REVIEW OF LITERATURE

Haberlandt (1902), who is regarded as the father of tissue culture made the first attempt to culture leaf cells culture of *Laminum purpureum* and hair cells of *Tradescantia* and *Pulmonaria* on Knopts’s salt solution with sucrose. Unfortunately none of the cells showed response.

Pegel (1979) reported the importance of sitosterol and sitosterolin in human and animal nutrition. He explained that only plants can synthesise these compounds and humans and animals obtain them from their diet. Even though their absorption efficiency is low their apparent synergistic stimulatory effect on the immune system and prophylactic effect on a variety of diseases of human being is very high.

Arora and Bhojwani (1989) reported the *in vitro* propagation of *Saussurea lappa* Clarke. In their work they have induced high frequency of shoots from leaf explants on MS media supplemented with NAA (0.5 µM).

Sharma *et al.*, (1991) reported *in vitro* clonal multiplication of *Coleus forskohlii* Briq. on MS media supplemented with Kn (2.0 mg/L) and IAA (1.0 mg/L) using nodal segments as explants. Rooting occurred on MS media containing IAA (1.0 mg/L). Plantlets were successfully established under field conditions.

Purohit *et al.*, (1994) reported the micropropagation of *Chlorophytum borivilianum*. Shoot multiplication has been achieved on MS media supplemented with 22.2 µM BA using young shoot bases as explants. All shoots rooted on ¾ strength MS media with 9.8 µM IBA. Rooted shoots were successfully established in pots.

Augustine *et al.*, (1997) reported the *in vitro* regeneration of *Curculigo orchoides* Gaertn. A nodular callus was obtained from leaf explant on MS media with BAP (2.22 - 4.44 µM). Shoots were developed from callus on MS media. Shoots were rooted on MS media with NAA (0.57-5.71µM) and successfully transferred to the soil.
Wawrosch et al., (1999) multiplied the plant *Swertia chirata* Buch.-Ham. ex Wall. by adventitious shoot regeneration from root explants. Shoots were multiplied on modified MS media with 3 µM BAP and rooting was achieved on hormone free MS media. Acclimatized plants were transferred to the soil.

Wijowska et al., (1999) reported *in vitro* culture of unfertilized ovules of *Viola odorata* L. The highest rate of callus induction was on MS media with 2, 4-D and BAP. Roots regenerated from callus on the same media and on media with different concentrations of auxins and cytokinins.

Arockiasamy et al., (2002) reported *in vitro* regeneration of *Solanum trilobatum* L. They induced the multiple shoots from nodal explants on LS media with 5 mg/L BAP. The regenerated shootlets were rooted on LS media with different concentrations of IBA. The rooted plantlets were hardened and successfully established in the soil.

Beena and Martin (2002) reported *in vitro* propagation of *Ceropegia candelabrum* L. Friable callus developed from leaf explants grown on MS media supplemented with 4.52µM 2, 4-D, developed the somatic embryos. 50% of the somatic embryos were matured and developed into plantlets. Plantlets acclimatized under field conditions with 90% survival.

Begum et al., (2002) reported *in vitro* rapid clonal propagation of *Ocimum basilicum* L. Subculture of *in vitro* shoots produced a highest frequency of rooting on MS media containing 1.0 mg/L NAA. Plantlets were successfully established under *ex vitro* condition.

Bais et al., (2002) reported the *in vitro* propagation of *Spilanthes mauritiana* DC. Maximum shooting was achieved on MS media with BA (1.0 mM) and NAA (0.1 mM) with minimal callusing from axillary bud explants. Shoots rooted best in MS media supplemented with IAA (0.2 mM) and the plants were well established in the soil.

Jeyakumar and Jayabalan (2002) reported *in vitro* regeneration of *Psoralea corylifolia* L. The highest rate of shoot multiplication was obtained on MS media containing 2.22 µM BAP from nodal explants. The maximum
rooting was on MS media containing 4.92 μM of IBA. The plantlets, thus developed were hardened and successfully established in the soil.

Grover et al., (2002) reported about medicinal plants of India with anti-diabetic potential. The study included 45 such plants and their products (active, natural principles and crude extracts) that have been mentioned/used in the Indian traditional system of medicine and have shown experimental or clinical anti-diabetic activity.

Roksana et al., (2002) induced multiple bulblets formation by repeated (fourth) subculture of regenerated plantlets of Allium sativum L. on both liquid and semi-solid MS media with 0.5 mg/L 2 ip and 0.25 mg/L NAA. The regenerated bulblets were successfully established in the soil.

Amin et al., (2003) reported an in vitro clonal propagation of Paederia foetida L. Multiple shoots obtained from nodal segments on MS media with 1.0 mg/L BA. For rooting, ½ strength MS media supplemented with 0.1 mg/L of IBA was used. After two weeks of acclimatization they were transferred to open environment.

Awad et al (2003) evaluated the effect of β-sitosterol, a plant sterol that induces apoptosis in breast cancer cells in intrinsic and extrinsic pathway. The study indicated that the betasitosterol supplemented at 16 M for 30days to MDA-MB-231 cells induced 39% and 80% increase in the activity of caspases 8 and 9 respectively compared to cholesterol supplemented cells.

Bhavish and Yogesh (2003) micropropagated Curculigo orchioides Gaertn. from meristem explant. Multiple shoots were obtained from the meristem tip culture on MS media supplemented with BA (2.21 μM). The shoots were rooted on ½ strength MS media supplemented with NAA (0.53 μM). In vitro plantlets were acclimatized in pots.

Ebru-Bedir et al., (2003) developed a protocol for in vitro propagation of Hydrastis canadensis L. Optimum callus was produced from leaf explants on MS media supplemented with 5.3 μM NAA and 2.2 μM of TDZ. Shoot multiplication was achieved on MS media with 2.2 μM TDZ in combination with 0.5 μM NAA.
Prajapati et al., (2003) reported the in vitro propagation of Curculigo orchioides Gaertn. an anticarcinogenic herb. The maximum shoots from nodal explants in LS media supplemented with 5 mg/L BAP and 0.05 mg/L IAA. The maximum percentage of rooting was obtained with 1 mg/L IBA. The rooted plantlets were hardened and successfully established in the soil.

Ghosh and Bannerjee (2003) reported the influence of plant growth regulators on in vitro callogenesis and in vitro shoot regeneration from leaf and nodal explants of Justicia gendurussa Burm. F.

Morozowska and Wesołowska (2004) developed a method for in vitro clonal propagation of Primula veris L. from shoot tip explants. In their study, phytochemical analysis revealed that the flavonoid compounds in leafy shoots from in vitro culture were similar to those leaves from field cultivation.

Ali et al., (2005) developed a suitable micropropagation method for Hypericum perforatum L. They obtained highest callus on MS media supplemented with kinetin and 2, 4-D (0.5 mg/L) in darkness from leaf disc explants. Highest number of shoots were obtained from leaf callus and easily acclimatized in greenhouse conditions.

Rehman et al., (2005) developed an efficient in vitro protocol for rapid production of plantlets using rhizome tip and lateral bud explants of Kaempferia galanga L. on MS medium with auxins and cytokinins and were acclimatized and established in the soil with 85% of success.

Tiefeng et al., (2005) reported an efficient plant regeneration system for Pinellia ternatea (Thunb.) Breit. Callus was induced in tubers on MS media with 9.1 μM 2, 4-D and 4.4 μM BA. The highest shoot regeneration was on MS media supplemented with 9.3 μM kinetin and 2.3 μM 2, 4-D. The rooted shoots were successfully transferred to the soil.

Uei-Chern et al., (2005) reported an improved protocol for in vitro micropropagation of Bupleurum Kaoi. Maximum numbers of hyperhydric shoots were obtained from nodal segments on ½ strength MS media supplemented with 0.25 mg/L BA. Plants were acclimatized successfully and established in the soil.
Chandra et al., (2006) reported successful propagation of *Picrorrhiza kurroa* Royle ex Benth. *In vitro* shoot multiplication was achieved using nodal segment on MS media containing 1.0 M BAP. Rooting was observed in MS media supplemented with IBA. The plantlets raised were well established in the field.

Gopi et al., (2006) developed a protocol for regeneration of *Ocimum gratissimum* L. Maximum shoots were observed on the MS media containing 0.5 mg/L BAP and 0.25 mg/L IAA. Regenerated shoots were rooted on ½ strength MS media supplemented with 0.5 mg/L of IAA. Complete plantlets acclimatized and successfully grown in garden soil.

Lattoo et al., (2006) reported the rapid plant regeneration of *Chlorophytum arundinaceum* Baker. Maximum shoot buds were obtained on MS media containing 4×10⁻⁶ M Kn and 2×10⁻⁶ M IBA from shoot crown explants. Healthy regenerated shoots were rooted in ½ strength MS media supplemented with 5×10⁻⁶ M IBA. Rooted plantlets were well established in the soil-sand (1:1).

Velayutham et al., (2006) developed an efficient method for *in vitro* regeneration for *Cichorium intybus* L. Totipotent callus were induced from leaf and root explants on MS media supplemented with different concentrations of IAA, IBA, NAA and 2,4-D at 0.5-10 µM in combination with BAP (2 µM). Maximum number of shoots were obtained on MS media with BAP (4 µM) and IAA (1 µM). The shoots were rooted on MS media supplemented with IAA, IBA and NAA. Rooted plantlets were successfully established in the field after hardening.

Ahmed et al., (2007) developed an efficient method for *in vitro* multiple shoot induction from nodal segments of *Stevia rebaudiana* Cav. Bertoni. on MS media supplemented with 1.5 mg/L BA and 0.5 mg/L Kn. Highest rooting percentage was recorded on MS media with 0.1 mg/L IAA. The rooted plantlets were hardened and successfully established in the soil.

Beegum et al., (2007) reported *in vitro* regeneration of *Ophiiorrhiza prostrata* D. Don. internode and proximal leaf explants cultured on MS media.
supplemented with NAA and BA developed shoots, calli and roots. Multiple shoots were developed in callus on MS media supplemented with 8.87 µM BA and 2.46 µM IBA. Shoots cultured on ½ strength MS media with 10.74 µM NAA and 2.32 µM Kn produced roots. Rooted shoots were well established in the soil.

Bin et al., (2007) reported a protocol for in vitro propagation of *Saussurea involucrata* Kar. Highest shoot regeneration frequency per leaf explant were achieved on MS media containing BAP and 2.5 µM NAA. The regenerated shoots were well rooted on a media containing 2.5 µM IAA. Regenerated plantlets survived and grew vigorously in greenhouse condition.

Chun-Rong et al., (2007) reported the effect of β-sitosterol on early cellular damage in irradiated thymocytes and a possible mechanism of effect on irradiation-mediated activation of the apoptotic pathways.

Huang et al., (2007) simultaneously extracted beta-sitosterol, stigmasterol and ergosterol coexisting in *Arisaema roxburghii* by a supercritical fluid extraction (SFE) procedure. Then estimated by a simple high-performance liquid chromatography/atmospheric pressure chemical ionization ion trap mass spectrometry (HPLC/APCIMS).

Karuppusamy and Pullaiah (2007) were achieved the shoot multiplication of *Bupleurum distichophyllum* Wight. from nodal and shoot tip explants, respectively on the media containing 1.0 mg/l BAP and 0.1 mg/l NAA. The regenerated shoots were successfully rooted on MS supplemented with 2.0 mg/l IBA, after sequential hardening, survival rate was 71%.

Kim et al., (2007) reported high frequency plant regeneration in *Podophyllum peltatum* L. An embryogenic callus developed from cotyledon explants on MS media with 6.78 µM 2, 4-D under continuous darkness. High frequency somatic embryogenesis was occurred in the callus grown on MS media with ABA (11.35 µM). Embryos were germinated and grown into plantlets with well developed roots on MS media with 2.89 µM GA3. Rooted plantlets were acclimatized in the soil.
Kottapalli and Prasad (2007) reported an efficient protocol for rapid in vitro multiplication of *Drosera indica* L. Maximum multiple shoots were developed on MS media supplemented with Zeatin (0.5 mg/l) and Kinetin (0.5 mg/l). Rooting was achieved on MS basal media.

Mutasim *et al.*, (2007) reported in vitro multiple shoot regeneration from nodal explants of *Vernonia amygdalina* on MS media containing BAP (0.5 mg/L) in combination with NAA (0.5 mg/L). Regenerated shoots were rooted on MS media supplemented with 2 mg/L NAA. The rooted plantlets were acclimatized and transferred to greenhouse.

Nandagopal and Ranjitha Kumari (2007) developed an efficient protocol for the root culture of *Cichorium intybus* L. Highest percentage of rooting was induced from matured leaf explants under dark condition on MS media supplemented with 0.5 mg/L NAA and 0.1 mg/L IBA. The biomass of root culture was increased to 5.820 g in ½ strength MS liquid media with 0.2 mg/L NAA and 0.5 mg/L IBA under continuous agitation and total dark condition.

Chaudhuri *et al.*, (2007) reported the micropropagation of *Swertia chirata* Buch. The highest number of shoot regeneration was obtained in ½ strength MS media supplemented with 0.44 µM 6-BA and 4.65 µM 6-BA with 10 mM KNO₃ and 75 mg/L of casein hydrolysate. Regenerated plantlets were successfully transferred to the field and produced viable seeds.

Senthilkumar *et al.*, (2007) reported in vitro regeneration of the *Acmella calva* L. Maximum organogenic callus was induced from leaf explants on MS media containing BAP (3.0 mg/L) and NAA (0.3 mg/L). Adventitious shoots were developed from leaf callus on MS supplemented with BAP (3.0 mg/L) with NAA (3.0 and 0.3 mg/L). The rooting was achieved in the MS media containing BAP at 3.0 and 2.5 mg/L. The plantlets were established successfully in the soil and coir pith (1:1).

Shan-shun *et al.*, (2007) developed an in vitro propagation protocol for *Hydrastis canadensis* L. Maximum shoots were induced on MS media containing 2.5 µM TDZ and 5.0 mM NAA. In vitro shoots developed roots on
MS media with 1.0–2.0 mM BA. Plantlets were acclimatized and maintained in standard greenhouse conditions for further growth.

Sivanesan and Byoung (2007) reported *in vitro* propagation of *Sida cordifolia* L. Multiple shoots were achieved on MS media supplemented with 2.0 mg/L BA, 0.5 mg/L NAA, 1.0 mg/L adenine sulfate, and 10% coconut milk. Regenerated shoots were successfully rooted on ½ strength MS media supplemented with 2.0 mg/L IAA and 3% sucrose. Rooted plantlets were established in the field.

Senthilkumar and Rao (2007) reported an *in vitro* micropropagation of *Heliotropium indicum* L. The highest number of shoots was yielded on MS medium supplemented with Kn (1.0 mg/L), BA (0.5 mg/L) and IAA (0.05 mg/L). High frequency of rooting was obtained on ½ strength MS media with IBA (0.1 mg/L). Rooted plants were hardened and established in the field.

Wojcik and Podstolski (2007) reported the *in vitro* shoot regeneration of *Hypericum perforatum* L. Callus from leaf explant was obtained on MS media supplemented with 2, 4-D and Kinetin. Highest number of shoots were observed on MS media supplemented with 2.85 µM of IAA and 4.44 µM of BA. Shoots were rooted on MS media without hormones.

Alicja et al., (2008) reported the somatic embryos from immature zygotic embryos of *Arabidopsis thaliana* L. cultured on B5 media with 2, 4–D at 5 µM/L.

Bohidar et al., (2008) developed a protocol for *in vitro* regeneration of plants from nodal explants of *Ruta graveolens*. The highest number of shoot buds was obtained on MS media containing 1.0 mg/L BAP and 0.25 mg/L IAA. Elongated shoots were rooted on ½ strength MS media with NAA. The well rooted plantlets were hardened and acclimatized in the soil and their survival was about 90%.

Khalekuzzaman et al., (2008) developed a protocol for *in vitro* propagation of *Adhatoda vasica* Nees. Nodal explants were produced maximum number of shoots on MS media with 2.0 mg/L BAP and 0.2 mg/L NAA. Highest 80% rooting was achieved on MS media with 1.0 mg/l IBA.
Plantlets were acclimatized and successfully established in natural condition in pot.

Verma (2008) achieved in vitro regeneration of *Trichodesma indicum* L. through embryo culture. The zygotic embryos placed on MS media with different hormones like Kinetin, BA and NAA for the induction of callus and adventitious shoots. About 60% of micro shoots developed roots on MS media supplemented with IBA. The regenerated plants were successfully acclimatized and transferred to the soil.

Roy (2008) reported the rapid multiplication of *Boerhaavia diffusa* L. by using nodal explants. Maximum shoots were recorded in MS media with 1.5 mg/L BAP and 0.5 mg/L NAA from nodal segments. Best rooting on ½ strength MS with 1.0 mg/L of IBA or IAA was observed. Shoots produced roots on the same media. Plantlets were successfully acclimatized and established in the soil.

Sama et al., (2008) reported the pharmacognostic studies on *Dodonaea viscosa* leaves. They have carried out the pharmacognostic studies, microscopical structure, morphological characters, chemical analysis and numerical values of the plant.

Selvankumar et al., (2008) reported in vitro regeneration of *Andrographis affinis* Nees. They achieved highest shoot regeneration on MS media containing 2 mg/L BA and 1 mg/L Kn from nodal explant. Rooting was achieved on MS with 2 mg/L IBA. Regenerated plants were hardened and successfully transferred to the soil.

Singh and Sharma (2008) were induced callus in *Lycopersicon esculentum* Mill. from hypocotyle on MS media with 3 mg/L BAP and 0.5 mg/L NAA. The shoot regeneration from calli was obtained in MS media supplemented with 100 g/L PEG, 2 mg/L BAP and 1 mg/L IAA. Best rooting was occurred in MS media with 100 g/L PEG and 1.0 mg/L NAA.

Sivanesan et al., (2008) reported the influence of plant growth regulators and Iron source on axillary shoot multiplication of *Scrophularia takesimensis* Nakai. MS media with 2.0 mg/L BAP and 1.0 mg/L IAA induced multiple
shoots from axillary shoot explants. Roots developed on MS media with increased FeSO₄ and Na₂EDTA. The in vitro grown plantlets were successfully established in the soil.

Lincy et al., (2009) developed a protocol for direct and indirect somatic embryogenesis from aerial stem explants of Ginger. The callus obtained from aerial stem was subject to stress for 40–60 days without subculturing turned into embryogenic and then produced somatic embryos in a media containing 2 mg/L BA. The mature, club-shaped somatic embryos were germinated on a media containing BA and NAA in different concentrations. Direct somatic embryogenesis was observed from the aerial stem and leaf base explants with the use of TDZ alone or in combination with IBA.

Amit et al., (2009) reported high frequency shoot regeneration and enhanced Isoflavones production in Psoralea corylifolia L. Maximum shoots were induced from cotyledonary nodes on MS media with TDZ (8 μM). Root differentiation was on MS media. Regenerated shoots and roots showed enhanced production of isoflavones compared to the field grown plants.

Amritpal (2009) reviewed significant pharmacological activities of Acanthus ilicifolius L. He reviewed the analysis of traditional medicinal usage and phyto-pharmacological investigations of the medicinal plant.

Arif et al., (2009) reported the in vitro propagation of Picrorrhiza kurroa Royle ex. Benth. Shoot multiplication was achieved from nodal explants on MS media with 0.6 mg/L NAA. The elongated shoots rooted on MS media. Rooted plantlets were acclimatized and transferred to the soil.

Balaraju et al., (2009) reported the micropropagation of Swertia chirata Buch. Highest numbers of multiple shoots were induced from shoot tip explant on MS media with BAP at 1.0 mg/L and Kn 0.1 mg/L. Shoots were transferred to half-strength MS media with NAA 0.1 mg/L for rooting. Plants were hardened within the culture room.

Baskarana and Jayabalai (2009) reported an in vitro regeneration of Psoralea corylifolia L. Green compact nodular calli were induced from hypocotyl explants on L2 media with 10 μM NAA and 2 mM TDZ. Higher
shoot regeneration was achieved on L2 media supplemented with 2 mM BA, 4 mM TDZ and 50 mg/L BVN. Elongated shoots developed roots and hardened soil mixture and vermiculite (3:1), later transferred to the field.

Biswas et al., (2009) reported the clonal propagation of Boerhaavia diffusa L. Maximum multiple shoots produced on MS media with 2.0 mg/L BAP and 0.2 mg/L NAA from nodal explants. Rooting was achieved in half strength of MS media with 1.0 mg/L IBA. Plantlets were successfully transferred to the soil.

Gopalakrishnan et al., (2009) reported the plant regeneration of Plumbago rosea L. Multiple shoots were developed from leaf explants on MS media with 6.66 μM BAP and 2.69 μM NAA. The elongated shoots rooted on half strength MS media. Rooted plantlets were hardened and successfully transferred to the soil.

Guadalupe et al., (2009) reported in vitro propagation and conservation of Castilleja tenuiflora Benth. Shoot multiplication and elongation were achieved by using axillary buds on MS media with 0.1 mg/L IBA and 0.25 mg/L BAP. Roots were induced on MS media with IBA 1.0 mg/L. Plantlets were acclimatized and established in the soil.

Hemant et al., (2009) reported in vitro propagation of Cannabis sativa MX-1 using synthetic seed technology. Axillary buds isolated from aseptic multiple shoot cultures and were successfully encapsulated using calcium alginate. Encapsulated explants exhibited the best regrowth on MS media containing TDZ (0.5M). Under in vivo 100% of encapsulated synseeds developed into plantlets on 1:1 potting mix-fertilome with coco natural growth media, moistened with full strength MS media. Regenerated plantlets were hardened and successfully transferred to the soil.

Ibrahim et al., (2009) reported alkaloid production in callus of Hyoscyamus muticus L. using both hypocotyl and leaf as explants. The best callus growth was achieved on MS media containing 86 mM sucrose, 0.25 mM tropic acid and 0.5 g/L yeast extract. While media containing 43 mM sucrose,
0.5 mM tropic acid and 2 g/L yeast extract resulted best production of alkaloids in callus.

Janarthanam et al., (2009) reported in vitro regeneration of *Stevia rebaudiana* Cav. Bertoni. The Juvenile leaf explants produced maximum callus on MS media containing 1.31µM 2, 4-D and 2.22 µM BAP. Callus transferred to MS media supplemented with 4.44 µM BA and 1.34 µM NAA showed better growth response and produced shoots. All plantlets produced profuse rooting during hardening and successfully transferred to the field.

Robinson et al., (2009) reported the in vitro regeneration of *Emilia zeylanica* C. through somatic embryogenesis. Embryogenic callus was induced from stem explants on MS media with Kinetin (0.50 mg/L) and 2, 4- D (0.10 mg/L). The well developed embryos were developed into complete plantlets on MS media containing BAP (0.05 mg/L) and ABA (0.10 mg/L). Regenerated plantlets were hardened in a mixture of soil, sand and vermiculite and transferred to the soil.

Kalidass and Mohan (2009) reported a micropropagation protocol for *Phyllanthus urinaria* L. Maximum shoot multiplication was achieved from nodal segments on MS media with 1.0 µM BA. Rooting was achieved on MS media with 2.0 µM IBA. Regenerated plants were successfully acclimatized and transferred to the soil.

Karthikeyan et al., (2009) reported the rapid multiplication of *Scoparia dulcis* L. Maximum shoot multiplications were obtained from nodal segments on the MS media containing 0.5 mg/L BAP and 0.25 mg/L IAA. Regenerated shoots were rooted on half strength MS media with 0.5 mg/L of IBA. Plantlets were acclimatized and successfully grown in the garden.

Karthikeyan et al., (2009) reported in vitro multiplication of *Centella asiatica* L. Nodal explants cultured on MS media with 2.0 mg/L BAP were produced multiple shoots. Shoots transferred to MS media containing 1.5 mg/L IBA for rooting. The rooted plants were successfully established in green house condition after hardening.
Kone *et al.*, (2009) reported *in vitro* regeneration procedure for *Vigna subterranea* L. Multiple shoots were produced from the nodal and apical stem explants on MS media plus B\textsubscript{5} vitamins and supplemented with cytokinins alone and in combination with NAA. Regenerated shoots rooted on full-strength MS media. *In vitro* grown plants were successfully transferred to the soil and all survived plants were morphologically normal.

Madhavan *et al.*, (2009) reported the pharmacognostic studies on the root tubers of *Asparagus gonocladus* Baker. This study provides taxonomy of the species, pharmacognostic and physico-chemical details of the root tubers and helps in laying down the standardization and pharmacopoeial parameters.

Nafees *et al.*, (2009) developed a protocol for *in vitro* propagation of *Gerbera jamesonii* L. The callus was obtained from seed explants on MS media with BA (2 mg/L). Shoots were developed from callus on MS media with BA (4 mg/L) and IBA (1 mg/L). Rooting was induced on MS media containing BA and IBA (0.5 mg/L). The plantlets were acclimatized and transferred to the soil.

Parashuram *et al.*, (2009) developed a protocol for *in vitro* plant regeneration in *Withania somnifera* Dunal. Callus obtained from cotyledonary leaf explants of *in vitro* raised seedlings on MS media supplemented with NAA (1.0 mg/L) and Kn (1.0 mg/L). Shoots from callus were obtained on MS media with BAP (2.0 mg/L) and Kn (0.5 mg/L) and 10% CM. The rooting was induced on MS media with IBA (2.0 mg/L). Plantlets were hardened in half strength MS and then transferred to the pot containing sand and soil mixture (1:1).

Patel and Shah (2009) reported the regeneration of *Stevia rebaudiana* Cav. Bertoni. Maximum callus induction was from leaf explants on MS media containing 2.0 mg/L BAP and 2.0 mg/L NAA. Shoot multiplication was achieved on MS media with 2.0 mg/L BAP and 0.2 mg/L NAA. Rooting was better on ¼ strength MS media with 0.1 mg/L IBA. The rooted plantlets were hardened successfully in Tera care media.
Robinson et al., (2009) published a protocol for micropropagation of *Costus speciosus*. The highest shoot proliferation was obtained from Pseudostem explant on MS media supplemented with 0.05 mg/L BA. Maximum numbers of roots were obtained on MS media with 0.1 mg/L IBA. Over 75% of the plantlets were survived and transferred to greenhouse conditions.

Prabhat et al., (2009) developed a protocol for in vitro regeneration of *Rauvolfia serpentine* L. Highest callus induction from leaf explant was obtained on MS media with BAP (1.0) and IAA (0.5 mg/L). Maximum shoot regeneration was on MS media with BAP (2.5 mg/L) and IAA (0.4 mg/L). Rooting was obtained on MS Media containing BAP (2.5mg/L), IAA (0.5mg/L) and NAA (0.5 mg/L). After acclimatization plantlets were transferred to the soil.

Prabhu et al., (2009) reported pharmacognostic investigation of the leaves and stems of *Viburnum erubescens* Wall.ex DC. They have carried out the pharmacognostic studies, microscopical structure, morphological characters, chemical analysis and numerical values of the plant.

Raja et al., (2009) reported an in vitro propagation of *Caralluma sarkariae*. Callus was regenerated from mature internodal explants on MS media with various concentrations of auxins. Maximum shoots were obtained from the callus on MS media with BAP, Kinetin and NAA. Shoots were rooted on ½ strength MS media containing NAA. Regenerated plants were acclimatized in the soil.

Rout et al., (2009) reported in vitro propagation of *Abutilon indicum* L. The callus induction was observed on MS media with 2.5 mg/L 2, 4-D and 0.5 mg/L Kn. Shoots were developed on MS media with 2.0 mg/L Kn and 1.0 mg/l NAA. Rooting was induced on half strength of MS media with NAA. The plantlets were successfully transferred to the field.

Sadia et al., (2009) reported the in vitro regeneration of *Mentha piperita* L. Shoot regeneration was achieved on ½ strength MS media from shoot
meristem explant. Rooting was recorded at four different concentrations of auxins. The rooted plants were successfully transferred to the soil.

Shivanna et al., (2009) developed a protocol for the regeneration of *Biophytum sensitivum* (L.) DC. MS media supplemented with 2, 4-D (2.5 mg/L) induced embryogenic calli from inflorescence explants. Embryogenic calli produced embryoids when transferred to MS media with NAA (1.0 mg/L) and BAP (3.0 mg/L). Embryoids were developed on half strength MS media. Rooted plantlets were survived in the soil.

Banerjee et al., (2009) reported the pharmacognostic and preliminary phytochemical investigation of the bark of *Bridelia retusa* Willd. They have carried out the pharmacognostic, microscopical, morphological and various chemical parameters of the bark.

Wojciech and Wadas-Boron (2009) reported the influence of melatonin on *in vitro* development of *Vaccinium corymbosum* L. The influence of melatonin on *in vitro* cultures was intermediate but more similar to IAA when compared to IBA. Production of axillary shoots on MS media supplemented with melatonin and IAA was higher than on MS media with IBA. In contrast to IAA melatonin reduced the adventitious shoot development.

Yunfei et al., (2009) reported the *in vitro* propagation of *Gentiana straminea* Maxim. MS media with 2, 4-D was efficient for both callus induction and embryogenesis in seeds. Somatic embryoids were developed into plantlets on MS media with N⁶-adenine. The regenerated plants were transferred to the field and showed 5.82% of genticopicroside which is higher than control plants.

Ahmad et al., (2010) reported *in vitro* plant regeneration from leaf derived callus of *Ruta graveolens* L. Maximum callus was observed on MS media supplemented with 10 μM 2, 4, 5-T. The highest shoot multiplication was observed on MS media with 7.5 μM BA and 1.0 μM NAA. Regenerated shoots were rooted *in vitro* on MS media with 0.5 μM IBA and plantlets were successfully acclimatized.
Altafahmed (2010) reported in vitro propagation of Acorus calamus L. Rhizome explants on MS media with different combinations and concentrations of auxins developed into multiple shoots. Rooting was induced on MS media with IBA. Plantlets were acclimatized and transferred to the soil.

Abragam et al., (2010) carried out the pharmacognostic studies of the leaf, stem and root of the Hedyotis puberula (G. Don) Arn. This included microscopic, physico-chemical constant, fluorescent analysis and preliminary phytochemical evaluations.

Tavers et al., (2010) reported in vitro propagation of the wild carrot Daucus carota L. subsp. halophilus (Brot.) A. Shoot proliferation was induced from the shoot tips of in vitro germinated seeds on MS media with 4.4µM BA. Shoots rooted on half strength MS media. Plants obtained by shoot proliferation were acclimatized.

Badoni et al., (2010) reported the micropropagation of Hedychium spicatum Smith. MS media with Kinetin and IAA were used for shoot elongation. Roots were induced from in vitro shoot tip on MS media with 5.0 µM/L Kn and 1.0 µM/L IAA. 40-50% of plants were acclimatized.

Matcher et al., (2010) successfully developed a root-derived callus line of Panax sikkimensis Ban. They report accumulation of anthocyanins by small cell aggregate selection method. The growth index was 221.36 and an anthocyanin content of 2.76 mg/g on a modified MS media containing 4.5µM 2, 4-D and 1.2µM kinetin.

Babeet et al., (2010) reported in vitro and in vivo comparative study of primary metabolites and antioxidant activity in Spilanthes acmella L. Primary metabolites in leaf callus obtained on MS media with 2, 4-D and plant parts (root, stem, leaf) were screened and quantified for the soluble sugars, starch, phenolic contents and lipids.

Federico et al., (2010) reported micropropagation of Dianthus caryophyllus L. The maximum callus with shoots was obtained on MS with 15.9 µM NAA, 47.08 µM AgNO₃, and 0.74 µM Kinetin. Rooting induced on
MS media with 15.7 μM NAA and 47.08 μM AgNO₃. The shoots obtained showed little hyperhydricity. After gradual acclimatization, 80% plants were survived.

Hashem and Kaviani (2010) developed a protocol for In vitro proliferation of Aloe vera L. Maximum shoots per shoot tip explant and rooting were shown on MS media supplemented with 0.5 mg/L BA and 0.5 mg/L NAA. The highest number of roots was obtained on MS media supplemented with 2.0 mg/L IBA and 1.0 mg/L NAA. After hardening they showed 100% of survival.

Danova et al., (2010) reported in vitro culture of Hypericum rumeliacum Boiss. and production of phenolic compounds and flavonoids. The nodal explants were cultured on BA-supplemented MS media showed regeneration through meristemoids. The exclusion of BA from the media resulted in an increase in phenolic compounds and flavanoids content.

Kumaraswamy et al., (2010) reported an in vitro multiplication of Pogostemon cablin Benth. In vitro derived nodal segments on MS media with BA and Kn (0.5 mg/L) induced maximum shoots. Rooting was achieved on half strength MS media with 100 mg/L activated charcoal. Rooted shoots acclimatized in green house and successfully transferred to the soil.

Madhavan (2010) reported the pharmacognostic evaluation of stem and pseudobulbs of Flickingeria nodosa (Dalz.) Seidenf. The study was on taxonomical details, macro and microscopical characters and physico-chemical details. HPTLC profile of aqueous and alcoholic extracts of stem and pseudobulbs of the plant was also studied.

Bueno et al., (2010) reported in vitro response of different explants of Salvia hispanica L. The highest percentage shoots were obtained from nodal segments was of 78% on MS media with NAA; GA₃ and BA. A better survival of shoots and a higher proliferation of leaves/plantlet were observed with 1 μM of BA. There were different responses depending on the explant and the different growth regulators with different concentrations used.
Murugan et al., (2010) reported *in vitro regeneration* of *Glycine max* L. Somatic embryos were formed on the immature embryonic shoot tips on MS media with 6% sucrose, 164.8µM 2, 4-D, 5 µM asparagine and 684µM glutamine. The embryos were desiccated and regenerated on hormone-free MS media. Plantlets were transferred to the soil.

Muruganantham et al., (2010) reported the somatic embryogenesis in *Vigna mungo* L. Leaf explants developed embryogenic callus on MS media with 1.5 mg/L 2, 4-D. Liquid MS media with 0.25 mg/L 2, 4-D produced the globular, heart-shaped, and torpedo-shaped embryos in liquid culture of callus. Torpedo-shaped embryos were developed into cotyledonary-stage embryos on MS liquid media containing 0.5 mg/L abscisic acid. Approximately 1–1.5% of the embryos were developed into plants.

Patricia et al., (2010) developed a protocol for *in vitro* propagation of *Evolvulus glomeratus* Nees et. Martius and *Evolvulus arizonicus* A. Multiple shoots obtained from nodal segments on MS media with BAP (2.2 µM). Best rooting was observed on *ex vitro* acclimatization.

Prathyusha et al., (2010) reported the pharmacognostic studies on *Artemisia sieversiana* Ehrhart. Ex. Willd. The study was on the taxonomy, anatomy, powder study pertaining to organoleptic, microscopic, fluorescence and physical constant evaluations.

Parida et al., (2010) developed a protocol for rapid multiplication and *in vitro* production of leaf biomass in *Kaempferia galanga* L. The highest rate of shoot multiplication from lateral bud of rhizome as explants, as well as leaf biomass production was observed on MS media supplemented with BA (1 mg/L) and IAA (0.5 mg/L). The regenerated plants were acclimatized in greenhouse and subsequently transferred to the field.

Shahabadkar et al., (2010) reported the preliminary pharmacognostic and phytochemical investigation on the seeds of *Sterculia foetida* L. Preliminary qualitative chemical analysis of extract was found positive for flavonoids, saponins and alkaloids in ethanol extracts.
Shukla et al., (2010) studied the macroscopic and microscopic characters of seeds, physico-chemical evaluation, preliminary phytochemical studies and analgesic activity of the seeds of *Amman subulatum* Roxb.

Sreedharren et al., (2010) highlighted the exomorphology and histomorphology of leaf, petiole, stem, root and phytochemical study of *Plectranthus amboinicus* Lour. to identity the drug in crude form.

Sujatha et al., (2010) reported the biological evaluation of (3b)-STIGMAST-5-EN-3-OL as potent anti-diabetic agent in regulating glucose transport using *in vitro* model. The mechanistic role of (3b)-stigmast-5-en-3-ol in augmenting glucose uptake to overcome insulin resistance is deciphered in this study.

Thiyagarajan and Suriyavathana (2010) determined the phytochemistry and antimicrobial properties of the various extract of *Manicotti esculanta crantz* varieties Mulluvadi I, CO3 root bark. Phytochemical analysis of Mulluvadi I, CO3 and revealed the presence of alkaloids, tannins, saponins, flavonoids, glycosides and phenols. Variable ranges of antimicrobial activity of extracts were observed.

Agarwal and Meenakshi (2010) reported Pharmacognostic and biological studies on Senna & its products.

Yaser et al., (2010) reported *in vitro* regeneration of *Sutherlandia frutescens* L. The highest percentage of callus formation was obtained from rachis explants on MS media supplemented with 45.41 μM/L TDZ. Half-strength MS media supplemented with 24.6 μM/L IBA was optimal for root induction. The *in vitro* plants were successfully acclimatized in a growth chamber.

Yonghong et al., (2010) reported the production of alkaloids from *Pinellia ternata* Thunb. They used different combinations of 2, 4-D, BA, kinetin and NAA to induce the callus which are differ in colour, texture, differentiation status, and alkaloid content. The combination of NAA and BA induced Protocorm-like bodies formation. The PLB were rich in alkaloid content than callii and wild plants.
Bagadekar and Jayaraj (2011) reported in vitro flowering in *Heliotropium indicum* L. In vitro flowering was obtained in shoot tip culture on MS media supplemented with IBA (2.0 mg/L) and BAP (1.0 mg/L). In vitro flowered plantlets were successfully hardened and acclimatized in the soil.

Karnawat, *et al.*, (2011.) induced high multiple shoots from nodal explants of *Verbesina encelioides* on MS medium supplemented with 3 mg/L BAP and they claimed that, the in vitro regeneration is more successful by axillary buds than indirect organogenesis.

Pattar and Jayaraj (2011) reported in vitro vegetative propagation of *Blepharis mollluginifolia* Pers. Direct shoot induction was from nodal explants on MS media supplemented with BAP (0.5 mg/L). In vitro grown shoots were rooted on MS media with IAA (0.5 mg/L). The well rooted plantlets were successfully hardened and acclimatized in the soil.

Pattar *et al.*, (2011) reported the pharmacognostic and preliminary phytochemical investigations of *Blepharis mollluginifolia* Pers. They have developed a pharmacognostic data base of the plant.