CHAPTER II
REVIEW OF LITERATURE

The literature on the effect of varieties, maturity stages and seed extraction methods on seed quality parameters in brinjal have been reviewed and presented in this chapter. Since the literature pertaining to these aspects in brinjal is rather limited, reviews on other related crops are also included.

The following aspects were reviewed which were related to this research work.

2.1 Effect of varieties

2.2 Effect of fruit maturity stages

2.3 Effect of seed extraction methods

2.1 Effect of varieties

Ravi Hunje et al. (2007) studied influence of fruit maturity on seed quality of two chilli varieties and noticed significant difference among two varieties for fruit weight (g), seed weight per fruit (g) and 1000 seed weight (g). They further reported that the interaction effect of varieties and maturity stages was also found significant for same these characters.

Uma Jyothi et al. (2008) found significant differences for germination and vigour index among the seven chilli cultivars taken under study. Among the cultivars, LCA 206 showed the highest germination percentage of 97.3 and the lowest germination of 56 per cent by cultivar Paprika type. Similar trend was also observed for vigour index in different cultivars ranging from 130.5 (Paprika type) to 523.6 (LCA 235) indicating that there is genetic variability among the cultivars employed in the study.

Kaveh et al. (2011) examined five tomato lines and the data indicated that there were significant differences among inbred-lines in the germination percentage and germination rate.

Bhatt et al. (2013) studied seed germination and seedling growth in Solanum species to water stress under in vitro conditions and found significant differences among the cultivars /genotypes for germination (%), root length and shoot length.
Rahman et al. (2015) studied various seed quality characters in brinjal during seed extraction in two varieties. Among the two varieties BARI begun-5 recorded numerically higher 1000 seed weight and seedling length than the other variety BARI begun-8.

Ketema et al. (2016) studied nine tomato varieties for various growth and seed quality parameters. Analysis of variance showed existence of significant difference for the characters moisture content, germination per cent, root length and seedling dry weight.

Kumar et al. (2017) analysed thirty three genotypes of tomato and reported significant differences for all the seedling parameters taken under study viz. germination percentage, germination rate, root length, shoot length, root dry weight and shoot dry weight under different PEG-6000 concentrations along with control.

Ruiz and Parera (2017) analysed two bell pepper cultivars and reported significant difference for germination (%) and germination rate. More over they also reported that the interaction effect of cultivars and seed age was found significant for germination (%) and germination rate.

Tetteh et al. (2018) studied effect of maturity stages on seed quality of two tomato accessions and noticed highly significant differences among two accessions for seed vigour (first count) and germination (%) in both petri dish and seed box whereas, 100 seed weight was found non-significant. They further reported that the interaction effect of accession x maturity stages was found significant for seed vigour (first count) and germination (%).

2.2 Effect of fruit maturity stages

The seed quality depends mainly on the stage at which seeds are harvested. Harvesting of fruits at right stage is very much essential for getting good quality seeds. Seeds obtained from immature and over mature fruits were poor in seed quality. The seeds harvested at physiological maturity will have maximum viability and vigour. Thus, harvesting at optimum stage of maturity not only minimizes the loss of viability and vigour of seeds but also prevent the seeds from field damage due to insect pests and disease and adverse environment conditions. Constitution of seeds extracted from fruits at
different maturity stages is likely to differ due to differential supply and accumulation of food reserves in the seeds.

Sakar and Farouk (1953) noticed that the highest fruit weight (114.85 g) in pepper chilli was obtained when fruits were harvested at 52 days after anthesis. The highest seed weight per fruit (2.05 g) was noticed in fruits harvested at 56 days after anthesis. The lowest fruit weight (25.50 g) and seed weight (0.20 g) were observed from the fruit harvested at six days after anthesis.

Chauhan and Bhandari (1971) reported that good germination (85.6 %) was recorded from the seeds, when fruits were harvested 30 days after anthesis at fully matured, dry and cracking stage in okra cv. Pusa Sawani.

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

Nowsielska (1979) observed poor germination in the seeds of capsicum when fruits were harvested at ripening stage as compared to the seeds harvested at ripened stage. The weight and size of seeds in capsicum increased with fruit ripening period.

Varatharaja and Ramakrishnan (1979) reveled that in bitter gourd variety “CO-1”, the fruit attained maximum development in 42 days after flower opening and the seeds attained full maturity in 60 days after anthesis. The seed moisture content was 15.2 to 15.5 per cent on the 60th day after anthesis. The seed attained germination potential only 24 days after anthesis, which had improved gradually recording maximum of 95 per cent on the 60th days after anthesis.

Petrov et al. (1981) reported that brinjal seeds from fruits harvested at botanical maturity had higher test weight, germination energy and germination rate.

Prasad and Ramasamy (1980) reported that the seeds attained maximum germination only on the 80 days after anthesis. Harvest of fruits beyond this period resulted in decline in germination due to development of dormancy in ash gourd (CO-1).

Domain (1982) noticed that test weight and germination energy was maximum in the seeds obtained from ripened fruit of eggplant. Similarly, test weight, germination per
cent and field emergence were the higher when brinjal fruits were harvested at 75, 80 and 85 DAA. Seeds obtained from 30 DAA were not capable of germination.

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

Vadivelu (1983) found that tomato seeds extracted from fully mature fruits with yellow colour stage, yellow to red colour stage and red colour stage had germination of 62-68 %, 72-78 % and 92-93 %, respectively.

Singh et al. (1985) recorded highest germination per cent (80.00 %) in tomato fruits harvested at the stage of turning towards red and red ripe stage, whereas only 64.00 % germination was recorded in the seeds obtained from matured green fruits.

Singh and Sidhu (1985) observed the higher germination (92.00 %) was obtained in full and half ripe fruits, whereas the lowest germination (22.00 %) was recorded in the seeds extracted from purple coloured fruits in brinjal.

Buriev (1987) reported that best quality cucumber seeds were obtained from 40 days after anthesis with higher germination, vigour, and seedling dry matter.

Edwards and Sundstrom (1987) found that in pepper, maximum germination (81.00 %) was obtained when the seeds were extracted from red coloured fruits compared to those extracted from orange fruits.

Jayabarathi et al. (1990) found that brinjal fruits harvested at completely yellow stage gave the highest seed yield (102.5 kg/ha), seed recovery (34.64 %), seed germination (90.00 %) and vigour index (2201) compared to other stages.

Kalavathi (1990) noticed that the highest germination (91.20 %), vigour index (174) were observed when the seeds were harvested at 130 days after sowing compared to seeds of premature stage i.e., 100 DAS (8.80 %) in chilli.

Chaudhari et al. (1992) observed that the highest germination (94.62 %), seedling length (6.37 cm) and vigour index (11649) were obtained from the seeds harvested at full mature and ripe with red skin. They also reported increased seed quality parameters with increase in maturity stages in tomato.
Ascota et al. (1994) observed that in chilli cv. Jorocho, seeds obtained from ripe fruits gave higher germination (93.96 %) compared to green red fruits. Similarly, higher germination (76.80 %) and seedling vigour index (1444) were observed with seeds extracted from fruits harvested at full red colour stage.

Biradar (1994) reported that maximum germination percentage (92.21 %), shoot length (5.12 cm), root length (4.89 cm), seedling vigour index (921.17) was recorded when fruits were harvested at 71 DAA as against earlier and later stages of harvesting.

Krishnamurthy (1995) reported that the germination (80.63 %), root length (6.88 cm), shoot length (5.31 cm), vigour index (927) and field emergence (74.45 %) were higher in chilli fruits at 100 per cent ripe stage than those at earlier stages.

Baruah et al. (1996) observed highest test weight (299 mg), speed of germination (16.0) in the fruit harvested at red ripe stage compared to control in tomato.

Naik et al. (1996) noticed that the fruits of chilli cv. Arka Gaurav harvested at full yellow colour recorded maximum 1000 seed weight (1.69 g), germination (88.00 %). Root length was also maximum when fruits harvested at full yellow colour stage compared to the fruits harvested at full green colour which recorded minimum 100 seed weight (0.28 g) and germination (48.00 %).

Radheshyam et al. (1996) studied the effect of stage of fruit maturity on seed quality in six cultivars of chilli which was harvested at the red ripe turning stage. Their seed quality parameters were assessed and results indicated that the moisture content (14.7 %) and EC (2228.8 mmohs/m) were higher in seeds from fruit harvested at the red ripe turning stage, but the germination (72.40 %) and viability (90.00 %) were higher in red ripe stage fruits.

Vinodkumar (1998) reported that paprika chilli seeds extracted from fruits harvested at 60 days after flowering showed highest 1000 seed weight (8.29 g), germination (96.50 %), field emergence (90.50 %), shoot length (7.67 cm), root length (5.67 cm) and seedling vigour index (1288) compared to seeds obtained from fruits harvested at other stages.
Adirai and Vanagamudi (1999) reported that significant differences in fruit and seed development in different stages of maturity. The maximum vigour and viability were recorded on 70th day after anthesis in ash gourd.

Balaraj (1999) revealed that chilli fruits harvested at full red colour, recorded highest germination (84.53 %), seedling length (16.76 cm), seedling vigour index (1418), dry weight of seedling (0.212 g) and field emergence (82.00 %) while electrical conductivity was less (1.16 dSm⁻¹) compared with other stages of harvesting.

Biradar (1999) noticed that chilli fruits harvested at full red colour stage recorded significantly the highest fruit weight (0.73 g) followed by over ripen stage (0.72 g). The lowest fruit weight (0.51 g) was obtained when fruits were harvested at green coloured stage. He also reported that maximum 100 seed weight (5.31 g), germination (87.33 %), seedling length (17.54 cm), vigour index (1541), seedling dry weight (0.211 g) and field emergence (85.39 %) and lowest electrical conductivity (1.117 dSm⁻¹) were observed in the fruits harvested at full red colour stage.

Demir and Samit (2001) reported that occurrence of maximum tomato seed quality is related to changes in fruit colour but not in seed dry weight. Seed harvested from red-firm fruit (70 DAA) attained not only maximum germination under stress condition but also maximum emergence and seed quality constant values. Delayed harvest (80, 90 days after anthesis) caused decline in seed quality.

Kanwar (2001) found that the stage of harvest and postharvest ripening had significant effects on seed germination in cucumber cv. Poinsette. Maximum seed germination (92.90 %) was observed when fruits were harvested at 45 DAA, whereas the minimum (23.40 %) was recorded when fruits were harvested at 25 DAA. Seed germination was observed maximum (77.40 %) when seeds were extracted 10 days after harvest. Maximum field emergence and vigour index (86.40% and 1251.7, respectively) were obtained when seeds were extracted at 45 DAA. Field emergence and seed vigour were found to be maximum (73.40 % and 90.0, respectively) when seeds were extracted at 10 days after harvest.

Pandita and Nagarajan (2001) noticed that in chilli, fruit harvested at full ripe stage resulted in higher germination (96.00 %), seedling fresh weight (22.5 mg), vigour
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index (622) and field emergence (84.00 %) compared to fruits harvested at mature green and half red coloured stage.

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

Hamsaveni et al. (2003) observed highest fruit weight (52.15 g), 1000 seed weight (2.20 g), germination percentage (90.11 %), vigour index (822), seed dry weight (1.90 mg), field emergence (81.86 %) and low electrical conductivity (1.17 dSm\(^{-1}\)) when fruits of tomato were harvested at full red colour.

Sajjan and Jamadar (2003) revealed that the harvesting of okra fruits at 40 DAA was significantly superior over all the harvesting stages in terms of seed quality parameters viz., 100 seed weight (6.51 g), seed diameter (5.93 mm), seed germination (89.10 %), vigour index (2477.1) and least EC (0.787 dSm\(^{-1}\)) reflecting physiological maturity and it was on par with those harvested at 45 DAA (6.48 g, 5.93 mm, 85.30 %, 2468.1 and 0.726 dSm\(^{-1}\), respectively). It was concluded that, the harvesting of okra seeds between 35-40 DAA is the most optimum period for harvest and drying within the fruits is the most useful practice for successful seed production of okra.

Sureshbabu et al. (2003) reported that fruits harvested at full yellow colour maturity stage and kept up to six days of post harvest ripening recorded higher fruit weight, seed weight per fruit, 1000 seed weight, germination percentage, field emergence, vigour index and other seed quality parameters in brinjal cv Composite-2 among three fruit maturity stages viz., purple, half yellow, full yellow and six post harvest fruit ripening periods.

Jolli and Ekbote (2005) the studied effect of fruit maturity on seed quality in chilli cv. Byadgi dabbi. They found significant difference in chilli for germination (%), field emergence, seedling fresh weight (mg), vigour index I and vigour index II when fruit were harvested at full red ripe stage.

Murugesan and Vanangamudi (2005) reported that harvesting of fruits at 70 days after anthesis was found to be the suitable stage for best seed quality in ash gourd.
Sajjan and Vyakarnahal (2005) observed that optimum stages to harvest okra fruits for seed purpose in 40 days after anthesis coupled with shade drying resulted in higher test weight, germination, root length, shoot length, seedling dry weight, vigour index and reduced electrical conductivity.

Dias et al. (2006) reported that tomato seeds extracted from the fruit harvested at full red colour with a short period of post-harvest ripening recorded highest germination percentage (92.00 %), seedling emergence (65.00 %) and speed of germination (3.7) in comparison with the fruit harvested at green and colour break stage.

Shantappa et al. (2006) opined that fruits harvested at orange red colour stages resulted in highest dry weight of 100 seed (26.38 g), germination (88.81 %), shoot length (13.93 cm), seedling dry weight (136.18 mg) and vigour index (2665) compared to fruits harvested at early or late stages of maturity in bitter gourd.

Shamsheer Ahmed et al. (2008) found that seeds obtained from fruits harvested at red ripe stage and allowed up to 14 days of post harvest ripening period recorded higher 1000 seed weight (5.78 g), germination percentage (89.10 %), shoot length (7.30 cm), root length (10.67 cm), seedling vigour index (1780) and seedling dry weight (6.820 mg) with lower electrical conductivity (1.417 dSm⁻¹) in chilli.

Alan and Eser (2008) noticed that seeds extracted from fruits harvested at 40 days after anthesis (DAA) had less than 50 % germination in both cultivars of pepper taken under study. When seeds were extracted from fruits ripened for 10 and 20 days after harvest, their viability and the vigour increased to 81 % and 89 % respectively, in hot pepper and 77 % and 89 % respectively in conic red pepper. Seeds from 60 DAA fruits achieved the maximum germination and vigour levels in both cultivars. Delayed harvest (80 DAA) resulted in a significant decline in seed quality.

Manjunatha et al. (2009) carried out an investigation to know the influence of stage of fruit harvesting and post harvest ripening on seed quality in bell pepper cv. Arka Gaurav. Seed weight/fruit, germination, root length, shoot length, seedling dry weight and seedling vigour index were maximum when fruits were harvested at full yellow colour.

Passam et al. (2010) evaluated two eggplant varieties for seed in order to determine optimum harvest time (20-65 DAA). From the results, it was concluded that
the optimum time of harvest for seed production was 55 DAA for both cultivars cv. Emi and cv Tsakoniki.

Vidigal et al. (2011) monitored changes in seed quality during fruit maturation in order to identify the stage of maximum quality of seeds and the optimum harvest time. From the study, it was concluded that sweet pepper seeds of cv. Amarela Comprida reaches mass maturity at approximates 75 DAA, when seed water content was 47.3 % and fruits were red outside.

Martins et al. (2012) studied the physiological maturity of eggplant seeds by harvesting the seeds at 49, 56, 63, 70 and 77 DAP with two post-harvest storage periods. From the study, it was concluded that the ideal point for harvesting eggplant fruits for extraction of seed with high physiological quality occurs at 70 DAP. Further they also suggested that the post-harvest storage period of the fruits before the extraction of seeds does not alter quality of seeds.

Devaraju et al. (2013) studied the influence of stage of fruit harvest on seed quality of cucumber cv. Hassan local. Among the five different stages of fruit harvest, maturity stage 50 DAA recorded highest values for filled seeds/fruits, 1000-seed weight, germination per cent, mean seedling length, seedling dry weight, vigour index I and II, and field emergence in comparison with 20, 30, 40 and 60 DAA indicating that 50 DAA is optimum stage for harvesting fruits for better seed quality.

Kalyanrao et al. (2014) opined that maximum fruit weight (2.02 kg), fruit length (44.51 cm), number of filled seeds per fruit (484.3) and seed yield per fruit (72.23 g), higher germination (94.38 %) and seedling length (33.08 cm) were recorded in the fruits harvested at 60 DAA in bottle gourd.

Takac et al. (2014) noticed that seed from technologically mature fruit had germination around 25 % in eggplant. In semi-mature fruit, germination abruptly increased from 2 % (seed extracted after harvest) to 88 % (seed extracted 20 days after harvest). Seeds obtained from botanically mature fruit had maximum germination after storing for 20 days after harvest and amounted to 99 %. The 1000 seed mass increased with storage life and it reached 5.48 g in botanically mature fruit.

Vidyadhar et al. (2014) studied on influence of stage of fruit maturation on the seed yield and quality traits in cherry tomato grown under different protected conditions
concluded that seed extracted from fruits harvested 65 days after anthesis showed maximum germination per cent (81.00 %), seedling dry weight (0.014 g) and lowest electrical conductivity (0.008 µSiemens/cm/g) value. This was due to accumulation of more fry matter and photo assimilates at this stage in the fruit and seed.

Franquera (2015) studied physiological maturity to determine the optimum time of harvest and physiological changes in eggplant seeds and found that seeds of eggplant had maximum dry weight at 50 DAA when it reached physiological maturity.

Hullur et al. (2015) revealed that among various maturity stages of chilli, fruits harvested at red ripe stage when subjected for 20 days post-harvest ripening (M₄) recorded higher seed quality parameters viz., 1000 seed dry weight (6.95 g), seed germination (66.00 %), seedling length (9.9 cm), seedling dry weight (1.50 mg), seedling vigour index-I (748), total dehydrogenase activity (1.314), field emergence (56.00 %), while lower values were recorded for electrical conductivity (1.743 dSm⁻¹) and moisture content (10.93 %) for fresh seed.

Singkaew et al. (2017) found that the winter season delayed physiological maturity of seeds by ten days in comparison with rainy season in tomato. Highest weight of dried seed, germination and germination index was obtained at 60 DAP. They also indicated that the proportion of irregular shaped seeds and abnormal and weak seedling were independent of fruit and seed maturity.

2.3 Effect of seed extraction methods

The availability of quality seed is most important for increasing production and productivity of brinjal. Quality of seed is also found to be influenced by method of extraction. Although large scale seed production is undertaken with natural fermentation, chemical methods proved to be advantageous, as they are easier and faster than natural fermentation. Knowledge of correct method of seed extraction is must for obtaining better seed quality.

Karivartharaju et al. (1989) reported that the tomato seeds extracted by hydrochloric acid at the rate of 10 ml per liter of pulp, recorded highest germination percentage (94.00 %), vigour index (1986) and lower EC (56 µmhos/cm) after eight months of storage period, while citric acid extraction indicated poor seed quality after the entire eight months of storage.
Gowda *et al.* (1991) studied the different seed extraction techniques in tomato and concluded that soaking in 5 % HCL for 45 min or 4 % H$_2$SO$_4$ for 30 min resulted in the highest percentage germination (96.00 % and 94.00 %, respectively) and vigour index (594 and 550, respectively) compared to fermentation for 24-120 h at ambient temperature and alkali extraction by soaking in NaOH.

Naik *et al.* (2000) found that seed soaking for 30 minutes in sulphuric acid (40.00 %) recorded the highest germination percentage (88.86 %), root (7.64 cm) and shoot (9.28 cm) length, seedling vigour index (1351), dry weight (24.52 mg) and field emergence (82.54 %) and the lowest electrical conductivity (0.914 dSm$^{-1}$) compared to fermentation and alkali (NaOH or NaHCO$_3$) extraction of brinjal seeds.

Ravikumar (2001) reported that seed extracted by fermentation method resulted in higher quality seed in cucumber *viz.* germination, vigour index, root length, shoot length, seedling dry weight with reduced electrical conductivity.

Dev and Sharma (2002) showed that maximum seed recovery and seed vigour index was obtained in acid fermentation @ 10 ml / kg of pulp for 45 minutes in cultivar pusa purple cluster in brinjal. However, results with respect to germination percentage and 1000 seed weight remained non-significant.

Mini *et al.* (2003) observed that manual seed extraction using 2 % HCL for 30 minutes followed by drying under shade resulted in best quality seeds in ash gourd. The seeds extracted by this method had highest germination (88.33 %), speed of germination (19.26), and vigour index (704).

Mini *et al.* (2005) concluded that seeds extracted after soaking the fruit pulp in 15 ml. HCL for 30 minutes followed by drying the seeds initially in shade for one day and then in sun avoiding peak hours showed maximum germination (99.50 %), speed of germination (24.9) and vigour index (1086) in water melon.

Leomara *et al.* (2013) suggested that extraction of seeds by fermentation and applying hydrochloric acid to pulp/seed reduced the physiological seed quality. All drying methods reduced the seed moisture content permitting adequate storage and maintenance of seed physiological quality of brinjal.
Rahman *et al.* (2015) suggested that wet seed extraction without fermentation is comparatively better than dry method in maintaining physiological quality (*viz.*, germination %, seedling dry weight, seedling length and seedling vigour index) of eggplant seeds. They also suggested that dry seed extraction method is laborious as well as difficult to accomplish and may only be used for small-scale seed extraction.