>Red</td>
<td>Light</td>
<td>2</td>
<td>Stellate</td>
<td>Flat</td>
<td>2.62</td>
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<tr>
<td>9.</td>
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<td>Red</td>
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<tr>
<td>10.</td>
<td>IMP-B(oblong)</td>
<td>difficult</td>
<td>Angular</td>
<td>Red</td>
<td>Dark</td>
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<td>Stellate</td>
<td>Flat</td>
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<tr>
<td>11.</td>
<td>IMP-B(round)</td>
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<td>Dark</td>
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<td>Round</td>
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<td>Dark</td>
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<td>Flat</td>
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Table 10. Characterization of tomato genotypes based on number of locules
Plate 11. Characterization of tomato genotypes based on shape of pistil scar
Plate 12. Characterization of tomato genotypes based on fruit blossom end shape.
Table 10: Grouping of tomato genotypes based on chemical tests

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>Phenol test</th>
<th>Modified phenol test</th>
<th>Peroxidase test</th>
<th>NaOH test</th>
<th>KOH test</th>
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<td>Absent</td>
<td>Absent</td>
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<tr>
<td>DM-4</td>
<td>Absent</td>
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<td>Absent</td>
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<tr>
<td>IMP-B(oblong)</td>
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<tr>
<td>IMP-B(round)</td>
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<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
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<tr>
<td>IMP-D(round)</td>
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<td>Absent</td>
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<td>Absent</td>
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</table>
Table 11: Grouping of tomato genotypes based on seedling growth response to GA$_3$ (100 ppm) application in terms of per cent increase over control

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>Control (cm)</th>
<th>Seedling response (cm)</th>
<th>Per cent increase over control</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMT-1</td>
<td>11.44</td>
<td>14.61</td>
<td>27.19</td>
<td>Medium response</td>
</tr>
<tr>
<td>DMT-2</td>
<td>13.18</td>
<td>16.55</td>
<td>24.29</td>
<td>Medium response</td>
</tr>
<tr>
<td>DMT-3</td>
<td>17.26</td>
<td>21.01</td>
<td>24.53</td>
<td>Medium response</td>
</tr>
<tr>
<td>DMT-4</td>
<td>16.10</td>
<td>20.77</td>
<td>36.63</td>
<td>High response</td>
</tr>
<tr>
<td>DMT-5</td>
<td>12.77</td>
<td>19.05</td>
<td>52.69</td>
<td>High response</td>
</tr>
<tr>
<td>DMT-6</td>
<td>10.50</td>
<td>16.12</td>
<td>40.05</td>
<td>High response</td>
</tr>
<tr>
<td>DM-4</td>
<td>13.81</td>
<td>15.96</td>
<td>25.44</td>
<td>Medium response</td>
</tr>
<tr>
<td>LINE NO.C3</td>
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<td>16.25</td>
<td>19.45</td>
<td>Low response</td>
</tr>
<tr>
<td>LINE NO.C4</td>
<td>16.23</td>
<td>17.76</td>
<td>13.85</td>
<td>Low response</td>
</tr>
<tr>
<td>IMP-B(oblong)</td>
<td>18.35</td>
<td>24.55</td>
<td>32.28</td>
<td>High response</td>
</tr>
<tr>
<td>IMP-B(round)</td>
<td>18.16</td>
<td>24.27</td>
<td>41.21</td>
<td>High response</td>
</tr>
<tr>
<td>IMP-D (round)</td>
<td>17.36</td>
<td>11.04</td>
<td>11.8</td>
<td>Low response</td>
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<tr>
<td>Mean</td>
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<td>17.36</td>
<td>50.42</td>
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<tr>
<td>S.Em ±</td>
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<td>1.19</td>
<td>7.58</td>
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</tr>
<tr>
<td>CD (0.05)</td>
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</tr>
<tr>
<td>CV</td>
<td>5.42</td>
<td>11.02</td>
<td>40.62</td>
<td></td>
</tr>
</tbody>
</table>

Note: Low response : < 20% increase over control  
Medium response : 20 – 30% increase over control  
High response : > 30% increase over control
Table 12: Grouping of tomato genotypes based on seedling growth response to 2, 4-D (5 ppm) application in terms of percent decrease over control

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>Control (cm)</th>
<th>Seedling response (cm)</th>
<th>Per cent decrease over control</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMT-1</td>
<td>11.57</td>
<td>7.98</td>
<td>42.70</td>
<td>Moderate affected</td>
</tr>
<tr>
<td>DMT-2</td>
<td>13.89</td>
<td>8.35</td>
<td>61.60</td>
<td>Highly affected</td>
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<td>33.20</td>
<td>Moderate affected</td>
</tr>
<tr>
<td>DMT-5</td>
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<td>10.05</td>
<td>26.06</td>
<td>Least affected</td>
</tr>
<tr>
<td>DMT-6</td>
<td>10.98</td>
<td>8.95</td>
<td>22.59</td>
<td>Least affected</td>
</tr>
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<td>DM-4</td>
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<td>Moderate affected</td>
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<td>13.70</td>
<td>11.58</td>
<td>15.99</td>
<td>Least affected</td>
</tr>
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<td>14.75</td>
<td>11.02</td>
<td>24.10</td>
<td>Least affected</td>
</tr>
<tr>
<td>IMP-B(oalong)</td>
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<td>13.65</td>
<td>36.65</td>
<td>Moderate affected</td>
</tr>
<tr>
<td>IMP-B(round)</td>
<td>15.83</td>
<td>10.24</td>
<td>62.20</td>
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</tr>
<tr>
<td>IMP-D (round)</td>
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<td>11.25</td>
<td>61.69</td>
<td>Highly affected</td>
</tr>
<tr>
<td>Mean</td>
<td>14.25</td>
<td>10.88</td>
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<tr>
<td>S.Em ±</td>
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<td>0.69</td>
<td>0.97</td>
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</tr>
<tr>
<td>CD (0.05)</td>
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<td>10.96</td>
<td>4.70</td>
<td></td>
</tr>
</tbody>
</table>

Note:
- Least affected: < 30% decrease over control
- Moderate affected: 30-50% decrease over control
- Highly affected: > 50% decrease over control
Table 13: Data indicating that coefficient of similarity among the tomato genotypes

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<tr>
<th></th>
<th>G1</th>
<th>G2</th>
<th>G3</th>
<th>G4</th>
<th>G5</th>
<th>G6</th>
<th>G7</th>
<th>G8</th>
<th>G9</th>
<th>G10</th>
<th>G11</th>
<th>G12</th>
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<td>0.99</td>
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<td>0.97</td>
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<td>0.97</td>
<td>0.97</td>
<td>0.99</td>
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Genotypes DMT-1, DMT-2, DMT-3, DMT-4, DMT-5, DMT-6, DM-4, Line No. C3, Line No. C4, IMP-B (oblong), IMP-B (round) and IMP-D (round), exhibited colorlessness. It indicated that Sodium hydroxide (NaOH) test is a negative test for these tomato genotypes (Table 10).

4.5.6 GA\textsubscript{3} test

The data on seedling growth response to GA\textsubscript{3} (100 ppm) application in terms of per cent increase over control and their grouping of different genotypes are presented in (Table 11).

The enhancement of seedling length due to exogenous application of GA\textsubscript{3} showed considerable variation among the genotypes. Highest (52.69\%) seedling length over control was observed in DMT-5 lowest (13.85 \%) seedling length over control was observed in Line No. C4. Genotypes differed significantly with regards to seedling length and grouped as high responsive (> 30.00\% increase over control), medium responsive (20.00-30.00\% increase over control) and low responsive (<20\% increase over control).

High response genotypes were, DMT-5 (52.69\%), DMT-6 (40.05\%), DMT-4 (36.63\%), IMP-B (round) (41.21\%) and IMP-B (oblong) (32.28\%). Medium response genotypes DMT-1 (27.19\%), DMT-2, (24.29\%) DMT-3 (24.53\%), DM-4 (25.44\%), whereas low response genotypes were Line No. C3 (19.45\%), Line No. C4 (13.85\%), and IMP-D (round) (11.80\%) for the GA\textsubscript{3} application (Table 11).

4.5.7 2-4-D test

The data on seedling growth response to 2, 4-D (5ppm) application in terms of per cent decrease over control and their classification are presented in (Table 12).

The application of 2, 4-D in general decreased the seedling length over control. High affected variety was IMP-B (round) (62.20 \% decrease over control) and least affected variety was DMT-3 (14.07 \% decrease over control). Significant differences were observed among the genotypes with respect to 2, 4-D application and classified into high affected (> 50\% decrease over control) moderate affected (30.00-50.00\% decrease over control) and least affected (<30\% decrease over control).

High affected genotypes were DMT-2 (61.60\%), IMP-B (round) (62.20\%), IMP-D (round) (61.69\%) moderate affected genotypes were DMT-1 (42.70\%), DMT-4 (33.20\%), DM-4 (30.06\%) IMPB (oblong) (36.65\%) whereas least affected genotypes were DMT-3 (14.07\%), DMT-5 (26.06\%), DMT-6 (22.59\%), over control of the 2, 4-D application (Table 12).

4.6 Molecular characterization by RAPD analysis

Twelve tomato genotypes were analyzed for molecular characterization using twenty random decamer primers. Fourteen primers produced polymorphic bands among twenty and revealed a high DNA polymorphism among the genotypes. Twenty primers produced a total of 100 amplified products, among them 31 were polymorphic with an average of 28.72 per cent polymorphism (Table 14). The primers OPD-16 showed 80 per cent polymorphism OPE-08 showed 66.66 percent polymorphism and the primers (OPE-19 & OPG-08) showed 60 percent of polymorphism while the primers OPF-19 and OPF-05 showed least polymorphism (14.28 per cent) compared to others. The number of bands ranged from 3 (OPA-06) to 9 (OPE-08) with an average of 5.00 bands per primer and 1.55 bands per primer were polymorphic.

The similarity coefficient ranged from 0.88 to 0.99 (Table 13). The highest molecular diversity was observed between the genotypes DMT-3 and DMT-6 with similarity coefficient (Sij) of 0.88. High similarity with Sij 0.99 was observed between genotypes DMT-5 and DM-4, DMT-5 and LINE NO.C3, IMP-B (oblong) and DM-4, IMP-B (round) and IMP-D (round)
Genotypes DMT-1 and DMT-2 are closely related with Sij value 0.97.

The dendrogram constructed from pooled data revealed two major clusters with eight sub cluster. The genotypes which fell in first cluster DMT-1, DMT-6 and DMT-2 were 92 percent similar with remaining genotypes. However the genotypes DMT-5 and DM-4 showed the greater similarity with other genotypes (Table 14).
Table 14: RAPD banding patterns generated using twenty primers for twelve different tomato genotypes

<table>
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<th>Sl. No.</th>
<th>Primer</th>
<th>Number of bands</th>
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<th>Monomorphic</th>
<th>Percent polymorphism</th>
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<td></td>
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Fig 7. Dendrogram representing twelve genotypes of tomato
Plate 13. DNA banding pattern of 12 tomato genotypes with OPA-04

Plate 14. DNA banding pattern of 12 tomato genotypes with OPB-02
Plate 15. DNA banding pattern of 12 tomato genotypes with OPF-12 and OPF-19
5. DISCUSSION

The production of economic yield in any crop generally depends upon the cumulative effects of interactions among several factors such as genetic make up of crop variety, climatic factors, mineral nutrition and cultural practices adopted. Various environmental factors such as temperature, light, rainfall and relative humidity that prevail during different plant growth stages and development exert considerable influence on vegetative growth, seed yield and seed quality, as well as the incidence of certain pests and diseases. The seed yield and quality depend upon the production of photosynthates and their partitioning in the plant.

Application of organic manures has been a noble and traditional practice of maintaining soil health and fertility. The importance of organic manures is, now-a-days realized because of high cost of fertilizers and their inherent capacity to supply most essential nutrients for a balanced nutrition to the crop growth. Organic nutrients generally facilitate crop rooting, improve water retention capacity and results in the even distribution of nutrients in soil profile.

India has made spectacular breakthrough in production and consumption of fertilizers during the last four decades. But consumption of chemical fertilizers will be quite a limiting factor for increasing agriculture production in future. Because of escalating energy cost, chemical fertilizers are not available at affordable prices to farmers. Moreover, the unbalanced and continuous use of chemical fertilizers is leading to reduction in crop yields and in imbalanced of nutrients in the soil which has adverse effect on soil health.

Although, chemical fertilizers are playing a crucial role to meet the nutrient requirement of the crop, persistent nutrient depletion is posing a greater threat to the sustainable agriculture. Therefore, there is an urgent need to reduce the usage of chemical fertilizers and in turn increase in the usage of organics which are needed to check the yield and quality levels. The aforesaid consequences have paved way to grow tomato using different organic manures and biofertilizer. Use of organic manures alone or in combination with chemical fertilizers, helps in improving physico-chemical properties of the soil and also improves the efficient utilization of applied fertilizers. Considering the importance of these organic manures and their utility, the present investigation was undertaken to find out the Effect of organic manures on growth, seed yield and quality in tomato. The results obtained in this study are discussed below.

5.1 Effect of organic manures on seed yield and quality in tomato var. DMT-2

5.1.1 Effect of manures on plant growth parameters

Significant differences in 50% flowering, plant height, number of truss per plant, number of cluster per truss, number of cluster per plant due to sources of nutrition were noticed.

Maximum plant height at 60, 90, and 120 DAT (65.20, 107.85 and 164.58 cm), significantly less number of days for 50% flowering (36.10 days), significantly highest number of truss per plant (12.10/truss), number of cluster per truss (4.33/plant) and number of cluster per plant (11.27/plant) were observed with application of recommended dose of fertilizer (FYM40 t/ha + 115:100:60 kg NPK/ha). while, application of FYM alone (11.5 t/ha) recorded significantly lowest values for the parameters like trusses per plant (3.33 trusses/plant), clusters per truss (1.07 clusters/truss) and truss per plant (2.40 truss/plant).

Significantly superior values with respect to growth parameters recorded by recommended dose of fertilizer (FYM: 40 t/ha + 115:100:60 kg NPK/ha). It might be attributed to the quick and readily availability of essential elements like N,P and K to the plants at all stages of plant growth. These results are supported by the report of Sharma (1995) in tomato, Wange and Kale (2004) in brinjal.
5.1.2 Effect of organic manures on yield and yield components

Significant increase in the number of flower per cluster (11.80/cluster), number of fruits per truss (12.75/truss), number of fruits per plant (47.13), number of seeds (110.44), seed yield per plant (30.24 g), 1000 seed weight (2.87), seed yield per plot (241.72 g) seed yield per hectare (108.28 kg) were found in T11 treatment (40 t/ha + 115:100:60 kg NPK/ha) followed by T10 treatment.

While significantly lesser number of flower per cluster (4.20/cluster), number of fruits per truss (8.54/truss) in FYM (11.5/ha), number of fruits per plant (31.43) seed yield per plot (189.98) in vermicompost (5.75 t/ha) number of seeds (80.77). Seed yield per plant (14.65 g), 1000 seed weight (2.42), seed yield per hectare (87.85 kg) in FYM (11.5 t/ha) were noticed.

These results are in conformation with report of Amrithalingam (1988) in chilli and Shashidhara (2000) in Chilli., which worked as an efficient photosynthetic structure and produced high amount of carbohydrates in the plant system. Similar findings were also reported by Amburani et al. (2002) in brinjal.

Increase in seed yield and its components may be attributed due to increase in 1000 seed weight, seed weight per fruit as a result of improvement in seed number due to adequate mother plant nutrition. Further, it can be ascribed due to influence of other yield attributes such as number of fruits per plant and fruit weight per plant. Similar findings were also reported by Thamizh and Nanjan (1998) in potato and Shashidhara (2000) in chilli.

5.1.3 Effect of organic manures on seed quality parameters

Seed quality parameters exhibited significant differences due to manures application.

Seed germination percentage, shoot length, root length, seedling vigour index seedling dry weight and field emergence was significantly higher (95.89%, 12.86 cm, 11.96 cm, 2349 and 26.94 mg 88.33% respectively) in T11 treatment (RDF- FYM 40t/ha 115:100:60 kg NPK/ha), which was followed by T10 treatment (Recommended Dose of Chemical Fertilizer -115:100:60 kg NPK/ha). Whereas, significantly lower seed quality parameters were observed in T1 treatment (FYM @ 11.50 t/ha) (85.92%, 7.89 cm, 7.25 cm, 1228 and 17.05 mg, 71.55 % respectively) were observed.

Significant increase in the seed quality parameters noticed in T11 treatment may be due to higher fruit weight, number of seeds per fruit and 1000 seed weight as evident from this study, which might have produced more number of heavier and bolder seeds contributing to better seed quality, these results are in confirmation with the report of Amrithalingam (1988) in chilli and Shashidhara (2000) in chilli.

5.2 Plant morphological characters

Use of plant diagnostic characteristics to identify a variety has been classical taxonomic approach for both varietal purity testing and varietal identification. Seedling leaf color, days to maturity, flowering behavior, Foliage density, leaf type, exterior color of immature fruit, fruit shape, exterior color of mature fruit, easiness of fruits to detach from pedicel, fruit shoulder shape, easiness of fruit wall to be peeled, skin color of ripe fruit, flesh color of pericarp, flesh color intensity, fruit cross sectional shape number of locules shape of pistil scar and fruit blossom end shape showed significant difference among the 12 tomato genotypes.

The present study on some morphological descriptors for characterization viz., plant growth type, stem color, flower character and test weight did not show any difference in any of the tomato genotypes, and hence no varietal identification could be made. Hence, these descriptors are found to be unsuitable for characterization of tomato genotypes.

The significant difference was observed among the genotypes for foliage density. Based on the foliage density, the genotypes were grouped into three categories as dense, inter mediate and sparse. Similar result were reported by Kwon et al. (1987), Muhammad Arshad et al. (2006), Purnima et al. (2008) in soybean, Avasthi and Rao (2007) in linseed and Sudhakar et al. (2007) in sesame. The variation in the branches was mainly due to genetic factors.
5.2.1 Leaf morphological characters

Leaf color varied from variety to variety. Among 12 genotypes nine genotypes were green foliage viz. DMT-1, DMT-2, DMT-3, DMT-4, DMT-5, DMT-6, DM-4, Line No. C3, Line No. C4, IMP-B (oblong) and remaining genotypes were greenish white foliage viz IMP-B (round), IMP-D (round) and DM-4. Several workers characterized genotypes on the basis of leaf color viz., Similar studies on varietal variation based on seedling morphology were done in rice (Anon., 1999), French bean (Chandrashekhar, 2005), soybean (Agarwal and Pawar, 1990) and blackgram (Chakraborthy and Agarwal, 1989).

Leaf shape varied from variety to variety. All 12 genotypes were grouped into five groups as standard, potato leaf type, dwarf, peruvianum and hirsutum. Standard leaf shape observed in DMT-1, DM-4, Line No. C4, IMP-B (round) AND IMP-D (round) genotypes whereas DMT-2, DMT-3, and DMT-6 were potato leaf type, genotypes DMT-5 and IMP-B (oblong) grouped into peruvianum ovate and remaining genotypes DMT-4 and Line No. C3 categorized into dwarf and hirsutum resp.. Several workers characterized genotypes on the basis of leaf shape viz., Koszykowski and Burgoon (1983), Agrawal (1984), Tunwar and Singh (1985), in soybean; Sankarapandian (2002) in cow pea. Tarasatyavathi et al. (2004) characterized 75 released soybean genotypes based on leaf shape (lanceolate, pointed ovate, rounded ovate, triangular).

5.2.2 Flower morphological characters

Flowering behavior varied from variety to variety. The genotypes DMT-1, DMT-2, DMT-3, DMT-4, DMT-5, and DMT-6 were early flowering type (22.67-26.67 days after transplanting). However remaining were grouped as late flowering type (30.67-37.33 days after transplanting) viz Line No. C3, Line No. C4, IMP-B (oblong) IMP-B (round), IMP-D (round) and DM-4. Similar results were reported by Muhammad Arshad et al. (2006), Purnima et al. (2008), Manjaya and Bapat (2008) in soybean; Rajendra Prasad et al. (2003) in sunflower; Avasthi and Rao (2007) in niger; Cupic et al. (2009) in cow pea. Reasons attributed for difference in days to 50 per cent flowering among the genotypes is that the character is dependent on a minor gene complex. The environmental conditions also have selective influence on flowering.

5.2.3 Fruit morphological characters

The fruit characteristics influence the yielding ability of the plant. The genotypic variation was observed for various characteristics such as days to fruit maturity, exterior color of fruit, fruit shape, fruit size, exterior color of mature fruit, easiness of fruits to detach from pedicel, fruit shoulder shape easiness of fruit wall to be peeled skin color of ripe fruit, flesh color of pericarp, flesh color intensity fruit cross sectional shape, number of locules, shape of pistil scar and fruit blossom end shape. This helps for classifying the genotypes into different groups.

The days to fruit maturity is one of the important morphological character which helps to identify one variety from others. Based on the maturity stage the genotypes DMT-1, DMT-2, DMT-3, DMT-4, DMT-5, and DMT-6 were grouped as early matured (38.33-40.67 days after transplanting) however remaining genotypes were grouped as late matured (49.33-53.33 days after transplanting). Similar type of varietal characterization was made by Chandrashekhar (2005) in French bean.

The exterior color of fruit is one of the important morphological character which helps to identify one variety from others. Based on the exterior color of fruit. The genotypes DMT-1, DMT-2, DMT-3, DMT-4, DMT-5, DMT-6, Line No. C3, Line No. C4 and IMP-D (round) were grouped as greenish white type where as IMP-B (oblong) and IMP-B (ROUND) as green. One genotype DM-4 as dark green similar results were reported by Ravikumar (1999) in soybean; Sankarapandian (2002) in cow pea; Muthiah (2006) in green gram. The variation in the pod colour was due to genetical control.

The fruit shape is also one of the morphological character which helps to identify one genotypes from others. Based on fruit shape genotypes were categorized into Flattened, Cylindrical, High rounded, Rounded and heart shaped.
The genotype DMT-1 as flattened, the genotypes DMT-2, DMT-5 and IMP-B (oblong) as cylindrical, the genotypes DMT-3, DMT-6, DM-4, Line No. C4 and IMP-B (round) as high rounded, the genotypes DMT-5 and IMP-B (oblong) as cylindrical, the genotype IMP-D (round) as heart shaped similar results were reported by Ezekiel et al. (2011) in tomato, Muthiah (2006) in green gram. The variation in fruit shape was due to genetical control.

The fruit size one genotype of the morphological character which helps to identify one genotypes from others and genotypes were grouped into small viz. Line No. C4, five genotypes grouped into intermediate viz. DMT-1, DMT-2, IMP-B (oblong), IMP-B (round), IMP-D (round) and remaining six were grouped into large viz DMT-3, DMT-4, DMT-5, DMT-6, DM-4, Line No. C3

The Exterior color of mature fruit varied from genotypes to genotypes among different tomato genotypes. The genotypes were categorized into yellow and red. Genotypes DMT-1, DMT-2, DMT-3, Line No. C4, Line No. C3 were grouped into yellow and the genotypes DMT-4, DMT-5, DMT-6, DM-4, IMP-B (oblong), IMP-B (round), IMP-D (round) were grouped into red

The Easiness of fruits to detach from pedicel Varied significantly among different tomato genotypes. The genotypes were categorized into easy intermediate and difficult detachment of fruits from pedicel. Genotypes Line No. C4, Line No. C3, DMT-6, DMT-1, DMT-2 were grouped as easy detacher where as the genotypes, IMP-D (round), IMP-B (oblong), IMP-B (round), DMT-4, DMT-5 and genotypes DMT-3, DM-4 as intermediate detacher and difficult detacher respectively.

The Fruit shoulder shape varied significantly among different tomato genotypes. The genotypes were categorized into Flat and moderately depressed. Genotypes DMT-1, Line No. C3, DMT-3, DMT-6, DMT-2 were grouped as flat shoulder shape fruit where as the genotypes DMT-4, IMP-D (round), DM-4, Line No. C4, IMP-B (oblong), IMP-B (round), DMT-5 were grouped as moderately depressed shoulder shape.

The easiness of fruit wall (skin) to be peeled varied significantly among different tomato genotypes. The genotypes were categorized into Easy, Intermediate, and Difficult. The variety DM-4 was grouped as Easy, The genotypes Line No. C4, DMT-2, DMT-4, DMT-5, DMT-6, Line No. C3, DMT-1 were grouped as Intermediate, genotypes DMT-3, IMPB (oblong), IMP-B (round), IMP-D (round) were grouped as difficult

The Skin color of ripe fruit varied significantly among different tomato genotypes. Based on the skin color of ripe fruit were catagarise3d into yellow and colorless. The genotypes DMT-1, DMT-2 IMP-D (round), DMT-3, DMT-4, DMT-5, DMT-6, DM 4, IMPB (oblong), IMP-B (round), were grouped as yellow, the genotypes Line No. C4, Line No. C3 were grouped as colorless.

The Flesh color of pericarp varied significantly among different tomato genotypes. Based on the Flesh color of pericarp were catagarise3d into yellow, pink and red. The genotypes DMT-1, DMT-2, DMT-3, DMT-4, DMT-5, DMT-6, were grouped as yellow, the variety DM-4 was grouped as pink and remaining genotypes IMP-D (round), Line No. C4, IMP-B (oblong), IMP-B (round), Line No. C3 were grouped as red.

The Flesh color intensity varied significantly among different tomato genotypes. Based on the Flesh color intensity genotypes were categorized into Dark, Intermediate and Light. The genotypes DMT-1, DMT-2, DMT-5, DMT-6, Line No. C4 were grouped as Intermediate. The genotypes Line No. C-3, DMT-4, DMT-3 were grouped as Light and remaining genotypes were grouped as IMP-D (round), IMP-B (oblong), IMP-B (round), Line No. C3, DM 4

The Fruit cross sectional shape varied significantly among different tomato genotypes. Based on the Fruit cross sectional shape genotypes were categorized into Angular, Irregular and Round
The genotypes DMT-1, DMT-2, DMT-3, DMT-5, Line No. C3 IMP-B (round), IMP-D (round), were grouped as round. The genotypes DM-4, DMT-4, were grouped as Irregular and remaining genotypes, IMP-B (oblong), Line No. C4, DMT-6 were grouped as Angular.

The number of locules in a fruit varied significantly among different tomato genotypes. Based on the number of locules genotypes were categorized into two loculed, three loculed, five loculed, and six loculed.

The genotypes DMT-1, DMT-2, DMT-3, DMT-5, Line No. C3 IMP-B (round), IMP-D (round), were grouped as two loculed. The genotypes Line No. C-4, DMT-6, IMP-B (oblong) were grouped as Irregular and remaining genotypes. DM-4 was grouped as five loculed and the variety DM-4 was grouped as six loculed.

The Shape of pistil scar varied significantly among different tomato genotypes. Based on the Shape of pistil scar genotypes were categorized into Irregular and Stellate.

The genotypes DMT-1, DMT-2, DMT-3, DMT-5, Line No. C3, IMP-B (round), IMP-D (round), Line No. C-4, DMT-6, IMP-B (oblong) were grouped as Stellate. The genotypes were grouped as Irregular and remaining genotypes DMT-4 DM-4 were grouped as Irregular.

The Fruit blossom end shape varied significantly among different tomato genotypes. Based on the Fruit blossom end shape genotypes were categorized into Flat, Intended and pointed.

The genotypes DMT-1, DMT-3, DMT-5, IMP-D, IMP-B (round) were grouped as pointed. The genotypes IMP-D, (round) DMT-6, Line No. C3, Line No. C4, DMT-2 IMP-B (oblong) were grouped as Flat, genotypes IMP-B (round), DM-4, DMT-4 were grouped as Intended. Ravikumar (1999) in soybean; Sankarapandian (2002) in cow pea; Muthiah (2006) in green gram.

5.3 Varietal response to various chemicals

Variatel identification by morphological characters is laborious, time consuming, tedious, cumbersome and costly affair. A number of chemical tests have been developed for varietal identification such as phenol, modified phenol, peroxidase test, sodium hydroxide test, potassium hydroxide test, gibberellic acid response test, 2, 4-D, and Malathion soak test. These chemical tests are very quick, easy and reproducible (Agrawal and Sharma, 1989). Very often these tests provide supportive evidence for the morphological evaluation of the seeds (Vanderburg and Vanzwol, 1991).

The present study on different chemical tests of characterization test viz., phenol tests, modified phenol, Fe2SO4, KOH, NaOH and peroxidase did not show any positive response in any of the tomato genotypes, as there was no colour change or reactions to the added chemical and hence no varietal identification could be made. Hence, these tests are found to be unsuitable for characterization of tomato genotypes and perhaps these chemical tests may be crop specific.

5.3.1 GA3 test

Seedling growth response to GA3 (100 ppm) application in terms of per cent increase over control and their grouping of different genotypes. Genotypes differed significantly with regards to seedling length and grouped as high responsive, medium responsive and low responsive. Seedling growth response to GA3 ranged from 11.80% (IMP-D (round)) to 52.69% (DMT-5) over the control.

Seedling length increased due to exogenous application of GA3. Similar results were also recorded by Agrawal and Sharma (1989), Chakrabarthy and Agrawal (1990) and Lee et al. (1992) in soybean; Sambasivarao et al. (2002) in groundnut. It is apparent that some of the soybean genotypes differed in their response to GA3. The differential response could be utilized to distinguish the soybean genotypes in conjunction with each other characteristics (Agrawal and Anil Pawar, 1990).

5.3.2 2, 4-D test

Variation in seedling growth response to 2, 4-D was due to inhibition of seedling growth and other activity. High affected variety was IMP-B (round) (62.20 % decrease over control) and least affected variety was DMT-3 (14.07% decrease over control).
Significant differences were observed among the genotypes with respect to 2, 4-D application and classified into high affected, moderate affected and least affected. High affected genotypes were DMT-2 (61.60%), IMP-B (round) (62.20%), IMP-D (round) (61.69%) moderate affected genotypes were DMT-1 (42.70%), DMT-4 (33.20%), DM-4 (30.06%) IMPB (oblong) (36.65%) whereas least affected genotypes were DMT-3 (14.07%), DMT-5 (26.06%), DMT-6 (22.59%), Over control of the 2, 4-D application. Similar type of classification was made by Chakrabarty and Agrawal (1990) in soybean; Shivakumar (2000) in rape seeds, Ponnuswamy et al. (2003) in cotton.

The differences in seedling growth reduction among the genotypes might be due to differences in ethylene production because of application of 2, 4-D (Sundaru et al., 1983). The most obvious response was extreme malformation of plants within a few days after treatment, it was not possible to measure varietal differences in foliage reaction accurately, reasons for differential was greater ability of some strains to recover by production of new floral primordial (Fribourg and Johnson, 1955).

5.4 Molecular marker

Genetic variation is a pre requisite for any crop improvement programme to be successful. DNA based molecular markers acted as versatile tools to study variability and diversity in different plant species. Though a range of plant characters are currently available for distinguishing between closely related individuals, their sensitivity to environment and less genome coverage hinders their usage. DNA based molecular markers clearly allow the comparison of genetic material of two individual plants avoiding any environmental influence on gene expression. Presently, many kinds of DNA based molecular markers such as RFLP, RAPD and AFLP etc., are available which detect polymorphism at the DNA level. The present study employed RAPD technique to assess genetic polymorphism. The major advantages of the RAPD technique is that, it does not need sequence information to start with. The polymorphism among the genotypes can be detected by using random primers variation in the banding pattern of the amplification products which occur because of variation in the length of DNA sequences flanked by the primers.

The present study utilized 12 tomato genotypes for RAPD analysis with 20 random decamer primers. The primers produced high degree of polymorphism with an average of 28.73 per cent. Among the primers used, the primers OPD-16 gave the highest polymorphism (80%) followed by OPE-08 (66.66 %) and OPW-11 (66.66%). On an average 5.00 bands per primer were amplified and 1.55 were polymorphic in nature. Similar result were reported by Doldi et al. (1997), Husain et al. (2009), Malik et al. (2009), Suprava Mohanty et al. (2010) in soybean.. Kocbner et al. (2003) and Silvana et al. (2005) obtained pattern of similarity between morphological and molecular clusters in barley and groundnut accessions respectively. On contrary, Kulkarni (2006) obtained dissimilarity between morphological and molecular clusters in case of chilli accessions. Hence, both morphological and molecular data can be used complementarily in genotype characterization. The study based on molecular data can be used for advanced markers for characterization of genotypes and use it for future breeding programme.

Practical utility

Based on the field experiment carried out during the course of investigation, the following recommendations can be made for practical utility.

1) Application of recommended dose of fertilizers (RDF)) was found to be useful for obtaining higher seed yield coupled with better quality seeds in tomato.

2) The morphological characters studied can be utilized for rouging during seed production

3) The morphological characters studied can be utilized for identification and characterization of tomato genotypes in DUS testing.

4) These characters are also helpful in genetic purity testing.

5) The RAPD markers are useful in identifying the genotypes at DNA level, which is not influenced by the environment. These molecular markers are helpful in assessing genetic purity at the shortest time.
Future line of work

In continuation of the present investigation, the following future line of work can be taken up for producing higher seed yield and quality in tomato.

1. Long term studies on organic manures along with other sources of nutrients need to be initiated to develop integrated nutrient management schedule for higher seed yield and seed quality in tomato.

2. Studies on different doses and time of application of organic manures need to be taken up for further investigation.

3. Long term seed storability studies with application of organic manures on tomato may be initiated.

4. To develop and standardize a biographic characteristics descriptor for identification of crop genotypes especially for seed industry based on morphological traits, chemical tests and electrophoresis banding pattern.

5. Seed keys have to be developed for the genetic purity test on routine basis in the seed testing laboratories.

6. As an expansion of present RAPD investigations, further research in tomato crop is to be carried out on the levels of genetic variation among tomato cultivars using, other molecular markers viz., SSR, SRAP, etc.
6. SUMMARY AND CONCLUSIONS

A field experiment was conducted at the University of Agricultural Sciences, Dharwad during kharif season of 2010-11 to study the effect of organic manures on growth, seed yield and quality in tomato. The experiment was laid out in randomized complete block design with three replications. The results obtained from the investigation are summarized in this chapter.

The field experiment consisted of 11 treatment combinations involving different organic manures. The organic manures were farm yard manure (11.5t/ha), vermicompost (5.75 t/ha) poultry manure (7.0t/ha) sheep manure (16.0t/ha), neem cake (2.0t/ha) and their combination 50% + 50%.

The plant height was significantly higher with RDF (40 t/ha FYM + 115:100:60 kg NPK/ha) and lowest height was recorded in FYM (11.5 t/ha) at all growth stages of tomato.

The application of organic manure along with chemical fertilizers had significantly taken least number of days for 50% flowering in tomato.

Significantly least superior for earliness in days to 50 per cent flowering was recorded in the treatment applied with RDF (115:100:60 kg NPK/ha + 40 t/ha FYM)

With respect to growth parameters, application of RDF recorded higher values for number of number of truss per plant (12.10) and number of cluster per truss (4.33) number of cluster per plant (11.27) number of flowers per cluster (11.80) while FYM (11.5t/ha) recorded lower values for the above characters (2.80, 1.07, 3.00 and 5.07).

With respect to yield parameters, application of RDF (40t/ha FYM 115:100:60 NPK kg /ha) recorded higher values for number of fruits per truss (12.75) and number of fruits per plants (47.13) number of seeds per fruits (110.44) ,seed yield per plant (30.24g), 1000 seed weight (2.87g), seed yield per plot (241.72g) and seed yield per hectare (108.28 kg) while FYM (11.5t/ha) recorded lower values for the above characters (8.54, 31.43, 80.77, 14.65g, 2.42, 200.82g, 87.85 kg respectively).

The seed quality parameters such as germination (95.89 %), shoot length (12.86 cm), root length (11.96 cm), seedling vigour index (2394), dry weight of seedlings (26.94 mg) and field emergence (88.33) were higher in the treatment of RDF as compared to other treatments.

From the present investigation, it can be concluded that the tomato crop receiving the recommended dose of fertilizers (40 t/ha FYM + 115:100:60 kg NPK/ha) recorded higher plant growth, yield and quality parameters which was followed by combination of FYM 50 per cent (5.75 t/ha) and vermicompost 50 per cent (2.87 t/ha).As the same treatment combination of RDF was recorded superior plant growth, yield and quality parameters in tomato and which was on par with the treatment combination of FYM 50 per cent + vermicompost 50 per cent.

Characterization of genotypes for purity testing as well as identification has attained much important in seed production programme of almost all major crops. All sectors of seed industry benefit from the ability to assess cultivar purity and identity. Therefore, information on well expressed and distinct characters of soybean variety should be made available to the seed producers and seed certification agencies in order to monitor the genetic purity of seeds.

With this view, the present study was carried out to characterize 12 tomato genotypes using plant morphological characters and molecular markers at the Seed Quality and Research Laboratory, National Seed Project (NSP), University of Agricultural Sciences, Dharwad. The results of the present study are summarized in this chapter.

Plant morphological characters

The twelve tomato genotypes were studied for various plant morphological characteristics such as seedling leaf color, days to maturity, stem color, flowering behavior, flower character ,foliage density, leaf type, exterior color of fruit, fruit shape fruit size, exterior color of mature fruit, easiness of fruit to detach from pedicel, fruit shoulder shape, easiness of fruit wall to be peeled, skin color ripe fruit, flesh color of pericarp, flesh color intensity, fruit cross sectional shape, number of locules, shape pistil scar , fruit blossom end shape and test weight.
Based on the seedling leaf color the genotypes were grouped as green foliage viz. DMT-1, DMT-2, DMT-3, DMT-4, DMT-5, DMT-6, DM-4, Line No. C3, Line No. C4, IMP-B (oblong) and remaining genotypes were grouped as greenish white foliage viz. IMP-B (round), IMP-D (round) and DM-4.

Based on the foliage density the genotypes were grouped into dense foliage viz. DMT-1, DMT-2, DMT-4, DMT-6, DM-4, and Line No. C3, Line No. C4, IMP-B (oblong) IMP-B (round), IMP-D (round), one was intermediate viz. DMT-5, and one was sparse foliage viz. DMT-3 on the basis of leaf type tomato genotypes were grouped in to Hirsutum, Dwarf, Peruvianum, Standard, Potato leaf type.

Based on the flowering behavior the genotypes were grouped into early flowering type (22.67-26.67 days after transplanting) viz. DMT-1, DMT-2, DMT-3, DMT-4, DMT-5, and DMT-6 however remaining were grouped as late flowering type (30.67-37.33 days after transplanting) viz Line No. C3, Line No. C4, IMP-B (oblong) IMP-B (round), IMP-D (round) and DM-4.

Among 12 genotypes five genotypes were standard viz. DMT-1, DM-4 Line No. C4, IMP-B (round), IMP-D (round), 3 genotypes were Potato leaf type viz. DMT-6, DMT-3, DMT-2, one was Dwarf, viz DMT-4, two were Peruvianum viz. DMT-5, IMP-B (oblong), and one was Hirsutum type viz. Line No. C3.

Based on exterior color of immature fruit genotypes were categorized into Greenish white, green and dark green.

Greenish white colour genotypes included DMT-1, DMT-2, DMT-3, DMT-4, DMT-5, DMT-6, and Line No. C3, Line No. C4, IMP-D (round), green colour genotypes includes IMP-B (oblong), IMP-B (round), whereas dark green colour genotypes was DM-4.

The fruit shape varied among different tomato genotypes. The genotypes were categorized into Flattened, Cylindrical High rounded Rounded and heart shaped based on fruit shape.

Among the 12 genotypes, one genotype was grouped into Flattened viz. DMT-1, three genotypes into Cylindrical viz. DMT-2, DMT-5, IMP-B (oblong) and five genotypes grouped in to High rounded viz DMT-3, DMT-6, DM-4, Line No. C4, IMP-B (round), one genotype grouped in to rounded viz. DMT-4, Line No. C3 and one genotype grouped into heart shaped like IMP-D (round).

The Fruit size varied significantly among different tomato genotypes. The genotypes were categorized into small, intermediate and large.

Among the 12 genotypes, one genotype was grouped into small viz. Line No. C4, five genotypes grouped into intermediate viz. DMT-1, DMT-2, IMP-B (oblong), IMP-D (round) and remaining six were grouped into large viz. DMT-3, DMT-4, DMT-5, DMT-6, DM-4, Line No. C3.

Based on number of days to maturity the genotypes were classified into as early matured (38.33-40.67 days after transplanting) viz. DMT-1, DMT-2, DMT-3, DMT-4, DMT-5, and DMT-6 however remaining genotypes were grouped as late matured (49.33-53.33 days after transplanting) viz. Line No. C3, Line No. C4, IMP-B (oblong) IMP-B (round), IMP-D (round) and DM-4.

The Exterior color of mature fruit varied significantly among different tomato genotypes. The genotypes were categorized into yellow and red.

Genotypes DMT-1, DMT-2, DMT-3, Line No. C4, Line No. C3 were grouped into yellow and the genotypes DMT-4, DMT-5, DMT-6, DM-4, IMP-B (oblong), IMP-B (round), IMP-D (round) were grouped into red.

The Easiness of fruits to detach from pedicel Varied significantly among different tomato genotypes. The genotypes were categorized into easy intermediate and difficult detachment of fruits from pedicel.
Genotypes Line No. C4, Line No. C3, DMT-6, DMT-1, DMT-2 were grouped as easy detacher where as the genotypes, IMP-D (round), IMP-B (oblong), IMP-B (round), DMT-4, DMT-5 and genotypes DMT-3, DM-4 as intermediate detacher and difficult detacher respectively.

The Fruit shoulder shape varied significantly among different tomato genotypes. The genotypes were categorized into Flat and moderately depressed.

The genotypes DMT-1, Line No. C3, DMT-3, DMT-6, DMT-2 were grouped as flat shoulder shape fruit where as the genotypes DMT-4 IMP-D (round), DM-4, Line No. C4, IMP-B (oblong), IMP-B (round), DMT-5 were grouped as moderately depressed shoulder shape.

The Ease of fruit wall (skin) to be peeled varied significantly among different tomato genotypes. The genotypes were categorized into Easy, Intermediate, and difficult.

The variety DM-4 was grouped as Easy, The genotypes Line No. C4, DMT-2, DMT-4, DMT-5, DMT-6, Line No. C3, DMT-1 were grouped as Intermediate, genotypes DMT-3, IMPB (oblong), IMP-B (round), IMP-D (round).

Based on the skin color of ripe fruit were categorized into yellow and colorless.

The genotypes DMT-1, DMT-2 IMP-D (round), DMT-3, DMT-4, DMT-5, DMT-6, DM-4, IMPB (oblong), IMP-B (round), were grouped as yellow, The genotypes Line No. C4, Line No. C3 were grouped as colorless.

Based on the Flesh color of pericarp were categorized into yellow and red.

The genotypes DMT-1, DMT-2, DMT-3, DMT-4, DMT-5, DMT-6, were grouped as yellow, the variety DM-4 were grouped as pink and remaining genotypes IMP-D (round), Line No. C4, IMP-B (oblong), IMP-B (round), Line No. C3 were grouped as red.

Based on the Flesh color intensity genotypes were categorized into Dark, Intermediate and Light.

The genotypes DMT-1, DMT-2, DMT-5, DMT-6, Line No. C4 were grouped as Intermediate, The genotypes Line No. C3, DMT-4, DMT-3 were grouped as Light and remaining genotypes were grouped as IMP-D (round), IMP-B (oblong), IMP-B (round), Line No. C3, DM-4.

Based on the Fruit cross sectional shape genotypes were categorized into Angular, Irregular and Round.

The genotypes DMT-1, DMT-2, DMT-3, DMT-5, DMT-6, Line No. C4 were grouped as round, The genotypes DM-4, DMT-4, were grouped as Irregular and remaining genotypes, IMP-B (oblong), Line No. C4, DMT-6 were grouped as Angular.

Based on the Number of locules genotypes were categorized into two loculed three loculed five loculed and six loculed.

The genotypes DMT-1, Line No. C3 IMP-B (round), IMP-D (round), were grouped as two loculed, The genotypes Line No. C3, DMT-6, IMP-B (oblong were grouped as Irregular and remaining genotypes,), DMT-4 was grouped as five loculed and the variety DM-4 was grouped as six loculed.

Based on the Shape of pistil scar genotypes were categorized into Irregular and Stellate.

The genotypes DMT-1, DMT-2, DMT-3, DMT-5, Line No. C3 IMP-B (round), IMP-D (round), Line No. C4, DMT-6, IMP-B (oblong ) were grouped as Stellate The genotypes were grouped as Irregular and remaining genotypes,), DMT-4 DM-4 were grouped as Irregular.

Based on the Fruit blossom end shape genotypes were categorized into Flat, Intended and pointed.

The genotypes DMT-1, DMT-3, DMT-5) were grouped as pointed. The genotypes IMP-D, (round) DMT-6, Line No. C3, Line No. C4, DMT-2 IMP-B (oblong) were grouped as Flat, genotypes IMP-B (round), DM-4, DMT-4 were grouped as Intended.
Chemical tests

The chemical tests viz., Phenol, modified phenol, Peroxidase, NaOH and KOH tests disabled the grouping of tomato genotypes based on the color response. Genotypes used in this investigation could not exhibited color of seed coat as well as solution. Hence they remained colorlessness.

Genotypes differed significantly with regards to seedling length and were grouped as high responsive, medium responsive and low responsive. Highest seedling length over control was observed in DMT-5 and lowest seedling length over control was observed in IMP-D (round). The application of 2, 4-D were decreased the seedling length over control and classified into high affected, moderate affected and least affected. Tomato genotypes were differentiated as high affected, moderate affected and least affected. Least affected genotypes were DMT-3, DMT-5, DMT-6, over control of the 2, 4-D application.

Molecular markers

Genetic variability at molecular level was estimated by using RAPD primers. RAPD profiles for all the 12 genotypes were generated with 20 random decamer primers. The level of polymorphism generated (80.00%) among the genotypes was high. On an average 5.00 bands per primer was produced. The highest molecular diversity was observed between the genotypes DMT-3 and DMT-6 and High similarity with Sij 0.99 were observed between genotypes DMT-5 and DM-4, DMT-5 and LINE NO.C3, IMP-B (oblong) and DM-4, IMP-B (round) and IMP-D (round). Genotypes DMT-1 and DMT-2 are closely related with Sij value 0.97.

To conclude, assessment of genetic purity is an important criterion in seed production programme. Therefore, simple and reliable techniques need to be developed for genetic purity assessment and variety identification. The study suggested that seed, seedling and plant morphological characteristics were found to be useful in broad classification of tomato genotypes. Further, the cultivar reactions to different chemicals like Peroxidase, NaOH, KOH, \( \text{GA}_3 \), and 2, 4-D were also found useful in grouping of tomato genotypes except first three tests viz. Peroxidase, NaOH and KOH. Fourteen RAPD primers gave good polymorphism among the twenty used for characterization which helps to distinguish the genotypes at molecular level.
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## Appendix I: Physical and chemical properties of soil experimental site

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Particulars</th>
<th>Values</th>
</tr>
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<tbody>
<tr>
<td>I.</td>
<td><strong>Physical properties</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Coarse sand (International Pippette Method) (Piper, 1966)</td>
<td>6.10%</td>
</tr>
<tr>
<td>2.</td>
<td>Fine sand (International Pippette Method) (Piper, 1966)</td>
<td>13.14%</td>
</tr>
<tr>
<td>3.</td>
<td>Silt (International Pippette Method) (Piper, 1966)</td>
<td>28.00%</td>
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<tr>
<td>II.</td>
<td><strong>Chemical properties</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Available nitrogen (Alkaline permanganate method)</td>
<td>0.0068%</td>
</tr>
<tr>
<td></td>
<td>Subbaiah and Asija, 1956</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Available P$_2$O$_5$ (Olsen’s method) (Jackson, 1967)</td>
<td>0.007%</td>
</tr>
<tr>
<td></td>
<td>Available K$_2$O (Flame photometry method) (Jackson, 1967)</td>
<td>0.016%</td>
</tr>
<tr>
<td>III.</td>
<td>pH</td>
<td>7.5</td>
</tr>
<tr>
<td>IV.</td>
<td>Electrical conductivity (dS/m)</td>
<td>0.31</td>
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Appendix 2: Monthly meteorological data for the experimental year 2010-2011 and the average of 60 years (1950-2010) at Meteorological Observatory, Main Agricultural Research Station, College of Agriculture, University of Agricultural Sciences, Dharwad

<table>
<thead>
<tr>
<th>Months</th>
<th>Rainfall (mm)</th>
<th>Temperature (°C)</th>
<th>Relative humidity (%)</th>
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<tr>
<td></td>
<td>2010</td>
<td>1950-2010</td>
<td>Mean maximum</td>
</tr>
<tr>
<td></td>
<td>2010</td>
<td>1950-2010</td>
<td>2010</td>
</tr>
<tr>
<td>January</td>
<td>0.8</td>
<td>0.062</td>
<td>29.67</td>
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<tr>
<td>February</td>
<td>0.4</td>
<td>0.547</td>
<td>32.20</td>
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<tr>
<td>March</td>
<td>Trace</td>
<td>15.65</td>
<td>33.73</td>
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<tr>
<td>April</td>
<td>43.8</td>
<td>39.27</td>
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<tr>
<td>May</td>
<td>63.1</td>
<td>68.39</td>
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<tr>
<td>June</td>
<td>63.4</td>
<td>108.51</td>
<td>28.77</td>
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<tr>
<td>July</td>
<td>155.0</td>
<td>138.70</td>
<td>28.64</td>
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<tr>
<td>August</td>
<td>190.7</td>
<td>154.45</td>
<td>26.92</td>
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<tr>
<td>September</td>
<td>164.9</td>
<td>135.23</td>
<td>28.15</td>
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<tr>
<td>October</td>
<td>177.0</td>
<td>94.43</td>
<td>30.13</td>
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<tr>
<td>November</td>
<td>92.8</td>
<td>52.49</td>
<td>29.67</td>
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<tr>
<td>December</td>
<td>0.6</td>
<td>2.83</td>
<td>28.94</td>
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<tr>
<td>Total</td>
<td><strong>952.5</strong></td>
<td><strong>810.55</strong></td>
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</table>
Molecular, morphological and chemical characterization of tomato genotypes (solanum lycopersicum] genotypes and influence of organic manures on seed yield and seed quality in tomato Cv.DMT-2

SUNNADAGUDI R. 2011 Dr. R. GURUMURTHY
MAJOR ADVISOR

ABSTRACT

The laboratory and field experiments were conducted, during kharif, 2010 for identification of tomato genotypes through morphological, chemical and molecular markers and influence of organic manures on seed yield and seed quality in tomato cv. DMT-2 at Seed Quality and Research Laboratory of National Seed Project, and main agricultural research station UAS, Dharwad respectively.

Twelve tomato genotypes were grouped into 18 groups based on the seed morphological characters such as seedling leaf color, days to maturity, foliage density, leaf type, exterior color of immature fruit, fruit shape, fruit size, exterior color of mature fruit, from pedicel, fruit shoulder shape, skin color, ripe fruit, flesh color intensity, fruit cross sectional shape, number of locules, shape pistil scar and fruit blossom end shape.

The chemical tests viz., Phenol, modified phenol, Peroxidase, NaOH and KOH tests disabled the grouping of tomato genotypes based on the color response. Genotypes used in this investigation did not exhibit change in seed coat color as well as solution. Based on the seedling growth response to GA$_3$, genotypes were grouped as low, moderate and high response and based on 2,4-D genotypes were grouped as least, moderate and highly affected.

Random amplified polymorphic DNA profile for all 12 genotypes was generated with 20 random decamer primers. The highest molecular diversity was observed between the genotypes DMT-3 and DMT-6 and High similarity with Sij 0.99 was observed between genotypes DMT-5 and DM-4.

The field experiment consisted of 11 treatments involving different organic manures. Among the treatments recommended dose of fertilizer (T$_{11}$) recorded significantly superior values over other treatments with respect to growth, yield and seed quality parameters.