ings by Sen and Sinha Ray[4] regarding decreasing trend in the occurrence of the drought in these regions.

Figure 2 *a*, *b* shows increasing trend in the frequency of heavy rainfall over Mumbai during the SW monsoon season and annual, respectively. Figure 3 *a* and *b* shows a decreasing trend in the frequency of heavy rainfall over the hill station Darjeeling during the SW monsoon season and annual, respectively.

The frequency of heavy rainfall during pre-monsoon and post-monsoon season shows significant decreasing trend which may be at least partly attributed to the decreasing trend in cyclonic activity.

The frequency of heavy rainfall during winter shows a decreasing trend which may be attributed to the increase in turbidity, modifying the cloud microphysical process which requires in-depth study.

The frequency of heavy rainfall during the SW monsoon season shows an increasing trend over the west coast of India which may be due to increasing activity of the west coast trough. Increasing trend in the frequency of heavy rainfall over drought-prone areas of the country may partly be attributed to the decreasing trend in the occurrence of drought over India.

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Groundnut mutants resistant to tobacco cutworm (*Spodoptera litura* F.)

Tobacco cutworm (*Spodoptera litura* F.), a defoliating insect has become a major pest on groundnut crop in recent years[1]. In Karnataka, the transitional tract has been identified as the hotspot for *S. litura* during the rainy season, where yield loss to the extent of 66.6 per cent has been reported[2]. At present groundnut is predominantly grown under rainfed conditions, where insecticidal control is more expensive. Further, the insecticidal control of *S. litura* may not be always effective because of its polyphagous nature, rapid multiplication and resistance developed to some commonly used insecticides[3]. Integrated pest management which aims at keeping the pest population below the economic threshold through ecologically sound, economically feasible and environmentally sustainable means could be a potential option. The cultivation of resistant varieties is an important component of integrated management of this pest in India.

All the cultivated varieties are susceptible to *S. litura* and prone to substantial yield loss. Research efforts have been successful in identifying genotypes resistant to *S. litura* but they suffer from undesirable attributes[4,5], making them unsuitable for direct cultivation. A number of wild *Arachis* spp. have shown very high resistance to *S. litura*[6] but their exploitation is restricted because of difficulties in hybridization and introgression. Hence, there is a strong need to develop a new germplasm combining high level of resistance to *S. litura* with other desirable attributes.

In a mutation breeding programme with Dharwad Early Runner (DER), a Valencia line (VL 1) was isolated in our laboratory. This on further treatment with Ethyl Methane Sulphonate (EMS) yielded twenty-two secondary mutants resistant to rust and/or late leafspot[7]. Some of these mutants were found to be resistant to *S. litura* in the field. The present investigation was undertaken to systematically evaluate these mutants in the field and also to study the effect of selected mutants on the growth and development of *S. litura* when reared artificially in the laboratory.

The experimental material for field evaluation comprised 22 stabilized mutants and their parents (DER and VL 1) along with resistant germplasm (GBFDS 272), and susceptible (JL 24) checks. Each genotype was sown in 2.5 m row with an inter row spacing of 30 cm and intra row spacing of 10 cm. The experiment was conducted in a randomized block design with two replications during the rainy season. Infestation of *S. litura* was artificially created by pinning an egg mass on each line at 45 days. As damage was mostly confined to the top leaves, the top five leaflets on the main stem of five randomly selected plants were scored at 65 days. The number of leaflets damaged and per cent leaf area damaged were visually assessed. The range and other parameters, viz. phenotypic and genotypic coefficients of variation, heritability and genetic advance revealed substantial amount of heritable variation for *S. litura* damage (Table 1). As indicated by high heritability and genetic advance, the area damaged was better than the number of leaves damaged as a criterion of resistance. Based on this, seven mutants (28-1, 28-2, 45, 98-1, 110, 110-1 and 172) were significantly

Table 1. Range and variation for damage due to *Spodoptera litura* in groundnut mutants

Parameter	Field damage: Maximum	Field damage: Minimum	Field damage: Mean	Coefficient of variation (%): Phenotypic	Coefficient of variation (%): Genotypic	Heritability	Genetic advance over mean
Leaf area damaged (%)	53.85	10.0	36.72	44.10	37.50	72.40	65.75
Number of leaves damaged	4.70	2.00	3.85	29.50	18.10	37.60	22.90

Table 2. Life history parameters of *Spodoptera litura* on selected groundnut genotypes

Genotype	Field damage		Larval mortality (%)			Larval weight (mg)			Gain in weight (mg)		No. of eggs per mass	Mean larval period
	DS	LDS	5 DAH	10 DAH	15 DAH	5 DAH	10 DAH	15 DAH	10 DAH	15 DAH		
Mutants												
28-2	10.0^{a}	2.1^{ab}	59^{b}	64^{b}	69^{bc}	23^{a}	316^{ab}	3325^{b}	293^{b}	3009^{ab}	170^{a}	21.5^{a}
45	10.9^{ab}	2.4^{a-c}	85^{a}	88^{a}	90^{a}	34^{bc}	288^{a}	2640^{a}	194^{a}	2395^{a}	145^{a}	21.3^{a}
110	22.1^{a-d}	4.2^{cd}	46^{c}	63^{b}	75^{b}	41^{cd}	678^{c}	4440^{b}	634^{b}	3726^{cd}	354^{b}	19.5^{bd}
Parents												
VL 1	23.1^{b-e}	3.7^{a-d}	47^{c}	58^{bc}	64^{cd}	32^{b}	724^{d}	4790^{c}	692^{e}	4066^{d}	334^{b}	19.8^{bd}
DER	30.6^{d-f}	4.3^{d}	34^{d}	45^{c}	58^{d}	42^{cd}	721^{d}	4845^{c}	712^{c}	4124^{d}	498^{c}	18.2^{d}
Checks												
GBFDS 272	15.3^{a-c}	2.0^{a}	33^{d}	54^{bc}	61^{cd}	43^{d}	364^{b}	3610^{b}	317^{bc}	3249^{bc}	502^{d}	18.3^{cd}
JL 24	38.7^{f}	3.9^{b-d}	10^{e}	24^{d}	69^{cd}	54^{e}	619^{c}	4770^{c}	565^{c}	4151^{d}	456^{c}	18.9^{bd}
SEm±	3.9	0.6	5.5	5.7	04	3.9	31.6	296	20	309.9	20.0	0.4
CV	23.2	24.5	15.0	12.5	7.0	12.6	7.4	8.93	5.0	10.7	21.2	6.1
CD (5%)	12.5	1.8	11.9	12.4	8.7	8.5	68.8	644.9	43.5	675.2	61.6	1.3

Figure(s) with same superscipt(s) do not differ at 5% level of significance; DS, per cent leaf area damaged; LDS, number of leaves damaged; DAH, days after hatching.

Figure 1. Differential response of groundnut mutants and checks to feeding by larvae of *Spodoptera litura*.

superior to susceptible check. Among them, the mutants 28-2, 45 and 110 were also found to be resistant to late leafspot disease and possessed good pod and kernel features besides early maturity[7].

Laboratory tests are often used to elucidate the nature of resistance and determine the effects of the resistant plant on the insect pest. In the present study, artificial rearing of *S. litura* was undertaken on these mutants to confirm and establish the nature of resistance. The resistant mutants along with their parents (VL 1 and DER) and checks (GBFDS 272 and JL 24) were grown separately in large (5 m × 5 m) plots. Egg masses of *S. litura* were collected from commercial groundnut fields that were not sprayed with pesticides. The uniform egg masses were incubated in disinfected rearing tins of 15 cm diameter and 7 cm height. The top of the tin was covered by muslin cloth secured with a rubber band. Rearing was undertaken separately on seven genotypes in three replications. The third leaf from the top in each genotype was used for rearing. The fresh leaves were provided daily after cleaning the tins. The total number of larvae and average weight of ten larvae were recorded at 5 days interval and pupae were kept in egg laying cages for moth emergence. Fresh groundnut plants wrapped with wet cotton were provided for egg laying. The total number of eggs in a mass was counted using a magnifying lens[8].

The *S. litura* larvae reared on mutants 28-2 and 45 consistently showed less leaf damage (Figure 1), high mortality, low weight and low gain in weight compared to susceptible check and parents at all the stages (Table 2). On these criteria, the mutants were comparable or even superior to resistant check. The mortality and the low gain in weight were very much pronounced especially at the early stages of the larval period indicating the effect of the existing resistant factor on neonate larvae. The resistance effect of these mutants also extended the larval period by three days and had pronounced effect on the fecundity of moths. The mortality at initial stages, low larval weight, extension of larval period and low fecundity indicate the possible role of antibiosis as a mechanism of resistance in mutants 28-2 and 45 (ref. 9). The resistant mutants along with their parents can constitute the most ideal material to establish the role of specific chemicals affecting the insect pest.

The mutants (28-2 and 45) were earlier found to be resistant to late leafspot disease and early maturing with good pod and kernel features[7]. Therefore they can be widely tested for their suitability in commercial cultivation. The pest and disease resistant nature of these mutants can be profitably exploited in future breeding programmes.

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On the coral reefs of the Gulf of Kachchh

The Gulf of Kachchh (22°15′ to 23°40′N and 68°20′ to 70°40′E) is a 7350 km^2 east-west oriented indentation lying between the Kachchh mainland and the Saurashtra Peninsula. The only reported site for coral formations in the Gulf of Kachchh is between 22°20′N and 22°40′N latitudes and 69° and 70°E longitudes along the coast of Jamnagar district[1].

Based on the existing classifications these reefs are grouped into fringing reefs (north of Okha, north of Beyt Shankhodar, fringing the mainland from Dhani beyt to Sikka, Jindra and Chad, Pirotan, near Valsura), platform reefs (Paga reefs, Bural Chank, Karumbhar, Munde reef, etc.), patch reefs (Goos and Ajad) and several coral pinnacles (e.g. Chandri, etc.)[2].

Observations on the coral reefs of the gulf using satellite imageries have so far been restricted only to the intertidal reefs because of the limitations in depth penetration of the sensors[3]. The reefs get exposed only during low tides[4]. As a result, available imageries and existing data from the Gulf of Kachchh are only

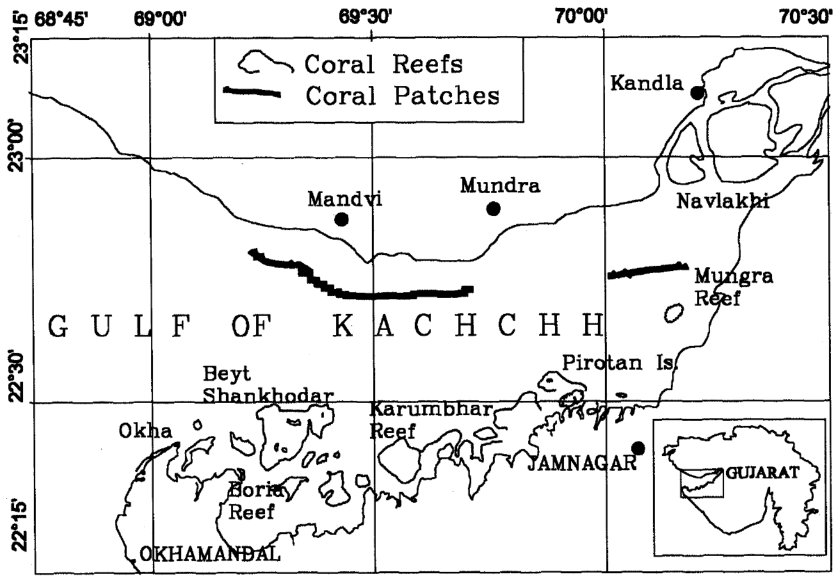

Figure 1. Coral distribution along the Gulf of Kachchh.