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Influence of maturity stages and post-harvest ripening on seed quality in chilli genotypes

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SUMMARY :

The present study was conducted at Department of Seed Science and Technology, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bangalore during 2011-12 to reveal the influence of maturity stages and post-harvest ripening on seed quality among ten (Bhut jolokia, Merkera local, Sweet baccatum, Gandhari, Biligiri local, Majjige menasu, Chinense habanero, Hot cherry, Cherry pepper and Shivani) chilli genotypes belonging to *Capsicum chinense, C. frutescence* and *C. annuum*. The results revealed that among maturity stages, fruits harvested at red ripe stage and subjected for 20 days post-harvest ripening (M_4) has recorded higher seed quality parameters *viz*., 1000 seed dry weight (6.95 g), seed germination (66.0 %), seedling length (9.9 cm), seedling dry weight (1.50 mg), seedling vigour index-I (748), total dehydrogenase activity (1.314), α-amylase activity (34.9 µg maltose ml^{-1} min^{-1}) and field emergence (56.0 %). Also minimum electrical conductivity (1.743 dSm^{-1}) and moisture content of fresh seed (10.93 %) was noticed.

KEY WORDS : Maturity stages, Seed quality, α–amylase activity, Total dehydrogenase activity

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The genus capsicum belongs to family Solanaceae. It has 90 genera and 2000 species and it is mainly grown for its fruit. Chilli has pleasant aromatic flavour, pungency and high colouring substances (Oleoresin). Chilli can be used both in ripe and green fruit stage and is a condiment for imparting pungency. The pungency in chilli is due to an active principle compound capsaicin. Chilli is a source of various minerals and also contains vitamins *viz.*, A, B and C. In food and beverage industries, chilli has got a great importance because of 'Oleoresin' which gives colour and flavour to the food. The indeterminate flowering and differential fruit maturity in chilli necessitates the harvest of fruits at different stages. The seeds extracted from the fruits of different harvesting stages are more likely to vary with differential supply of metabolites by mother plant, thereby likely to get altered in seed quality in terms of germination and vigour. The seed quality depends mainly on the stage

at which seeds are harvested. It's a well established fact that; seeds harvested at physiological maturity will have maximum germination and vigour. Thus, harvesting seed produce at optimum stage of maturity not only minimizes the loss of viability and vigour of seeds but also prevents the seeds from the field damage due to diseases, insect pests and adverse environmental conditions. Numerous authors have realized the difficulty in obtaining satisfactory emergences in pepper crops in field conditions (Cavero *et al*., 1995). Further, some genotypes belong to different species of capsicum show variation in germination (William *et al*., 1981). The genotypic variability for germination at various developmental stages is least understood and standardization of the methods for induction of uniform germination in these genotypes needs to be studied. Keeping all these backdrops in mind, the study was conducted to know the influence of maturity stages and post-harvest ripening on seed quality in chilli genotypes.

EXPERIMENTAL METHODS

The filed and laboratory experiments were carried out at Department of Seed Science and Technology, University of Agricultural Sciences, Bangalore. Ten chilli genotypes were selected for the study *viz.*, Bhut jolokia, Merkera local, Sweet baccatum, Gandhari, Biligiri local, Majjige menasu, Chinense habanero, Hot cherry, Cherry pepper and Shivani. The crop was sown in a Randomized Complete Block Design with three replications. Ten plants were selected at random from each genotype and the fruits from each genotype were harvested at three stages *viz.*, M_1 (Green stage), M_2 (Colour break stage), M_3 (Red ripe stage) and M_4 fruits harvested at red ripe stage and kept for post harvest ripening for 20 days. The seeds were extracted manually from each stage and genotype were dried to 6-7 per cent moisture level and tested for the seed quality parameters.

Germination percentage :

It was determined as per ISTA rules for seed testing (Anonymous, 1996). The seeds were placed in rolled paper towels. Hundred seeds of four replications were tested at a constant temperature of 25° C. The germination first and second counts were recorded on fourth and tenth day, respectively and per cent germination was expressed on normal seedling basis.

Seedling length and seedling dry weight :

From the standard germination test, ten normal seedlings were selected at random in each replication on final count. The shoot length was measured from collar region to the point of attachment of cotyledons and root length from the collar region to the tip of the primary root, sum of shoot and root length constitute the seedling length and mean was calculated and expressed in centimeters. The seedlings used for seedling length measurement was used for estimating dry weight. They were dried in a hot air oven maintained at 80 ± 2°C for 48 hours. After drying, the weight of dry seedlings was recorded and the mean seedling dry weight was calculated and expressed in milligrams.

Seedling vigour index :

Seedling vigour index was computed by adopting the formula as suggested by Abdul-Baki and Anderson (1973) and expressed in whole number.

Seedling vigour index-I = Germination (%) x Mean seedling length (cm)

Electrical conductivity (dSm^{-1}) of seed leachate :

The electrical conductivity of seed leachate was determined as per procedure outlined by ISTA (2010). Twenty five seeds were taken randomly in three replications and soaked in 50ml of distilled water for 18 hours at 25 ± 1°C. After incubation, the seed leachate was decanted and the conductivity of seed leachate was measured by Digital Conductivity Meter (Model-D1, 9009) and expressed in dSm^{-1}.

Total dehydrogenase activity ($OD@A_{480}nm$) :

The total dehydrogenase activity of the seeds was estimated as per the method described by Perl *et al.* (1978). Ten seeds of three replications selected randomly were pre-conditioned by soaking in water for 24 hours. Then ten pre imbibed seeds were randomly selected in each sample, seed was cut longitudinally and soaked in 0.5 per cent Tetrazolium chloride solution in a test tube and incubated at 25 ± 1ºC under dark for six hours. Then they were washed thoroughly with distilled water, the red coloured formazan from the stained embryos was extracted by soaking these embryos with 5 ml of 2-methoxy ethanol for 6-8 hours in an airtight container. The extract was decanted and the colour intensity was measured in spectrophotometer (Model mini spec 17) at 480 nm with suitable blank (Methoxy ethanol). The total

dehydrogenase activity (TDH) was expressed in absorbance.

~-amylase activity :

The α-amylase assay was carried out according to the method of Bernfeld (1955) with slight modification. The enzyme assay of sample was carried out along with blank and control for each sample. For sample analysis 0.1 ml of enzyme extract was taken in a cleaned test tube and 250 µl of 1 per cent soluble starch was added and incubated for 15 min. To this 500 µl of DNS reagent was added to stop the reaction and heated over water bath for 5 min and then cooled under running tap water after this, 250 µl of 40 per cent sodium potassium tartrate was added. Final volume of the reaction mixture was made to 5 ml by adding 3.9 ml of water. Absorbance was read at 560 nm. A control was prepared for each sample similar to that of sample but the reaction was terminated at zero time. Similarly blank was prepared for each sample by omitting starch. Standard curve was prepared by using maltose (0 to 100 µg). One unit of enzymatic activity is defined as one mg of maltose liberated/hour under the standard assay conditions and specific activity as µg maltose ml^{-1} min^{-1}.

Field emergence :

One hundred seeds in three replications were randomly collected from each genotype of each maturity stages and sown in the raised seedbed at 2-3 cm depth. The seedling emergences were recorded. The seedling above the ground level was considered as normal seedling. The average was calculated and expressed in percentage.

EXPERIMENTAL FINDINGS AND ANALYSIS

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Genotype performance :

The results pertaining to genotypic variation for seed quality parameters were presented in Table 1 and 2. The genotype Shivani has significantly better seed quality in comparison with the other genotypes. It was recorded high (72%) germination, total dehydrogenase activity (1.511), α-amylase activity (36.8 µg maltose ml^{-1} min^{-1}) and field emergence (58%). The genotype hot cherry recorded highest seedling length (12.6 cm), seedling dry weight (1.44 mg) and seedling vigour index (757). Chinense habanero was recorded highest electrical conductivity (3.685 dSm^{-1}). Whereas, lowest seed quality parameters were recorded in cherry *viz*., seed germination (10%), seedling length (5.6cm), seedling dry weight (0.93 mg), seedling vigour index-I (66), total dehydrogenase activity (0.426), α-amylase activity (9.5

Table 1 : Effect of fruit maturity stages on germination (%), seedling length (cm), seedling dry weight (mg) and seedling vigour index-I in chilli genotypes

Genotypes (G)	Germination (%)					Seedling length (cm)					Seedling dry weight (mg)					Seedling vigour index-I				
	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean
Bhut jolokia	8	17	22	32	20	6.8	7.9	10.0	10.2	8.7	1.00	1.23	1.50	1.73	1.37	55	147	302	322	206
Merkera local	13	17	23	35	22	7.2	9.7	10.9	11.0	9.7	1.00	1.23	1.43	1.63	1.33	92	490	812	895	572
Sweet baccatum	11	58	83	91	61	8.3	10.4	12.6	12.7	11.0	0.87	1.30	1.50	1.67	1.33	88	604	1032	1159	721
Gandhari	10	61	73	77	55	4.2	6.6	7.6	8.0	6.6	0.73	0.87	0.97	1.20	0.94	42	402	551	619	404
Biligiri local	12	68	93	97	67	5.9	6.3	7.0	7.1	6.6	0.90	1.00	1.03	1.23	1.04	71	424	658	685	460
Majjige menasu	14	52	92	93	63	6.7	7.8	8.8	8.8	8.0	0.83	1.13	1.20	1.30	1.12	94	403	814	818	532
Chinense habanero	8	22	34	42	27	8.9	9.5	10.4	10.4	9.8	0.97	1.27	1.43	1.73	1.35	74	352	739	746	478
Hot cherry	13	60	79	81	58	11.0	12.5	13.3	13.5	12.6	0.93	1.27	1.63	1.93	1.44	138	757	1048	1085	757
Cherry pepper	4	8	12	18	10	3.8	4.7	7.0	7.1	5.6	0.77	0.87	1.07	1.03	0.93	14	38	87	125	66
Shivani	15	79	97	97	72	7.8	8.7	10.5	10.6	9.4	0.90	1.23	1.43	1.57	1.28	116	681	1019	1029	711
Mean	11	44	61	66		7.1	8.4	9.8	9.9		0.89	1.14	1.32	1.50		78	430	706	748	
	S.E. ±		C.D. (P= 0.05)			S.E. ±		C.D. (P= 0.05)			S.E. ±		C.D. (P= 0.05)			S.E. ±		C.D. (P= 0.05)		
G	0.46		1.30			0.085		0.238			0.017		0.049			9.38		26.40		
M	0.29		0.82			0.054		0.151			0.011		0.031			5.93		16.69		
G × M	0.92		2.60			0.169		0.477			0.035		0.098			18.76		52.79		

Maturity stages (M) : M_1=green stage; M_2= colour break stage; M_3= Red ripe stage; M_4= Post- Harvest ripening stage

μg maltose ml^{-1} min^{-1}) and field emergence (6%). The rest of the genotypes are at par with each other. The effect of genotypes found significant with respect to seed quality parameters (Plate 1). The results revealed the genetic background of the genotypes determines the variation in seed quality since phenotypic expression mainly depends on environment and genetic makeup of the genotype. Such variations were also noticed by Kashinath (2003) and Krishna *et al*. (2007) in chilli and Demir and Samit (2001) in eggplant.

Maturity stages :

Significant variation were observed in all genotypes with respect to stages of maturity and the results pertaining to influence of maturity stages on seed quality parameters were presented in Table 1 and 2. The seeds extracted from the fruits harvested at red ripe stage and kept for post-harvest ripening for 20 days (M_4) has given maximum seed quality parameters such seed germination (66%), seedling length (9.9 cm), seedling dry weight (1.50 mg), seedling vigour index-I (748), total dehydrogenase activity (1.374), α-amylase activity (34.9 μg maltose ml^{-1} min^{-1}) and low electrical conductivity (1.743 dSm^{-1}), Compared to fruits harvested at green stage, colour break stage and red ripe stage.

Maturity stages found significantly for seed quality attributes (Plate 1). Eight per cent increase in germination was noticed in seeds harvested at red ripe stage kept for 20 days of post-harvest ripening (M_4) over the fruits of red ripe stage (M_3) (Fig. 1, 2, 3, 4 and 5). Similar results were also reported by Petrov *et al.* (1981) in egg plant. This might be due to attainment of physiological maturity of seeds where the maximum accumulation of food reserves, amino acid, phosphorus active substances, dry matter, sugar, water soluble proteins, acids and necotonic acid levels in seeds. On the contrary, all seed quality parameters were low in early harvested fruits (green and colour breaker stage), it may be due to the presence of large number of

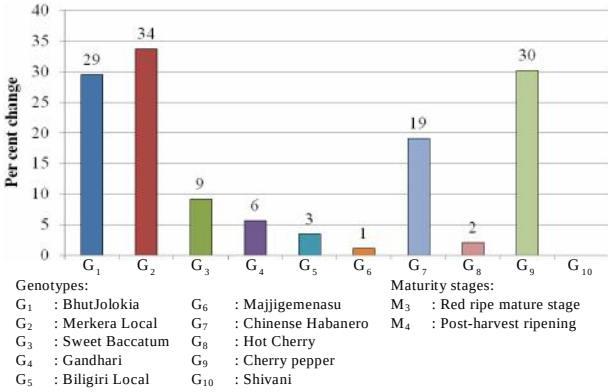


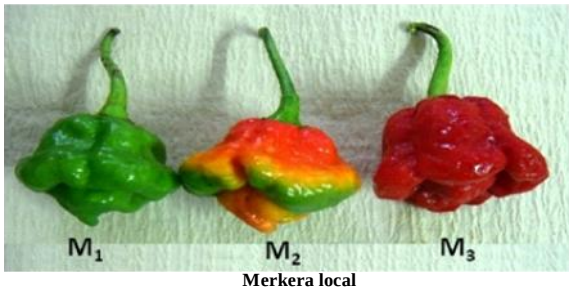
Fig. 1 : Per cent change in germination of M_4 over M_3

Table 2 : Effect of fruit maturity stages on electrical conductivity, total dehydrogenase activity, α-amylase activity and field emergence in chilli genotypes

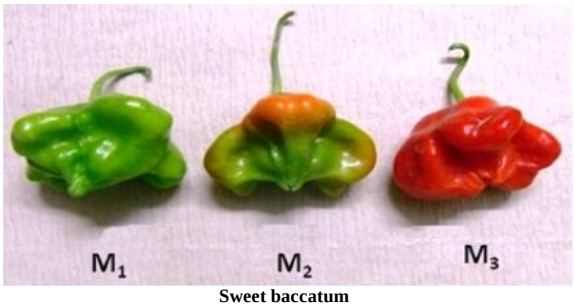
Genotypes (G)	Electrical conductivity (dSm^{-1})					Total dehydrogenase activity (OD at 480nm)					α-amylase activity (μg maltose ml^{-1} min^{-1})					Field emergence (%)				
	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean
Bhut jolokia	5.343	2.773	2.147	2.000	3.066	0.212	0.798	1.953	1.981	1.236	8.9	12.4	15.7	19.8	14.2	2	13	17	23	14
Merkera local	5.247	3.797	2.510	1.890	3.361	0.316	0.672	1.975	1.992	1.239	11.0	12.4	16.8	21.6	15.5	4	12	16	21	13
Sweet baccatum	5.430	3.830	2.110	1.733	3.276	0.197	0.581	1.054	1.065	0.724	8.9	26.5	42.1	45.1	30.6	5	43	81	79	52
Gandhari	3.187	2.163	1.507	1.400	2.064	0.166	0.215	0.701	0.703	0.446	8.4	28.5	34.2	34.9	26.5	3	46	56	60	41
Biligiri local	3.893	2.880	1.900	1.810	2.621	0.175	0.435	0.712	0.713	0.509	10.7	30.0	46.3	51.2	34.6	4	42	83	86	54
Majjigemenasu	3.883	1.893	1.513	1.333	2.156	0.198	0.568	0.940	0.945	0.663	11.3	25.1	45.8	46.1	32.1	2	34	82	85	51
Chinense habanero	6.040	4.117	2.650	1.933	3.685	0.225	0.875	1.700	1.701	1.125	8.9	15.3	20.0	24.7	17.2	3	15	21	31	17
Hot cherry	4.623	3.177	2.063	1.857	2.930	0.364	0.762	1.224	1.247	0.899	10.8	28.3	36.8	41.6	29.4	6	45	77	78	51
Cherry pepper	3.333	1.937	1.747	1.543	2.140	0.121	0.213	0.681	0.691	0.426	6.3	8.4	10.5	12.7	9.5	1	4	8	11	6
Shivani	4.247	2.430	2.060	1.930	2.667	0.437	1.396	2.103	2.107	1.511	11.5	36.6	48.4	50.8	36.8	5	57	83	86	58
Mean	4.523	2.900	2.021	1.743		0.241	0.651	1.304	1.314		9.7	22.4	31.7	34.9		4	31	52	56	
	S.E.±		C.D. (P=0.05)			S.E.±		C.D. (P=0.05)			S.E.±		C.D. (P=0.05)			S.E.±		C.D. (P=0.05)		
G	0.055		0.155			0.0015		0.0042			0.077		0.027			0.315		0.886		
M	0.035		0.098			0.001		0.0027			0.049		0.017			0.199		0.560		
G × M	0.11		0.31			0.003		0.0085			0.154		0.055			0.629		1.771		

Maturity stages (M) : M_1=green stage; M_2= colour break stage; M_3= Red ripe stage; M_4= Post- Harvest ripening stage

Bhut jolokia



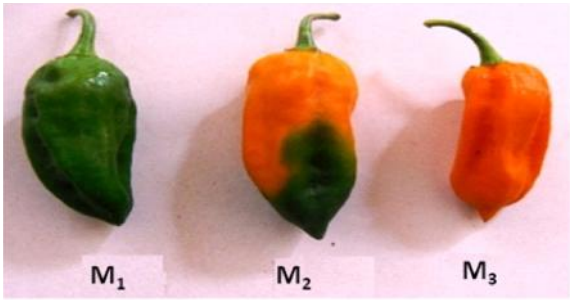
Merkera local



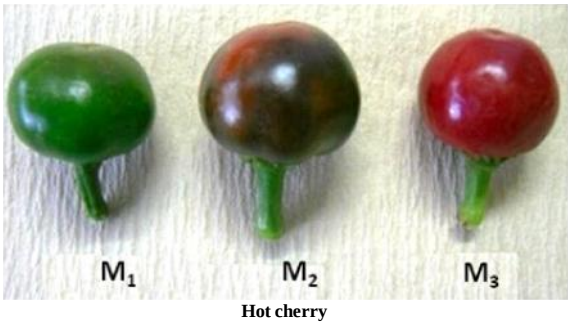
Sweet baccatum

Biligiri local

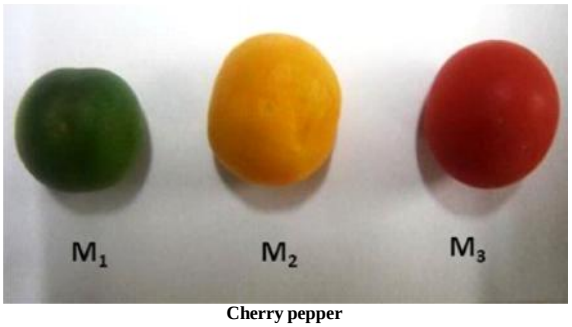
Majjige menasu



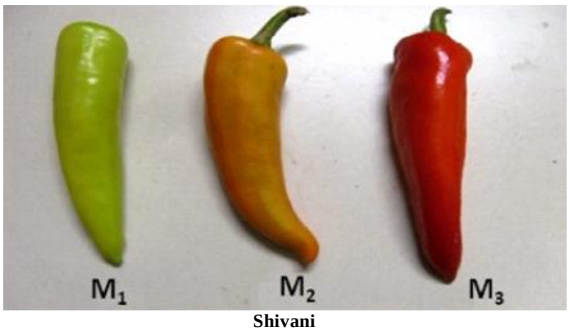
Chinense habanero



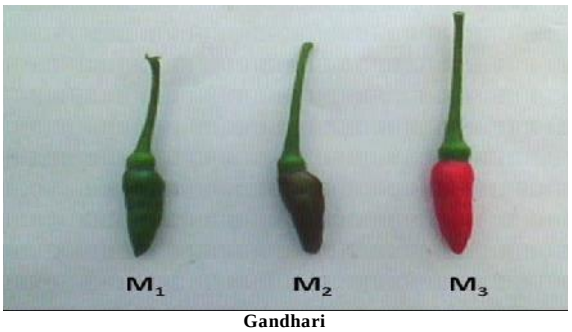
Hot cherry



Cherry pepper

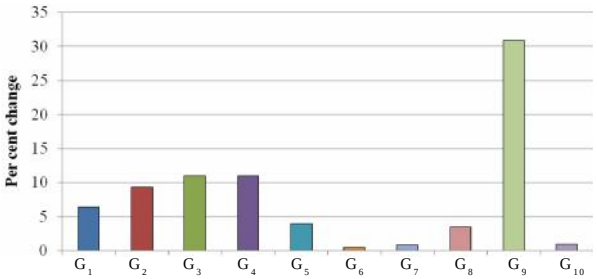


Shivani



Gandhari

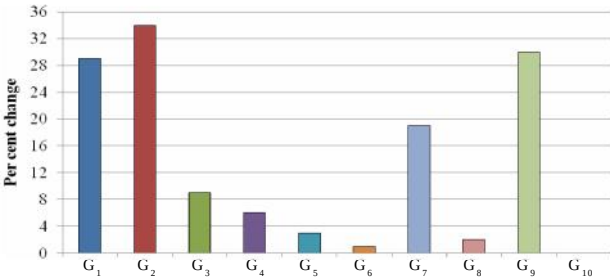
Plate 1 : Genotypic and maturity variation in chilli



Genotypes:
G_1 : BhutJolokia
G_2 : Merkera Local
G_3 : Sweet Baccatum
G_4 : Gandhari
G_5 : Biligiri Local
G_6 : Majjigemenasu
G_7 : Chinense Habanero
G_8 : Hot Cherry
G_9 : Cherry pepper
G_{10} : Shivani

Maturity stages:
M_3 : Red ripe mature stage
M_4 : Post-harvest ripening

Fig. 2 : Per cent change in seedling vigour index-I of M_4 over M_3



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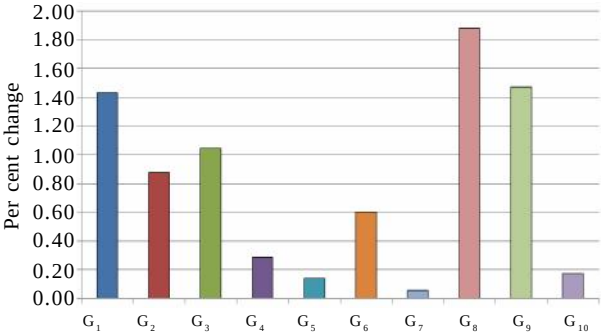
G_8 : Hot Cherry
G_9 : Cherry pepper
G_{10} : Shivani

Maturity stages:
M_3 : Red ripe mature stage
M_4 : Post-harvest ripening

Fig. 4 : Per cent change in ~-amylase activity of M_4 over M_3



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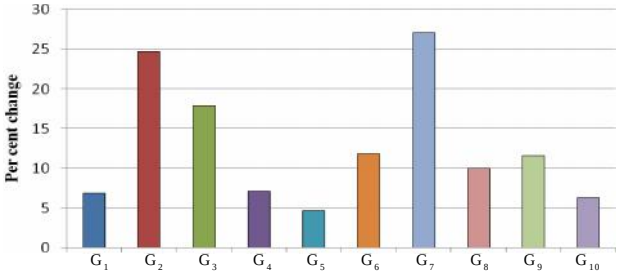
G_6 : Majjigemenasu
G_7 : Chinense Habanero
G_8 : Hot Cherry
G_9 : Cherry pepper
G_{10} : Shivani

Maturity stages:
M_3 : Red ripe mature stage
M_4 : Post-harvest ripening

Fig. 3 : Per cent change in total dehydrogenase activity of M_4 over M_3



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G_4 : Gandhari
G_5 : Biligiri Local
G_6 : Majjigemenasu
G_7 : Chinense Habanero
G_8 : Hot Cherry
G_9 : Cherry pepper
G_{10} : Shivani

Maturity stages:
M_3 : Red ripe mature stage
M_4 : Post-harvest ripening

Fig. 5 : Per cent change in electrical conductivity of M_4 over M_3

immature and under developed seeds with lesser food reserves and nutrients in the seeds (Naik *et al.*, 1996) in chilli. It was clearly evident that the chilli fruits may physiologically mature when they attain red ripe stage and harvesting of such fruits will results in better seed quality. The results also in agreement with Naik *et al.* (1996); Biradar (1999); Pandita and Nagarajan (2001); Demir and Samit (2001); Vinodkumar *et al.* (2002); Shantappa *et al.* (2006); Hunje *et al.* (2007) and Alan and Eser (2008) in chilli. The finding of the study revealed that among the selected genotypes, fruits harvested at red ripe stage and kept for 20 days of post-harvest ripening (M_4) gives higher quality seeds compared to the fruits harvested at dark green, colour break and red ripe stage.

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