CHAPTER V
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SEASONAL ACTIVITY

The information on the pest appearance, variation in its population on weekly and monthly basis and disappearance is very essential for planning and recommending the pest management practices.

Monthly activity

The major period of WBPH activity appeared in the month of September and October with maximum population density per hill being in the later month during the years of study. These results were in corroboration with the findings of Mahar et al., (1978); Shrivastava et al., (1982); Surendranath Reddy et al., (1983) and Ram, (1986). However, Misra and Israel, (1970); Nair and Misra, (1978) and Misra, (1980) reported peak activity in the month of August and September while Tao, (1962) recorded maximum population density in the month of July-August in Vietnam. These differences might be due to variations in environmental conditions of the different regions. The activity of the pest receded from November onwards.
When compared the relative abundance of the pest, 1986 was most favourable followed by 1985 and 1987. Observations on the sex ratio revealed female dominance during the study period (Table 5). Similar findings were also reported by Misra, (1980). Further, the sex ratio indicated that the magnitude of female dominance was higher in 1986 as compared to 1985 and 1987. This might be one of the reasons for maximum population pressure during 1986. Female dominance is therefore, an indication of possible population growth and persistence under favourable conditions.

**Weekly activity**

The weekly population studies revealed that in general the active period of WBPH confined between 37th SW to 44th SW and peaks being recorded in 41st/43rd SW (representing 2nd/4th week of October) during the kharif seasons of 1985, 86 and 87 (Fig.7). Similar trend was also observed by Mahar et al., (1978); Surendranath Reddy et al., (1983) and Ram, (1986).

In all 2, 3 and 2 peaks of population with varying intensities were recorded during 1985, 86 and 87 respectively. Shrivastava et al., (1982) also recorded two peaks during the kharif season of 1979.
In the present study these peaks appeared at a gap of 4 weeks. The period between two successive peaks coincided with one complete life cycle which was in the range of 19 to 31 days (Misra and Israel, 1970). These peaks of population represented the number of broods during the season.

Three year data on seasonal activity revealed that whitebacked planthopper peaked during 41st/43rd SW (October). Therefore, if management practices are initiated a week or two before this period, the population buildup of pest can be checked economically and effectively.

**Effect of weather factors on population density of WBPH**

The results of three year studies based on simple correlation analysis indicated that maximum and minimum temperatures had no significant effect on the population of WBPH. Positive correlation for the population density of this pest was observed with relative humidity and sunshine hours while significantly negative association was noticed with rainfall. On the contrary Surendranath Reddy et al., (1983) observed negative relationship with relative humidity and positive correlation with maximum temperature.
Mean of three years weather factors indicates that maximum and minimum temperatures, relative humidity, and sunshine in the ranges of 28.5-30.5°C and 17.0-23.0°C, 84-94 per cent and 5.5-10.5 hours are most conducive for the population buildup of the pest in the field (Fig.8). Similar findings with temperature were also reported by Suenaga, (1963). Bowling, (1967) observed that high humidity and moderate temperatures were conducive for the activities of pest in accordance with present findings. Further, Nair and Misra, (1978) reported, moderate range of maximum temperature (31.4 to 32.7°C) and high range of minimum temperature (24.9 to 26.0°C) and high relative humidity (83 to 85%) were associated with peak activity of the pest. It is clear from the 3 years results that among the 5 weather factors, the maximum relative humidity and the mean sunshine hours/day play deciding role in the population buildup and population dynamics of whitebacked planthopper. However, pest density in the field was negatively related with rainfall.

Further, the second degree quadratic analysis revealed that all weather parameters studied (maximum
temperature, minimum temperature, rainfall, relative humidity and sunshine) were related with the population buildup and the activity of this insect in either positive or negative manner suggesting that for insect population predictions, parabolic curves would work better than the linear ones. This is obvious because the insect population buildup is accelerated within some optimal range of each climatic parameter and outside these optimal values the insect population buildup affected adversely.

EFFECT OF WBPH RELEASED ON PANICLE

The whitebacked planthopper suck the vital plant sap from various parts of the rice plant, thus, affecting the yield attributing characters.

Per cent unfilled grains

Population levels of WBPH at three stages (i.e., flowering, milk and early dough) and per cent unfilled grains were positively correlated. The rate of increase in unfilled grains was more in flowering stage followed by milk and early dough stages (Fig.9).
Thousand grain weight

Inverse correlation was observed between population levels of WBPH at flowering, milk and early dough stages and thousand grain weight. The rate of grain weight reduction was more at milk stage than at flowering and early dough stages of panicle (Fig.10).

The yield attributing traits were adversely affected due to sucking of WBPH nymphs on various stages of rice panicle. Similar results were obtained in case of brown planthopper by Kaushik (1985).

VARIETAL RESISTANCE

Screening

Out of the 60 varieties, only six entries viz., CR 333-6-1, CR 333-6-2, IET 4695, Ptb 5, Anaikomban and MOI proved to be resistant and 13 entries indicated a moderate degree of resistance (Table 14). Entries CR 333-6-1 and CR 333-6-2 (derived from cross Jagannath/Mahsuri) were identified as resistant in earlier tests as well, in one or more co-ordinated trials (AICRIP, 1986), conducted at
various research centres of the country. Remaining 4 resistant entries viz., IET 4695 and donors PtB 5, Anaikomban and MOI also exhibited resistant reaction (Vaidya and Kalode, 1979; Reddy et al., 1985 and Pathak et al., 1986). However, at Ludhiana, the entries CR 333-6-1 and CR 333-6-2 had shown only moderate degree of resistance (AICRIP, 1986).

Thirteen moderately resistant varieties were HKR 26, RP 1800-10-5-8-2, RP 1800-35-40-83, RP 1801-45-50-72, RP 1801-101-90-89, RP 2081-144-58-51, RP 2081-176-122-14, RP 2081-210-48-57, RP 2149-3-17-1, RP 2069-3-4-4-6, Pandi and IR 62. Except Pandi and IR 62, the rest of eleven entries have been derived from one of the seven crosses viz., IR/579/Ch 13, Nam Sagui 19/IR 4215-301-2-2-6//IR 5853-162-1-2-3, Phalguna/Ptb 21, IET 5656/Ptb 21, Phalguna/Velathacheera, IET 6286/Phalguna and IET 5656/Andrewsali. These have been reported as resistant or moderately resistant from one or more co-ordinated trial testing centres (AICRIP, 1986). Rice variety Pandi (AICRIP, 1981) and IR 62 (Heinrichs et al., 1985) showed moderate grade of damage score to WBPH. At Coimbatore RP 1800-10-5-8-2 had given susceptible reaction (AICRIP, 1986) in contradiction to the present findings.
In case of IR 62 Velusamy et al., (1987) recorded high level of resistance to WBPH while this variety exhibited only moderate level of resistance in the present study.

The results clearly indicate that there is immense scope for resistant varieties as effective means of limiting the pest buildup. Hence, the varieties identified may be carried over for further testing and made use in breeding programmes.

**Mechanism of resistance**

**Nymphal preference**

All the resistant and moderately resistant varieties were relatively less preferred by nymphs of WBPH as compared to susceptible TN1 (Fig.11). Nonpreference mechanism was also reported as a factor of resistance in WBPH (Rivera, 1972; Song et al., 1974 and Pablo, 1976). Vaidya and Kalode, (1979) observed that resistant and moderately resistant varieties had less number of S. furcifera nymphs as compared to TN1 and suggested the possibility of some attractants in susceptible ones. Absence of feeding stimulants or presence of feeding deterrents/repellents could be
other possible reasons for nonpreference. In the present study, a positive correlation \((r = 0.86)\) was observed between number of nymphs settled and damage score suggesting a strong association between these two variables. The results indicate that nonpreference has a definite role in manifestation of resistance in varieties.

**Studies on antibiosis**

**Survival and development of nymphs**

All the test varieties showed significantly lower per cent of nymphal survival as compared to susceptible check TN\(_1\) at 15 and 21 days after caging (Table 15). This might be due to some sort of nutritional deficiency in the test varieties. The percentage of nymphs developing into adults was more on susceptible TN\(_1\) plants (80%) compared to test varieties (32-52%) and the growth period was prolonged on resistant and moderately resistant varieties. Because of the prolonged developmental period and reduced adult emergence, the insect growth index on all the resistant and moderately resistant cultivars was low (Table 16). Similar findings have been reported by Rivera, (1972); Choi et al., (1973);
The results of the present study further indicate that the lower survival and growth of insects in resistant varieties might be due to lower nutritive value and nonpalatability of food ingested. It is, therefore, obvious that the resistant/moderately resistant varieties can be effectively used to suppress pest buildup in management programmes.

**Feeding behaviour**

**Probing marks**

Probing punctures were significantly higher on susceptible cultivar TN₁ than on resistant or moderately resistant varieties (Table 17). Correlation analysis revealed significantly negative association between probing punctures and damage score (Fig.12). Veronica, (1985) also observed that the WBPH resistant varieties received greater feeding punctures than susceptible varieties.

**Honeydew excretion**

The amount of honeydew excreted by *S. furcifera* released on susceptible check TN₁ was 3-4 times more
as compared to resistant and moderately resistant varieties (Table 18). A significantly positive correlation was observed between honeydew excreted and damage score of test varieties (Fig.13). Veronica, (1985) observed that the WBPH deposited least quantity of honeydew when fed on resistant varieties than on susceptible rices. Similar observations with BPH have also been noted by Chelliah et al., (1981).

The observations made on feeding behaviour (probing marks and honeydew excretion) suggest that resistance of rice varieties to WBPH might be due to certain biochemical factors (gustatory) which adversely affected the normal feeding sequence on resistant varieties rather than olfactory or visual.

**EFFECT OF AGRONOMIC PRACTICES ON PEST BUILDUP**

**Influence of date of planting**

There was an increasing trend in insect density with respect to every new planting. The results clearly indicated that crop planted up to 3rd week of July harbour significantly low population of insects as compared to later plantings (Table 19). Similar results were reported by Israel, (1969) and Kaushik
(1985). Even with other rice insects the population remained very less to few insects in June and July plantings (Malik and Behera, 1965; Saroja and Raju, 1983 and Sunderaraju, 1986). The possible reason for such concurrent results may be that \textit{S. furcifera} prefers early and tender stages (specially tillering phase) of the crop growth as against aged ones.

**Influence of seedling age**

Seedling ages had no significant effect on the population density of WBPH (Fig.14) confirming the earlier report by Kaushik, (1985). However, the results further indicated that irrespective of seedling age at planting, 60-day-old-crop infested with more number of WBPH than the 30, 45, 75 and 90 day old crop.

**Influence of nitrogen**

Positive relationship was observed between graded levels of nitrogen and population of WBPH/hill. The regression analysis showed that with the addition of every one kilogram of nitrogen/ha, there was an increase of 0.14 insect per hill (Fig.15). Studies conducted elsewhere also confirmed the conducive role
of nitrogenous fertilizers in particular to WBPH and also other rice pests buildup (Dyck and Hsieh, 1972; Dyck, 1973; Kulshreshtha et al., 1974; Chatterji, 1975; Fernando, 1975; Velusamy et al., 1975; Pathak and Dhaliwal, 1981; Uthamasamy et al., 1983 and Karuppuchamy and Uthamasamy, 1984).

However, Nair and Misra, (1978) found no correlation between rice pest population and nitrogen levels.

House, (1965) and Bursell, (1970) suggested that high rates of nitrogenous fertilizer may result in more protein and amino acid synthesis by rice plant. The proteins and amino acids are among the essential requirements for the growth and development of immature insects and are often required by adults for their reproductive process. The present results support this opinion.

INSECTICIDAL STUDIES

Although significant advances have been made in the development of non-insecticidal methods of pest management in rice, insecticides are still indispensable. Insecticides still remain as the first line of defence against many rice insects.
Ovicidal activity

Among the ten insecticides tested for ovicidal action, only carbaryl (86.57%) and BPMC (86.38%) suppressed the hatching of eggs while the remaining eight insecticides registered very poor ovicidal effect. Considering both ovicidal effect and mortality of newly emerged nymphs, BPMC and carbaryl exhibited highest mortality (99.99%) followed by chlorpyriphos (88.78%), monocrotophos (75.64%), Phosalone (74.60%), quinalphos (71.14%) and dimethoate (61.00%). Malathion, endosulfan and phosphamidon showed poor mortality (less than 41%). The results on ovicidal effect of carbaryl in the present studies is in confirmation with observations recorded by Israel et al., (1968).

Effect of insecticides on nymphs of WBPH

Knockdown effect

Of the ten insecticide sprays tested, quinalphos, chlorpyriphos, phosphamidon, BPMC, phosalone, malathion, carbaryl and monocrotophos exhibited quick knockdown effect within 4 h exposure.
The remaining two (dimethoate and endosulfan) registered lower rate of effect. But after twenty four hours of the exposure, all the insecticides recorded 100 per cent mortality (Table 22).

Krishnaiah and Kalode, (1986) also reported that quinalphos, chlorpyriphos, monocrotophos, phosalone and BPMC recorded more than 90 per cent knockdown kill of WBPH within 4 h. After 24 hours caging, 28 insecticides (including phosalone, chlorpyriphos, quinalphos, carbaryl, monocrotophos and BPMC) exhibited 100 per cent mortality.

**Persistent toxicity**

The over all results based on all the treatments and observations revealed that insecticidal effects of carbaryl and monocrotophos persisted up to 15 days while quinalphos, chlorpyriphos and BPMC were observed to persist only up to 12 days. The remaining five insecticides (phosalone, malathion, endosulfan, phosphamidon and dimethoate) persisted only up to 9 days (Table 23). From the persistent toxicity point of view, carbaryl was the best insecticide followed by monocrotophos, BPMC, chlorpyriphos, quinalphos and phosalone. Krishnaiah
and Kalode, (1986) also found similar efficacy though the order of ranking varied.

Considering both the knockdown effect and persistent toxicity, carbaryl was the most effective insecticide in controlling WBPH. Among others, monocrotophos, BPMC, chlorpyriphos and quinalphos could be judged as better insecticides. Krishnaiah and Kalode (1986) also reported quinalphos, chlorpyriphos and carbaryl to be better insecticides for the control of the test insect.

PREDATORS

Among the biological control agents, predators like spiders, mirid bugs and beetles play an important role in keeping down population of whitebacked planthopper.

Predatory fauna

Spiders, mirid bug, C. lividipennis, staphylinid beetle, P. fuscipes and carabid beetle, Q. nigrofasciata were recorded as the predators of WBPH (Table 24). Of these, based on mean population
density *P. fuscipes* was found to be the most potential predator of WBPH followed by *C. lividipennis* and spiders. Among the spiders, three species of *Tetragnatha* (72.97% of spiders) have been found to be predominant over spiders (Table 25). Kaushik *et al.*, (1986) recorded *P. fuscipes*, *Brumus suturalis* and *Lycosa pseudoannulata* as predators of WBPH, GLH and BPH in Chhattisgarh, M.P. Gupta *et al.*, (1986) collected 15 species of spiders from paddy fields around Hyderabad, A.P. and reported that three species of spiders belonged to family Tetragnathidae which constituted about 47% of the spiders collected. Salim and Heinrichs, (1986) noted that the predators like *L. pseudoannulata*, *C. lividipennis* and *P. fuscipes* help in keeping down the population of WBPH, *Sogatella furcifera*. Thirteen species of insects and two species of spiders have been reported as predators of rice pests from Chhattisgarh, M.P. during kharif 1984-86. Of these, *T. manadibulata*, *Agriocnemus pygmaea*, *P. fuscipes* and *C. lividipennis* were observed in high numbers (Bharadwaj and Pawar, 1987). All above reports support the present findings with respect to two species of predators *C. lividipennis* and *P. fuscipes*. However, variation in species have been observed in case of spiders.
**Seasonal activity**

In general, all the predators were active throughout the crop period (32nd to 49th SW) with minor variations in activity period (Fig.16). The population density of spiders was more or less uniform in the field from 35th SW onwards covering last week of August and peak population was observed in 41st and 43rd SW (representing 2nd and 4th week of October) during 1986 and 1987. The activity of beetles started few days earlier in 33rd SW and 34th SW corresponding 2nd and 3rd week of August during 1986 and 1987. The mirid bugs were active from 35th to 49th SW with peak population in 43rd and 41st SW covering 4th and 2nd week of October during the years of study. Mirid bug, *C. lividipennis* was active from August to November and peak activity was observed in the month of October/November (Surendranath Reddy et al., 1983). Spider population was almost uniform throughout the crop season while mirid bug were abundant in the first fortnight of November in paddy fields elsewhere (DRR, 1985 and Krishnaiah et al., 1986). Spider population was recorded from 20 DAT to 50 DAT with a peak at 62 DAT during 1982-83 wet season (Kartohardjono, 1984). Chau and Hau, (1987) observed that *L. pseudoannulata*, *Tetragnatha*, sp.,
P. fuscipes and O. indica were active at 1-100, 1-70, 40-100 and 35-75 DAT. The inferences given by the above workers are almost similar to the present ones and confirm the results of this investigation.

**Predatory-prey relationship**

Correlation between predators (spiders, mirid bug and beetles) and WBPH as prey showed positive association between the two in all the experiments (Table 26) (Fig. 17). Similar findings with mirid bug and rice hoppers were also reported by Krishnaiah et al., (1986) and Balasubramanian et al., (1988). Krishnaiah and his associates also suggested that spiders, mirid bugs and beetles (especially staphylinid beetles) have an important role in controlling the hopper populations, agreeing with the present findings.

**Predation potential**

**Predation on nymphs**

On the basis of predation potential in a single day, the predators (in a ratio of 1:20,
predator : prey) can be ranked in descending order as *P. birmanica*, *Tetragenatha* sp., *P. fusciipes*, *O. nigrofasciata* and *C. lividipennis* (Table 27). Mirid bug preys on eggs, nymphs and adults of rice leaf and planthoppers which has been considered to be an effective predator of these insects (Hinckley, 1963; IRRI, 1973 and Lim, 1974). Pophaly et al., (1978) recorded 90 per cent kill of WBPH nymphs by mirid bug, *C. lividipennis* (in a 1:1 ratio) within a period of 24 hours. Predatory role of *P. fusciipes* on WBPH based on field and laboratory observations has been noticed for the first time in Chhattisgarh, M.P., by Shukla et al., (1983). *L. pseudoannulata* (a spider) consumed up to 100 nymphs and adults of WBPH within a period of 5 days (Arida and Shepard, 1985). The feeding rate of *L. pseudoannulata*, *C. lividipennis* and *P. fusciipes* was 5.9, 1.4 and 1.9 WBPH (4th instar) per day (Salim and Heinrichs, 1986). Within 24 hours Chau and Hau, (1987) recorded 85, 61, 58 and 52 per cent kill of BPH nymphs by *L. pseudoannulata*, *Tetragenatha* sp., *P. fusciipes* and *O. indica* in the ratio of 1:10 (predator : prey) respectively. All the reports with minor variations in feeding rate confirm the findings of the author.
Predation on eggs

Mirid bug besides predating on nymphs and adults, also prey on eggs of hoppers. On an average 23.29 per cent reduction in nymphal emergence was observed when the mirid bugs were caged singly on oviposited plants for a period of 24 hours (Table 28). The mirid bug fed on the eggs of leafhoppers and planthoppers (Hinckely, 1963; IRRI, 1973; Lim, 1974 and Pophaly et al., 1978). An adult mirid bug usually feed on 1 to 20 eggs of BPH at one feeding (Chiu, 1979).

From these results it may be inferred that mirid bug, spider species (particularly Pardosa and Tetragnatha) and beetles (specially Paederus sp.) are the potential predators of WBPH and are very often found in rice fields throughout the crop period. Therefore, conservation of these predators in an endemic area for natural control needs consideration by adopting judicious plant protection measures in pest management programmes aimed to control whitebacked planthopper.