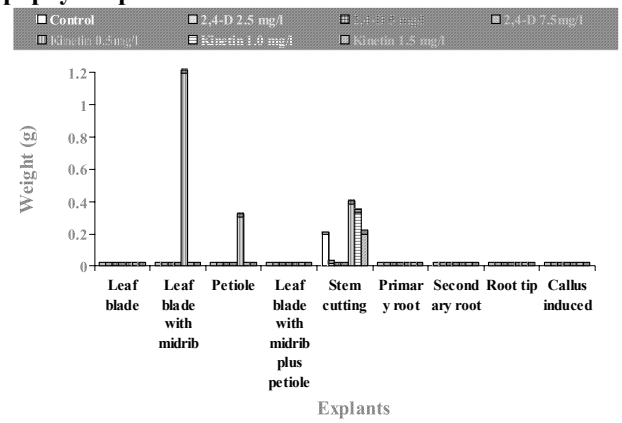
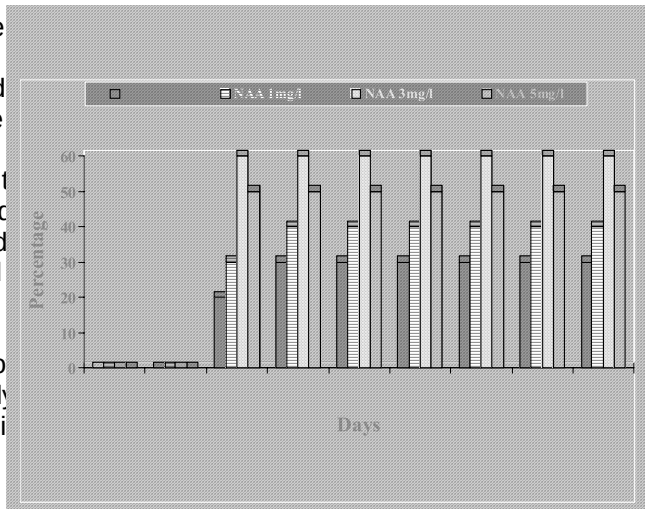
Fig. 5. Effect of growth hormones on callus growth of papaya explants



are incompatible to Mondal et al. (1994), might be due to difference in media formulations employed. In leaf blade the results obtained are supported by Leitz et al. (1983). Further justification is provided by Winnaar (1987) and Mondal et al. (1994). In case of petiole, results are controversial to findings of Mondal et al. (1994) for growth regulators used and Yang and Ye (1992) with respect to callus initiation. Concerning the treatments employed kinetin (0.5 mg L^{-1}) emerged as the best level employed (170%) for callus initiation for all the explants used followed by kinetin 1.5 mg L^{-1} (100%) and 1.0 mg L^{-1} (60%). 2, 4-D (2.5 mg L^{-1}) and control induced similar percentage of callus (30%). Analysis of cumulative effect of growth regulators at various levels depicted extremely higher response of the explants for callus initiation on media modified with kinetin (330%) than 2, 4-D with 30% callus initiation, only (Fig. 4). It is verified by the findings of Jordan et al. (1983) and Mondal et al. (1990). Kumar et al. (1992) and Fitch (1993) further strengthened the better performance of 2, 4-D on the other growth regulators except kinetin.

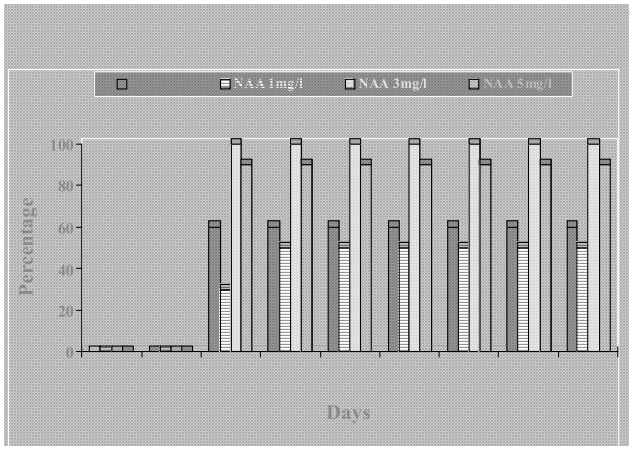
Callus growth (g). Leaf blade with midrib explant produced maximum (1.1939 g) callus followed by stem cutting (1.1238 g) and petiole (Fig. 5). Little is known about the callus growth in terms of weight. Further standardisation is desired for verification. Treatment comparison depicted kinetin (0.5 mg L^{-1}) as the best treatment (1.8843 g) ensued by kinetin (0.3327 g) at 1.0 mg L^{-1}. Among growth regulators, utilised kinetin (2.4163 g) was better than 2, 4-D (0.0124 g) with respect to total callus growth (Fig. 5). The results are supported by the findings of Jordan et al. (1983) and Mondal et al. (1990) who reported better performance of kinetin.

Time span to induce callus multiplication (days). In leaf blade with midrib explant, all the treatments initiated callus multiplication on 15th day of subculture (Fig. 6). Petiole yielded callus multiplication on 15th day of subculture in all treatments employed (Fig. 7). Stem cutting showed earliest callus multiplication on NAA (5 mg L^{-1}) ensued by NAA (1 & 3 mg L^{-1}) and control (Fig. 8). Results are contrary to the findings regarding the basal media application as MS media (Mondal et al., 1990; Kumar et al., 1992), modified White's



media with coconut water (Medora et al., 1979; 1984) and De Fossard medium (Drew, 1987). The results vary regarding the growth regulators employed as NAA and BA by Mondal et al. (1990) and kinetin by Kumar et al. (1992).

Callus multiplication (%). Leaf blade and leaf blade with midrib plus petiole, primary and secondary roots, root tip and callus derived from seedlings showed no response on any treatment. Petiole produced maximum callus (60%



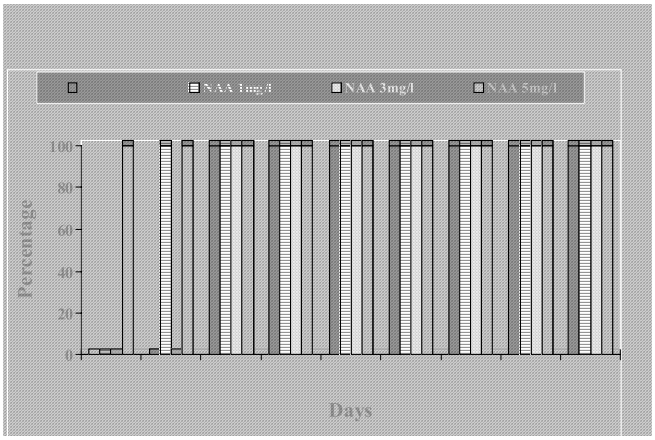
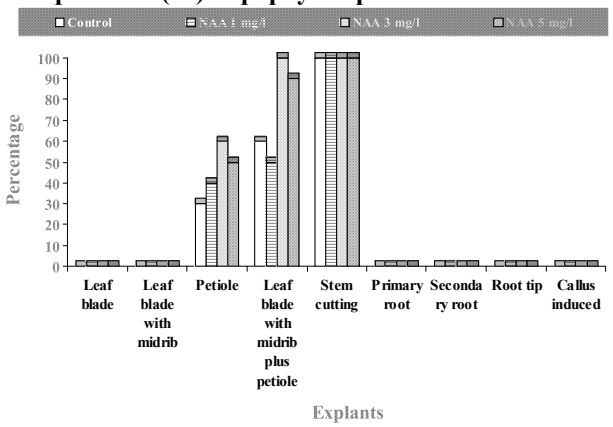


Fig. 9. Effect of growth hormones on callus multiplication (%) of papaya explants



cultures) on NAA (3 mg L^{-1}) followed by 50, 40 and 30% on NAA (5 & 1 mg L^{-1}) and control, respectively. Leaf blade with midrib derived callus generated maximum multiplication (100% cultures) on NAA (3 mg L^{-1}) ensued by 90, 60 and 50% on NAA (5 mg L^{-1}), control and NAA (1 mg L^{-1}), respectively. Stem cutting gave callus multiplication in 100% cultures on all treatments (Fig. 9). Maximum rate of total callus multiplication on all treatments was yielded by stem cutting (400%) followed by leaf blade (300%) and petiole (180%). NAA (3 mg L^{-1}) proved the best level with 260% of total callus multiplication ensued by NAA 5 mg L^{-1} (240%). NAA (1 mg L^{-1}) and control gave similar percentage i.e., 190% (Fig. 9). The findings of Mondal *et al.* (1990) are antagonistic to our results as they have reported callus growth on NAA and BA. Similarly, Kumar *et al.* (1992) reported callus growth on kinetin.

The comparison of various explants, obtained from *in vitro* raised seedlings of papaya (*Carica papaya* L.) revealed that stem cutting/nodal culture might be much better explant for callus induction on the MS media modified with kinetin as the growth regulator. The callogenic protocol development may be helpful to propagate male and female plants swiftly by subsequent embryogenesis and organogenesis. It may further be contributive in developing synthetic seeds and transgenic plants of papaya.

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