and lean season during the months of March and April might be the reasons for this.

Regarding the duration of training, more than one third (43.33 per cent) preferred three to five days training followed by two days training (41.33 pre cent). This finding is in agreement with that of Rajagopal (1986).

Conclusions

It was found that 12 major subject matter areas were most important to be considered for knowledge level training. All the respondents needed skill level training on packaging technology of cutflowers. The appropriate capacity building strategy for the potential export-oriented cutflower growers would be to organise an institutional type of training, offered by floriculture scientist using lecture with teaching aids preferably in one of the florists' field during April for a period of three to five days considering the identified major subject matter areas of knowledge and skill aspects of cutflowers. The study implies that it is essential to organise training programmes on cutflowers production for the potential growers in Nilgiris.

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Relative abundance of rice stem borer species in Tamil Nadu

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Abstract : Three species of rice stem borers occurred in Tamil Nadu, of which yellow stem borer (YSB), *Scirpophaga incertulas* (Walker) was more predominant than pink stem borer (PSB), *Sesamia inferens*, (Walker) dark-headed borer (DSB), *Chilo polychrysus* (Meyrick) in both Kar (June-September) and Pishanum (Oct-Jan) seasons. The PSB was second most numerous (35.21%) in Kar and was relatively as abundant as YSB in Pishanum (48.43%). The DSB was less common during either season (4.29-7.18%). Varieties had variable compostion of stem borer infestation. The YSB infestation was more from early tillering to maximum tillering stage, decreasing gradually with increasing PSB infestation from flowering stage. YSB was the most common species in all districts. PSB was more abundant than DSB in Coimbatore, Tanjore, Tuticorin, Madurai and Dharmapuri districts, whereas DSB was more numerous in Tirunelveli, Kanyakumari and Vellore districts. (*Key Words : Stem borer, Rice, Species composition, Relative abundance).*

Stem borers are most serious pests of rice in the tropical Asia (Pathak and Khan, 1994). They could not be controlled effectively despite the development of several management systems against them. Occurrence of diversified species at different growth stages of rice is one of the factors that vitiate man's efforts to manage them. Though several species of stem borers are known to occur in Asia, the yellow stem borer (YSB), *Scirpophaga incertulas* (Walker) (Pyralidae: Pyraustinae : Lepidoptera)

seems to have a wider distribution than others (Banerjee and Pramanik 1967; Chatterjee *et al.*, 1976). Chellaih *et al.* (1989) observed a low to moderate intensity of YSB not only in Tamil Nadu but also in other states. Though the pink stem borer (PSB), *Sesamia inferens* (Walker) (Noctuide: Lepidoptera) is one of the important pests of finger-millet in India, it infests rice as well (David and Kumaraswami, 1978). The dark-headed stem borer (DSB), *Chilo polychrysus* (Meyrick) (Crambidae : Lepidoptera) also infests rice in Tamil Nadu (David and Kumaraswami, 1978). Recently, reviewing the occurrence of stem borer species in India, Gunathilagaraj and Ganeshkumar (1997) observed that stem borers are on the decline in importance. However, information on the status of stem borer complex under different agro climatic conditions of Tamil Nadu is quite inadequate. The present study was therefore made to investigate the species composition of stem borers and their relative abundance in rice.

Materials and Methods

A roving survey was made at Agricultural College and Research Institue, Killikulam farm to ascertain the seasonal occurrence and relative abundance of stem borers by drawing random samples from ASD 16 grown during Kar (June to September) and Pishanum (October to January) seasons. At each sampling 50 hills were carefully uprooted at random and the infested tillers were dissected to detect the infestation as well as the species of borer involved. The larvae were identified based on the larval characters (Heinrichs, 1994). Species composition was calculated by the formula (total larvae of particular species) / (total number of larvae collected) x 100. Random samples of stem borer larvae were also drawn from fixed plots (4x5 m) with different varieties, namely ASD 16, ASD 19, ADT 36, IR 20, IR 50 and White Ponni at fortnightly interval during the Kar and Pishanum season during 1997-98. At each sampling 50 to 100 hills were examined to recover the larvae from the infested ones. A field trial was also conducted in randomized block design to study the incidence and species composition of stem borers. Three popular rice varieties, viz., ASD 19, ADT 39 and IR 20 were transplanted in 5 x 5 m plots at 15 x 10 cm spacing. Five replications were maintained. Observations on stem borer species as well as on the extent of stem infestation were made at fortnightly interval starting from 25 days after transplanting (DAT) until harvest. At each observation 25 hills were carefully uprooted at random in each plot and the infested tillers were dissected to detect the infestation as well as the species of borer involved. A random survery was made in Tirunelveli, Kanyakumari, Madurai, Thanjavur, Coimbatore, Dharmapuri and Vellore districts to determine the species composition.

Results and Discussion

Species composition

Periodical observations in the popular variety ASD 16 indicated that at least three species of stem borers occurred on rice during growing seasons (Fig. 1 and 2). Among them, YSB was more predominant than PSB and DSB in both Kar (60.0 per cent) and Pishanum (48.43 per cent) seasons. *Sesamia inferens* was second most numerous (35.21 - 44.38 per cent) while *C.polychrysus* was less common (4.29-7.18 per cent). Though nearly two-thirds of the larval population was of YSB in Kar, PSB (44.38 per cent) was relatively as abundant as YSB (48.43 per cent) in Pishanum.

Screening of commercial rice varieties in macroplots revealed that the varieties had more of infestation by YSB and PSB than of DSB (Fig. 3 and 4). Between the former two species, the varieties showed mixed trend over the two seasons. During the Kar season in 1997, YSB population was higher in ASD 19, ADT 36, ADT 39, ASD 16 and IR 20 (60.38, 57.14, 70.24, 65.08 and 52.00 per cent, respectively) than PSB population whereas IR 50 and White Ponni suffered more from PSB (52.24-57.84 per cent) than from YSB (47.62-47.76 per cent). Yellow stem borer occurred in lowest percentage in White Ponni and IR 50 and in highest percentage in ADT 39 (70.24 per cent). PSB infestation was lowest in ADT 39 (23.81 per cent) and highest in IR 50 and White Ponni (52.24-52.38 per cent) during the Kar season. Incidence of YSB ranged from a low of 40.32 per cent in IR 50 to a high of 55.81 per cent in ASD 16 while PSB infestation varied from a low of 31.11 per cent in ADT 39 to a high of 54.08 per cent in White Ponni duringPishanum season. Occurrence of PSB was rather as much frequent as that of YSB in Pishanum season. The results indicate that varieties had variable composition of stem borer infestation.

The district level survery revealed that paddy was subjected to damage from the three species of stem borers, viz., *S.incertulas*, *S.inferens* and *C.polychrysus*, of which YSB was collectively more

numerous (63.88 per cent) than PSB (22.8 per cent) and DSB (13.26 per cent) (Fig.5). The YSB occurred predominantly in all districts and its composition varied between 52.66 per cent in Tirunelveli district and 82.77 per cent in Vellore district. Occurrence of PSB and DSB varied among survey districts. While PSB was more abundant than DSB in Tuticorin, Madurai, Tanjore and Dhamapuri districts (23.56-39.21 per cent), DSB was more common than PSB in tirunelveli, Kanyakumari and Vellore Districts (17.23-39.65 per cent).

Stem borer incidence in relation to plant age

Age and variety of the host plants significantly influenced the infestation, size of population and species of stem borers (Table 1). Irrespective of the varieties grown (ADT 39, ASD 19, IR-20) during Pishanum season, the infestation was more at maximum tillering stage (70 DAT) (11.92, 12.22 and 10.96 per cent, respectively) in all the three varieties. The infestation started at seedling stage, i.e. 25 days after transplanting (DAT), increasing through the three-phase tillering stage. Thus density of deadhearts was more at maximum tillering stage (70 DAT). The incidence as whiteheads decreased later through flowering and heading stages. Among the three varieties, the incidence was significantly more in ASD 19 (9.32 per cent) than in ADT 39 (8.28 per cent) and IR 20 (7.67 per cent).

Composition of stem borer species in relation to plant age

In all the three varieties, the YSB caused 90-100 per cent damage at seedling stage (Fig.6). Later the YSB population slowly decreased to 25.81 per cent. On the other hand, PSB infestation was low at seedling stage before it gradually increased as YSB population decreased. In all varieties, the infestation by PSB increased from maximum tillering stage to flowering stage. During flowering to heading (70-100 DAT), the infestation was more due to PSB than due to YSB. DSB population was always lower.

Species composition

At least three species of stem borers occurred in rice, of which YSB was more predominant than PSB, and DSB in both Kar and Pishanum seasons (48.43-60.50 per cent). PSB was second most numerous (35.21 per cent) in Kar and was relatively as abundant as YSB in Pishanum (48.43 per cent). DSB was less common during either season (4.29-7.18). Kapur (1964) recognised 4-5 important species in major rice growing areas in India. Thus varieties had variable composition of stem borer infestation. YSB infestation was more in ASD 19, ADT 36, ADT 39, ASD 16 and IR 20 than that of PSB whereas IR 50 and White Ponni had more of PSB than of YSB in Kar. The proportion of YSB, PSB and DSB was of the same pattern in Pishanum season also in the selcacted varieties. Occurrence of PSB was rather as much frequent as YSB in Pishanum season as well. Husain and Begum (1985) reported that *S.incertulas* constituted 60-97 per cent of stem borers from July - October and *Chilo* sp. from Novermber to May while *S.inferens* was always at low levels. At AC & RI, Killikulam *S.incertulas* was dominant from June to September and from January to March, *S.inferens* from October to December while *C.polychrysus* was always rare. In the district level survey coccurrence of the three stem borer species showed variations, especially between PSB and DSB; YSB was the most common species in all districts. PSB was more abundant than DSB in Coimbatore, Tanjore, Tuticorin, Madurai and Dharmapuri districts, whereas DSB was more numerous in Tirunelveli, Kanyakumari and Vellore districts. Five to seven species of stem borers had earlier been known from different states of India (Banerjee and Pramanik, 1967). In West Bengal the stem borer complex in paddy comprised *S.incertulad, S.inferens, C.polychrysus, Chilo auricilius* Dudgeon, *Chilo suppressalis* (Walke) and *Chilo partellus* (Swinhoe) (Dutt and Kundu, 1983). *Scirpophaga incertulas, Scirpopaga innotata* (Walker) and *S.inferens* were more abundant in Haryana (Kushwaha, 1988) as well as Punjab (Pathak and Khan 1994). The DSB was first noticed in Kerala in 1956 and since than it has been reported to occur on rice in Tamil Nadu, Orissa, West Bengal and Assam (David and Kumaraswami, 1978).

Dynamics in species composition

Occurrence of stem borer species varied significantly with age and variety of host plants. Among the three varieties (ASD 19, ADT 39 and IR 20), the infestation was more in ASD 19 at 70 DAT, i.e. maximum tillering stage in Pishanum season. The infestation began at early tillering stage and increased through tillering stage with peak levels of deadhearts at maximum tillering stage before declining through flowering stage. Pathi (1994) also identified maximum tillering stage as

Table 1. Stem borer damage level in Pishanum crop

Crop stage	Crop age (DAT)	Percentage deadhearts / whiteheads			Mean
		ADT 39	ASD 19	IR 20	
Seedling	25	6.56 (2.56)	7.04 (2.65)	5.08 (2.25)	6.23 (2.49)
Early tillering	40	7.66 (2.77)	9.60 (3.09)	7.50 (2.74)	8.25 (2.87)
Active tillering	55	10.27 (3.26)	11.11 (3.33)	10.50 (3.24)	10.63 (3.26)
Maximum tillering	70	11.92 (3.45)	12.22 (3.49)	10.96 (3.31)	11.70 (3.42)
Flowering	85	7.78 (2.79)	9.79 (3.13)	7.11 (2.67)	8.23 (2.87)
Heading	100	5.46 (2.34)	6.15 (2.48)	4.87 (2.21)	5.49 (2.34)
	Mean	8.28 (2.88)	9.32 (3.05)	7.67 (2.77)	

	SEd	CD(0.05)
Varieties	0.057	0.11*
Age	0.080	0.17*
Variety x Age	0.140	0.26NS

*Significant at 5% level; NS - Non significant

(Mean of five replications - Figures in parentheses are square root transformed values):

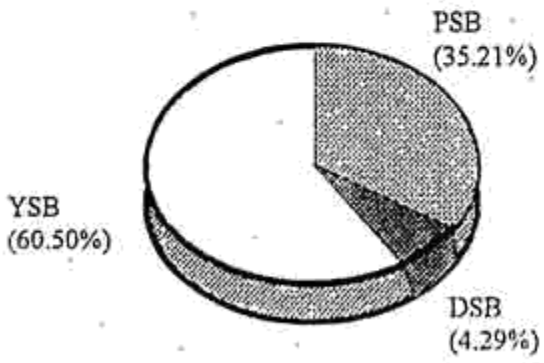


Fig. 1. Relative abundance of stem borer species in ASD 16 during Kar season (1997)

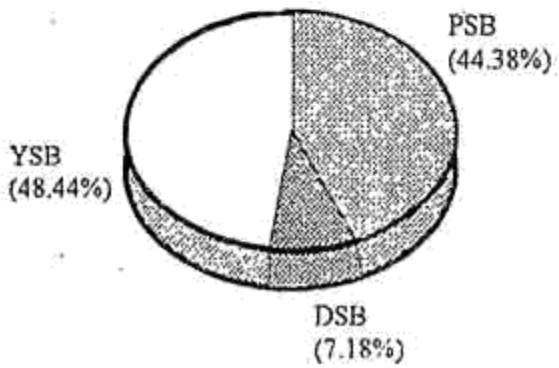


Fig. 2. Relative abundance of stem borer species in ASD 16 during Pishanum season (1997-1998)

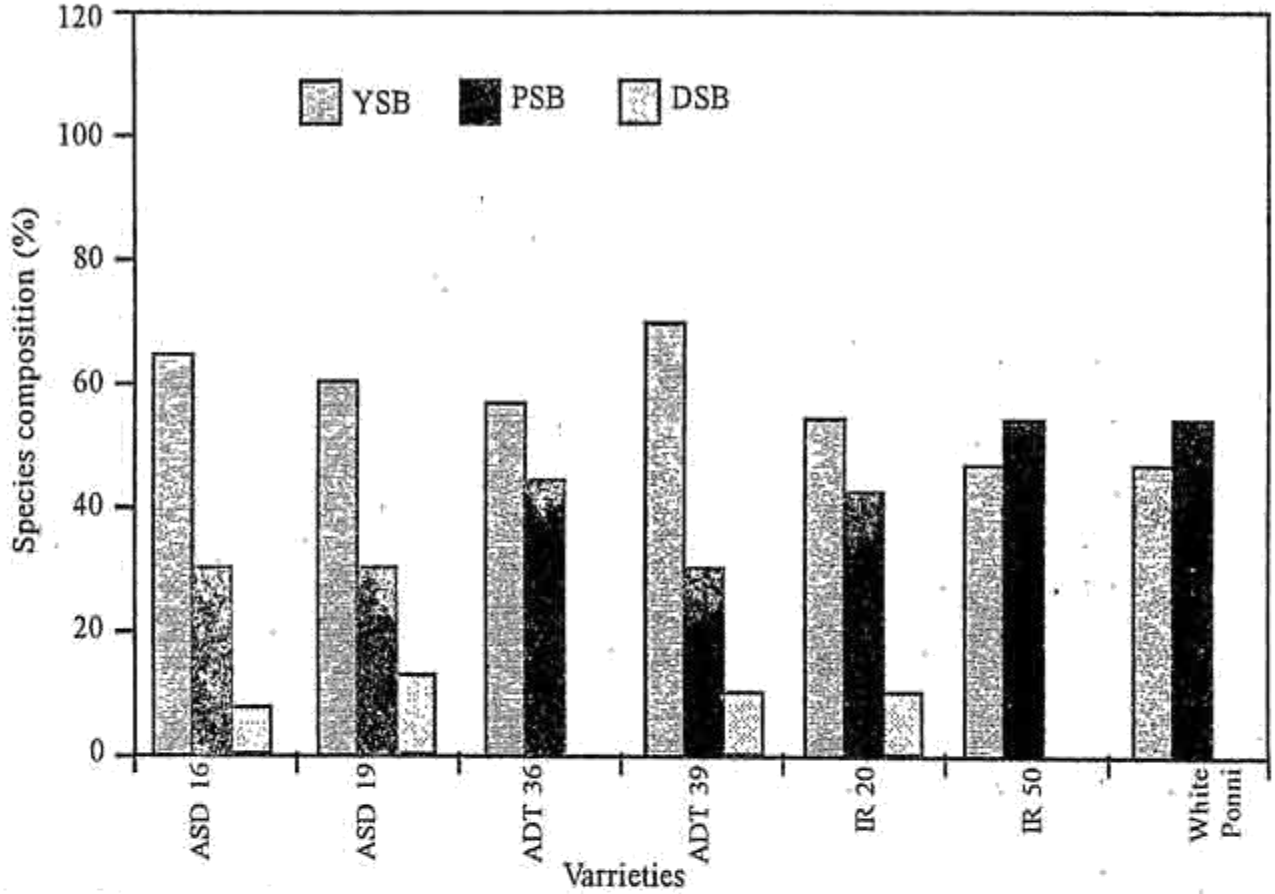


Fig. 3. Relative abundance of stem borer species in different rice varieties during Kar season, 1997.

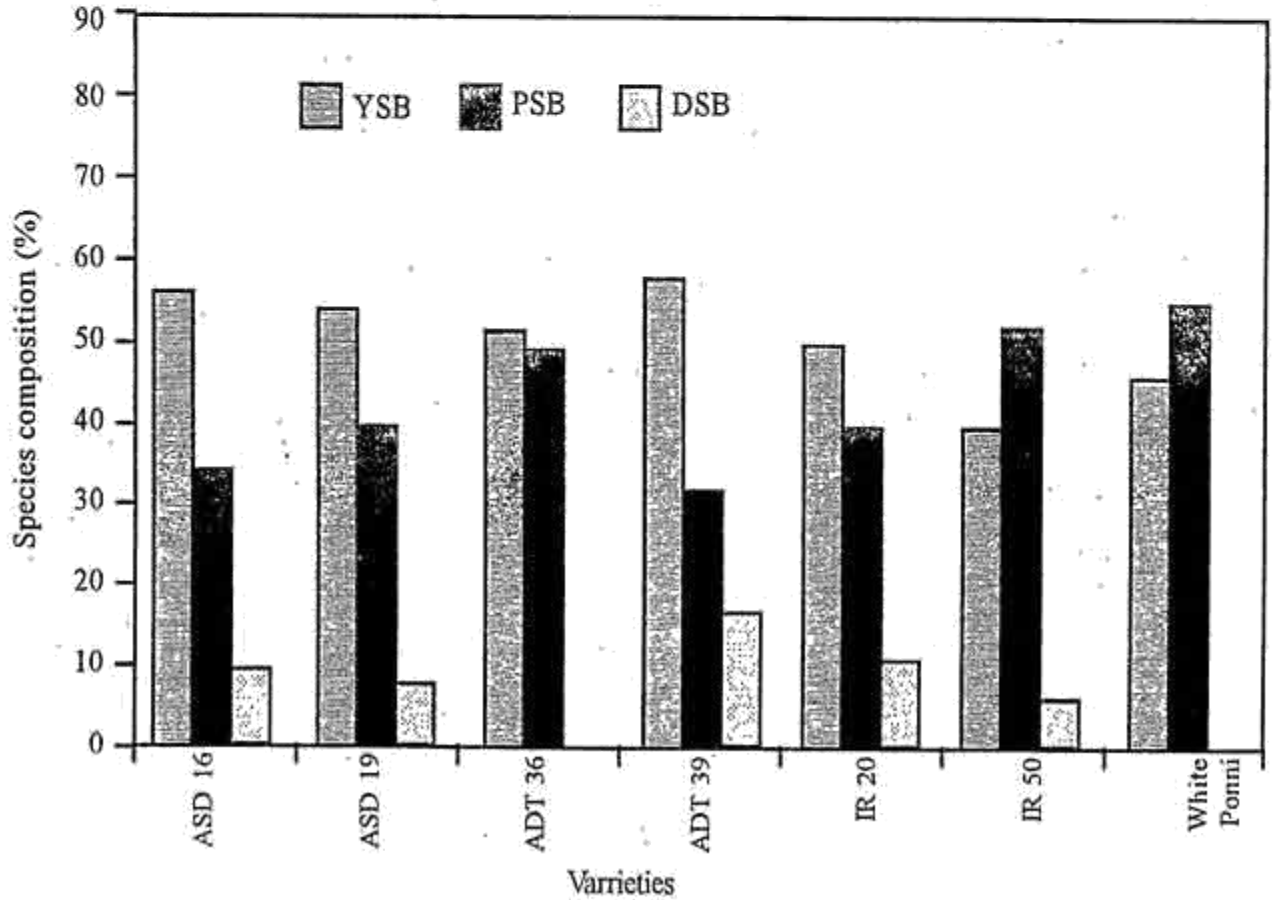


Fig. 4. Relative abundance of stem borer species in different rice varieties during Pishanum season, (1997-1998).

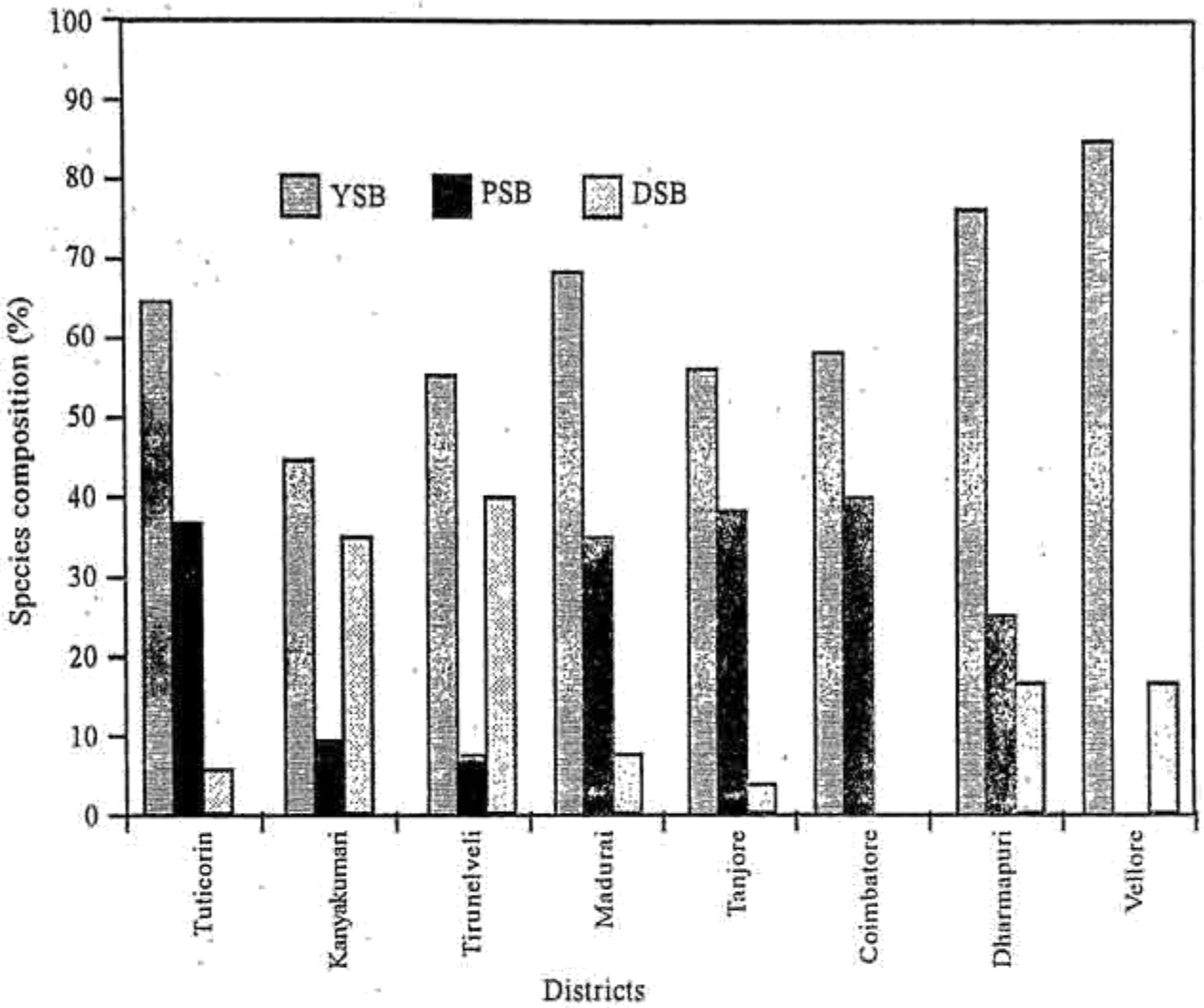
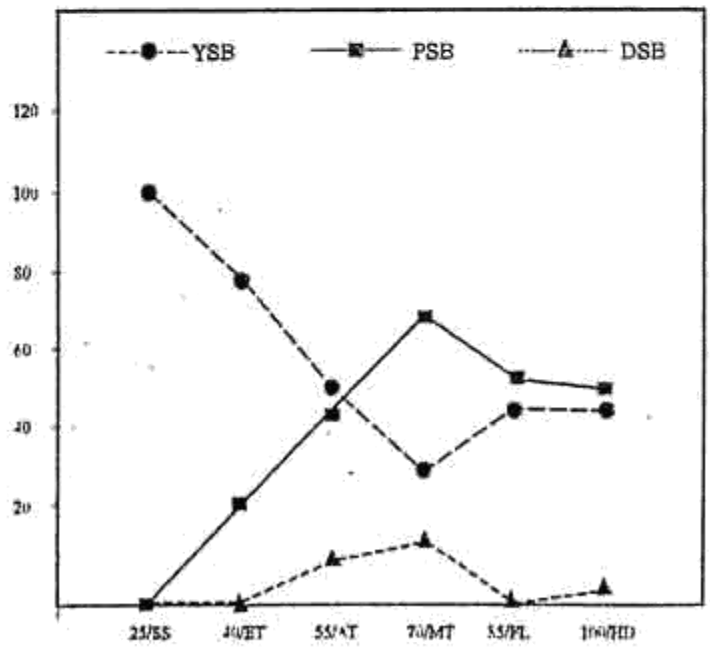


Fig. 5. Relative abundance of stem borer species in some districts of Tamil Nadu



(SS, Seedling Stage; ET, Early Tillering; AT, Active Tillering; MT, Maximum Tillering; FL, Flowering; HD, Heading)

Fig. 6. Relative abundance of stem borer species in relation to crop growth

the most vulnerable to infestation compared to flowering and early tillering stages. Samolo *et al.* (1988) observed that the stem borer incidence was more during vegetative phase than during the reproductive phase. Inter-species competition between YSB and PSB was evident with crop growth. YSB was the first to occur at early tillering stage, and sustaining its increase in population until maximum tillering stage. Later YSB infestation decreased gradually with increasing PSB infestation. Senapathi *et al.* (1990) also made rather similar observation that YSB was predominant upto 75 DAT while the PSB and *C.suppressalis* occurred from 90 DAT onwards irrespective of the season. YSB was more common between early tillering stage and maximum tillering stage while PSB was equally common (45 per cent) between maximum tillering stage and flowering stage, probably due to the crop maturity suitable for PSB larval feeding in between leaf sheath and stem.

The results of the investigation highlighted that the rice crop was subjected to the infestation by three stem borers viz., *Scirpophaga incertulas, Sesamia inferens* and *Chilo polychrysus. S.incertulas* was predominant in all rice growing districts of Tamil Nadu. Occurrence of the stem borer species varied in relation to plant age. The damage occurred 90-100 per cent due to the YSB. Later the YSB population slowly decreased as the PSB population gradully increased from maximum tillering stage.

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