Antibiosis in sugarcane genotypes against woolly aphid *Ceratavacuna lanigera* Zehntner

Sugarcane woolly aphid (*Ceratavacuna lanigera* Zehntner, Hemiptera, Aphididae) is becoming a major pest in Asia, Australia and Pacific Islands[1]. The first report from India was in 1958 from West Bengal[2]. In July 2002, woolly aphid was found in epidemic form in Maharashtra, Sangli being the epicentre. It has spread to the northern parts of Karnataka like Belgaum and Bagalkot districts.

Losses in cane and sugar yield could be substantial if plants are grown on riverbanks, waterlogged and heavily N-fertilized conditions. The losses are yet to be quantified as the pest is seen in patches. The natural enemies comprise parasites like ladybird beetle, syrphids, etc. In India, *Diapha aphidivora* and *Micromus igolotus* were considered to be potential predators for control of this pest[2]. The ultimate solution rests in identifying varieties resistant to woolly aphid. According to Schultz[3], defence mechanism or antibiosis is offered by certain endogenously produced compounds like phenolics, jasmonic acid, oxilipins, terpenoids, etc. These compounds are essential for resistance to pests and diseases in plants.

The objective of this study was to screen genotypes in the germplasm and estimate these compounds in selected varieties and relate it to infestation by woolly aphid.

Thorough screening of 250 sugarcane genotypes was done under field conditions for woolly aphid. No chemical sprays were adopted to control the aphid. Artificial infestation was done thrice (45, 90 and 120 days after planting) by stapling the infested leaves on sugarcane clumps. The predators were removed carefully. Eleven varieties of commercial importance were chosen, which had variable response to woolly aphid. By repeated artificial infestation it was ensured that there was no escape of the aphid attack on these genotypes. By close monitoring it was made sure that predators like *Diapha* and *Micromus* were not seen feeding on the genotypes. Visual scoring was done for woolly aphid attack, and the counts were taken in 1 m^2 area and grading was done.

After six months of growth, leaf samples were sent to Vidya Vihar, Mumbai for analysis of phenolic acid, jasmonic acid and terpenoids. Phenolic acid was determined[4] according to AOAC 1995. Terpenoids were estimated from leaf extracts by employing gas chromatography in capillary column. Qualitative analysis of jasmonic acid was done by thin layer chromatography under standard conditions (loc. cit.).

Phenolic acid and terpenoids are reported in per cent, while qualitative estimation of jasmonic acid is furnished as present or in traces.

Table 1 presents the contents of phenolic acid and terpenoids and presence of jasmonic acid along with yield and quality parameters of selected sugarcane varieties. It is evident that Co 2002-22 and Co 91010 are practically immune to woolly aphid attack. The third best variety was Co 79158, which had the highest concentration of terpenoids. Resistance to the pest is due to the presence of large quantities of phenolic acid and terpenoids in these varieties. The phenomenon is called antibiosis or defence mechanism, which is evolutionarily preserved[3]. Plants are chemically defended fortresses and organize defence system similar to signals used in animals. It is seen that there are 800–1500 regulated genes involved in plant response to a single insect[4]. Qualitatively, jasmonic acid was also present in varieties like Co 2002-22, Co 91010 and Co 79158. It is not clear whether polyphenols and terpenoids work in tandem to offer resistance to woolly aphid.

Higher sugarcane yield was noticed in Co 2002-22 (114 t/ha) and Co 91010 (115 t/ha), than checks like CoC 671 and Co 92020. These two varieties can be cultivated in pest-prone areas, which gives

Table 1. Effect of endogenously produced phenolic acid, terpenoids and jasmonic acid on woolly aphid along with yield and quality of sugarcane genotypes

Variety	Woolly aphid scoring (grades)***	Phenolic acid (%)	Terpenoids (%)	Jasmonic acid	Cane yield (t/ha*)	Brix (%)	Pol (%)	Juice purity**	Fibre (%)	CCS (%)
Co 2002-22	1	0.034	7.25	Present	114	22.11	20.39	92.22	13.50	14.38
Co 91010	1	0.025	7.65	Present	115	21.35	20.10	94.14	12.50	14.30
Co 2000-06	3	0.020	1.41	Present	103	19.78	18.69	94.44	13.60	13.32
Co 2001-09	4	0.018	2.04	Traces	87	17.32	15.56	89.83	12.81	10.87
Co 95020	4	0.019	4.86	Traces	94	18.26	17.01	70.10	13.12	12.05
Co 79158	2	0.024	8.81	Present	92	16.42	15.62	95.12	12.50	11.17
Co 99004	5	0.021	1.85	Present	83	21.26	19.26	90.59	13.00	13.47
Co 95003	5	0.011	3.35	Traces	94	20.78	19.15	92.15	13.21	13.50
Co 91013	5	0.017	3.61	Traces	91	20.45	18.88	92.32	13.00	13.32
Co 92020 (Check)	6	0.012	2.85	Traces	98	22.05	20.11	91.20	13.24	14.11
CoC 671 (Check)	6	0.016	2.70	Traces	96	22.92	21.42	93.45	14.10	15.14

*Cane yield is from micro plots 3 rows of 6 m length.
**Juice purity is from laboratory test where extraction is 50% or less, hence only relative figures.
***Woolly aphid grades: 1, No aphids in leaf; 2, 1–20%; 3, 21–40%, 4, 41–60%; 5, 61–80%; 6, 81–100%.

Figure 1. Sugarcane crops.

superior yield with acceptable quality. The additional advantage with Co 91010 is its high tolerance to moisture stress. It is a good ratooner. Varieties Co 91010 and Co 2002-22 will be micropropogated and released for general cultivation after big mill test.

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Effects of 2004 tsunami on marine ecosystems – a perspective from the concept of disturbance

The word Japanese tsunami means 'harbour waves'. They are triggered by large-scale perturbations of the ocean floor. Earthquakes as perturbations account for most of the tsunamis recorded so far. Shetye[1] has provided an excellent account on the generation and propagation of tsunamis in marine ecosystems. An earthquake of *M* 9.0 occurred offshore in northwestern Sumatra (epicentre: 3.32°N and 95.85°E) on 26 December 2004. It generated a huge tsunami, which devastated the Andaman and Nicobar Islands (AN), east coast of India and south Kerala. The objectives of this report are to provide a different look at the tsunami 26 December 2004 as a 'disturbance' to marine communities of the Indian Ocean and to present questions related to its most probable impacts that could be addressed by future researches. A few reports on the impact of the tsunami caused by the Sumatra earthquake were published recently[2–4]. But none of them focused on the tsunami as a disturbance to marine ecosystems.

Disturbance is a concept long recognized in ecology. Its prominence is witnessed by popular theories regarding its effects on organization and functions of ecological communities[5,6]. Excellent reviews are also available[7–9]. Disturbance is broadly defined as an uncommon, irregular event that causes abrupt structural changes in natural communities, thus moving them away from static or near-equilibrium conditions[7]. Pickett and White[9] defined it as any relatively discrete event in time that disrupts ecosystem, community or population structure, and changes resources, availability of substratum, or the physical environment. Resh *et al.*[8] included the criterion of intensity (physical force of the event), which is outside the predictable range in a typical disturbance. A tsunami fits well within all these definitions. Briefly, it is an infrequent, rare disturbance to marine communities, but with high intensity.

This tsunami devastated the AN, east coast of Andhra Pradesh and Tamil Nadu and south Kerala. The east coast of India from Srikakulam in Andhra Pradesh to Nagapattinam in Tamil Nadu was severely affected. Considering zonation of the ocean, littoral, neritic and benthic zones of AN as well as littoral and neritic zones of the Bay of Bengal (BB) are likely to have been disturbed intensively. More particularly, at the littoral and neritic zones of BB and AN, kinetic energy of the tsunami was converted to potential energy and resulted in severe devastation. The southern part of AN, located within 500 km from the epicentre of the earthquake was disturbed more severely. As one of largest tsunamis, triggered by the third largest earthquake on record[10], it is expected that the disturbance must be also severe in intensity. This one occurred in a less open Indian Ocean, in low latitude. It may be unique for monitoring disturbance to the tropical marine ecosystems. Physical disturbance is considered to be an important factor structuring marine communities[7,9,11–14]. Thus biotic communities, physical habitats and their heterogeneity, nutrient distribution and exploitable resources of these zones could be disturbed significantly. Future studies should focus on tsunami-disturbed changes in:

- Distribution, habitat and yield of exploitable resources like fishes, crustaceans and molluscs.
- Species richness and rates and sequences of recovery, in cases of species loss; primary productivity by phytoplanktons.
- Species composition, distribution and abundance of the principle taxa of primary producers (dinoflagellates in BB).
- Trophic status of the regions in the ocean around AN.
- Species richness, community structure and standing crop of macro and meio fauna.
- Zooplankton biomass as estimate of secondary production in BB.
- Impact of sedimentation and mud shield on coral reef communities in AN.