RESEARCH HIGHLIGHTS
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- Throughout the study region, a dominance of *Ae. albopictus* over *Ae. aegypti* was noticed.
- In this study, it was found that for both the *Aedes* species, discarded tyres were the most preferred breeding habitat resulting highest positivity indices followed by uncovered cemented tanks.
- For *Ae. albopictus*, the natural habitats were also preferred such as bamboo stumps and plant axils.
- Higher larval densities were recorded for *Ae. aegypti* in Islampur, New Mal and Siliguri. Similarly, for *Ae. albopictus* very high larval densities were observed for Nagrakata, North Bengal University, Hasimara and Alipurduar.
- To minimise the disease risk in areas where high larval densities were noted, proper control measures should be planned before the disease outbreaks season by mosquito breeding habitat destruction.
- Majority of the studied *Ae. aegypti* populations possessed low resistance levels against temephos but higher resistance ratios. One population NDPae was found to possess incipient resistance against 0.02ppm and resistance against 0.0125ppm temephos.
- Widespread resistance against DDT was revealed in all the tested populations of *Ae. aegypti* with the mortality 47.9% for DARae population, 55.4% for APDae, 56.6% for NDPae, 70.0% for COBae and 72.0% for JPGae.
- The population APDae reported moderate resistance against malathion with 72.5% mortality followed by incipiently resistant DARae with mortality 92.6%.
Most of the studied population were revealed to be susceptible or incipiently resistant to lambda-cyhalothrin and deltamethrin with the mortality ranging from 80.9-100% and 89.2-100% respectively.

Wide spectrum of resistance was noted against permethrin, with mortality as low as 50% for NDP<sub>ae</sub> to 83.3% for APD<sub>ae</sub> population.

Three of the tested <i>Ae. aegypti</i> populations were found to be severely (DAR<sub>ae</sub>: 50.0% mortality) to moderately resistant (NDP<sub>ae</sub>: 75.4% mortality) against propoxur.

Against DDT most of the populations showed high values of both KDT<sub>50</sub> and KDT<sub>95</sub> were recorded in majority of the tested populations of <i>Ae. aegypti</i> against DDT indicating its inefficacy in mosquito control.

Amongst the pyrethroid insecticides, high KDT values were recorded against permethrin, with the highest KDT<sub>95</sub> value for NDP<sub>ae</sub> population, i.e. 192.11 mins.

Prior exposure to 4% PBO before DDT was found to increase susceptibility to it in APD<sub>ae</sub> population, restoring the mortality rate 24.6%. Thus a part of the observed resistance might be conferred by detoxification through Cytochrome P450s. Against malathion, Carboxylesterases were revealed to drive the resistance (though partially) in APD<sub>ae</sub> population elevating the mortality from 72.5% to 94.0% when exposed to 10% TPP.

Against deltamethrin and lambda-cyhalothrin, Cytochrome P450s were recorded to be responsible for partial resistance in APD<sub>ae</sub>, JPG<sub>ae</sub> and NDP<sub>ae</sub>.

Carboxylesterase linked pathways were revealed to be involved in propoxur resistance in NDP<sub>ae</sub>, as use of 10% TPP could restore its mortality from 45.4 to 70.4%.
The activity of α-CCEs and β-CCEs were noted to range 1.07 fold to 3.11 and 1.19 to 2.46 folds respectively among the field populations than the control population, i.e. SP<sup>ae</sup>. The activity of CYP450 monoxygenases were noted to be 1.14 to 1.53 fold than SP<sup>ae</sup>. The activity of GSTs were uniform amongst the field caught populations of Ae. aegypti ranging from 1.06 to 1.39 times higher than that of SP<sup>ae</sup>.

Through kdr genotyping, both susceptible and mutant kdr allele were revealed to be present amongst the wild populations of Ae. aegypti. The frequency of the 1534C mutant allele was 50, whereas the frequency of the 1016G mutant allele was 45%.

Throughout the tested field populations of Ae. aegypti around five different isozymes of α-Carboxylesterase (Rf values 0.62, 0.68, 0.73, 0.82, 0.97) and three isozymes of β-Carboxylesterase (Rf values 0.62, 0.80 and 0.96) were found.

The highest number of isozymes of both the Carboxylesterases were recorded in NDP<sup>ae</sup> population, whereas the rest possessed a single isozyme (with varying intensities) in both the electrophoregrams.

Amongst the tested field caught populations of Ae. albopictus, only one of the eleven tested population (NGK<sup>al</sup>) exhibited incipient resistance against temephos at 0.02 ppm dosage. For the India Government recommended dosage of 0.0125 ppm, two populations possessed incipient resistance, NGK<sup>al</sup> and SLG<sup>al</sup>.

Amongst the field populations of Ae. albopictus, the LC<sub>50</sub> values ranged from 0.0001 to 0.0047 ppm. Similarly, the LC<sub>99</sub> values were found to be in the range of 0.038 to 0.081 ppm.

Severe to moderate resistance against DDT was revealed in the tested Ae. albopictus mosquitoes, namely SLG<sup>al</sup>, JPG<sup>al</sup> and NGK<sup>al</sup>.
However, complete susceptibility was recorded among the wild *Ae. albopictus* mosquito populations against malathion, deltamethrin and lambda-cyhalothrin.

Moderate level of resistance against permethrin was found in two of the *Ae. albopictus* population with mortality percentages 75.4 (APD\textsuperscript{al}) and 75.0 (JPG\textsuperscript{al}).

Severely resistant population of Indian *Ae. albopictus* against propoxur was revealed in this study for the first time with very low mortality, 42.5%.

As in *Ae. aegypti*, similar high values of KDT\textsubscript{50} and KDT\textsubscript{95} were noted against DDT, whereas low knockdown times were noted amongst the same mosquitoes population against deltamethrin and lambda-cyhalothrin.

Populations NGK\textsuperscript{al}, JPG\textsuperscript{al} and SLG\textsuperscript{al} were reported to possess Cytochrome P450 linked resistance against DDT, since prior exposure to PBO restored the mortality/susceptibility in these populations 15.1%, 19.7% and 41.25% respectively. Similarly, in APD\textsuperscript{al} and JPG\textsuperscript{al}, CytochromeP450\textsubscript{s} were revealed to confer resistance against permethrin.

Significantly higher activity of α-CCEs were noted in NGK\textsuperscript{al}, SLG\textsuperscript{al}, JPG\textsuperscript{al} and NMZ\textsuperscript{al} population. Similarly, for β-CCEs higher activities were noted for NGK\textsuperscript{al}, SLG\textsuperscript{al} and APD\textsuperscript{al} population, \textit{i.e.} 3.16, 2.83 and 2.74 folds than SP\textsuperscript{al} respectively. The activity of CYP450\textsubscript{s} monoxygenases were recorded to range from 1.03 to 1.94 times SP\textsuperscript{al}. The activity of GSTs were found to be ranging from 0.305 to 0.385 µM mg protein\textsuperscript{-1} min\textsuperscript{-1}.

The results of kdr genotyping revealed that, all but one (SLG\textsuperscript{al}) tested *Ae. albopictus* population were found positive for 1534C mutant allele reporting the frequency of this allele to be 29.8%.

Two different isozymes for both α- carboxylesterases (Rf values 0.81, 0.91) and β-carboxylesterases (Rf values 0.63 and 0.95) were found amongst the different field
caught mosquito populations. Isozymes α-Est II and β-Est II were more prevalent than the other isozyme. In case of α- carboxylesterases, NGK^al and JPG^al exhibited the presence of both the isozymes, whereas in were expressed in β- carboxylesterases SLG^al possessed both the isozymes.