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RESEARCH ARTICLE :

Survey for incidence of storage pest and malathion resistance against *Sitophilus oryzae* in maize

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SUMMARY : Rice weevil *Sitophilus oryzae* (L.) is one of the most important storage pests in the world and is of major importance in India causing considerable damage to stored cereals particularly wheat and rice. The dominance of pest is mainly influenced by temperature, light, relative humidity and storage practices as well as its competitive ability with other pests. There has been extensive and intensive use of various insecticides including malathion in storage premises for the control of insect pests. The continuous use of the insecticides has resulted in the development of resistance to major stored grain insects to several insecticides including malathion at various locations in the State Keeping this in view, the literature was critically reviewed on the following aspects.

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BACKGROUND AND OBJECTIVES

Maize (*Zea mays* L.) is one of the most important staple food crops of India and occupies a prominent position in global agriculture. Maize has become the third important food grain crop after wheat and rice. In India it ranks fifth in area and fourth in production. It is grown in an area of 8117.3 hectares with a production of 18 million tonnes (CMIE report, 2008). In Andhra Pradesh, it is cultivated in an area of 850 hectares with an average production of 3621 tonnes (Directorate of Economics and Statistics, 2008). The demand for maize is increasing year by year due to its diversified uses. About 35 % of the maize produced in the country is used for human consumption, 25 % each in poultry and cattle feed and 15 % in food processing and other industries.

After the harvest, grains are stored for different purposes for varying periods of storage. During storage, the grains are damaged by several insects in storage, of which rice weevil *Sitophilus oryzae*, rice moth *Corcyra cephalonica* stainton, red flour beetle *Tribolium castaneum* Herbst, angoumois grain moth, *Sitotroga cerealella* Oliver, lesser grain borer, *Rhizopertha dominica*, Fabricious and khapra beetle *Trogoderma granarium* Everts are of economic importance (Vaidya and Ramesh Lal, 2001).

Among the storage pests in maize, rice

weevil, *Sitophilus oryzae* (Linn), is the most destructive insect pest in northern telangana of Andhra Pradesh. The pest is cosmopolitan in distribution and the damage caused by this pest is more in warm humid conditions.

In India, godowns and warehouses of central and state government agencies are being sprayed regularly with malathion directed at floor, walls and stacks for the control of stored product insects. In this way, insect pests are continuously exposed to malathion which resulted in development of resistant strains (Bansode and Bhatia, 1990 and Joia and Kumar, 1996). Hence, it is reasonable to assess the malathion susceptibility in *S. oryzae* from time to time. The present investigations were therefore, undertaken during 2007-08 with the following objectives.

– Survey of insect pests of stored maize in 3 districts of Telangana region.
– Correlation of abiotic factors with the incidence of stored grain pests of maize in 3 districts.
– Assessment of resistance to malathion in *Sitophilus oryzae* collected from 3 districts.

RESOURCES AND METHODS

Studies on "Survey for the incidence of stored grain pests and relative resistance of malathion against *Sitophilus oryzae* in maise" were conducted during 2007-08. The survey was conducted in three districts of Telangana region *viz.*, Karimnagar, Nizamabad and Medak twice during April and July 2008. The laboratory studies were conducted during 2007-08.

Maize stored under varying climatic conditions in three districts of Telangana region were sampled from farmers stores and APSSDC. From each village, saples of maize weighing approximately two kilograms were drawn from top, middle and bottom bags using a sampler (20 cm length). Each sample was thoroughly mixed and dived into four parts, from which a sub sample of 500g maize seed was collected in a polythene bag (20 x 10 cm) and its open end was tightly closed with rubber bands to avoid change of moisture content and escape of insects. The remaining sub samples were used for maintenance of *S. oryzae* culture for resistance studies. The samples were replicated thrice from each village.

The grain samples were analysed physically for identifying the insect species, insects infestation of determining the moisture content of the grain.

For determining the insects infestation and damage caused by stored pests in maize, approximately 500 maize seed from each samples were transferred to cylindrical glass jar (500 ml), sufficient amount of water was added and the infested seed and insects which float on the water were collected separately. They were dried in shade on tissue paper and counted. Further examination was done under microscope to identify and separate maize seed infested by different insect species. Doubtful grains were moistened, cut opened and examined under microscope for hidden infestation.

The per cent infestation was calculated by counting the damaged and healthy seed from 500 maize seeds.

$$\text{Per cent infestation} = \frac{\text{Number of infested seed}}{\text{Total no. of seed}} \times 100$$

The moisture content of the maize samples obtained from 3 districts of Telangana region was measured separately with the help of OSAW universal moisture meter.

S. oryzae. seeds were thoroughly cleaned and kept in the incubator for four hours at a temperature of 55°C for 4 hours to kill the immature stages if any without affecting the viability of seeds (Soloman, 1952). Then they were kept in the cloth bags under laboratory conditions.The moisture percentage of the maize seed (14% moisture) was determined by using "OSAW universal" moisture meter (Pareek *et al.*, 1977). The efficacy of malathion against *S. oryzae* was studied using film residue technique.The test insects were exposed initially to a wider range of concentrations and on the basis of mortality recorded, a series of concentrations in a narrow range were selected to which the insects were exposed. This procedure was repeated till the mortality (%) ranging between 10 to 90 per cent was obtained. Mortality data was recorded at 24 hrs after treatment. The moribund insects were counted as dead. The per cent mortality and corrected mortality was calculated by Abbott's formula (1925). The same procedure was repeated for all the strains obtained from four places.

The mortality data obtained was corrected using

Table A : Concentrations of malathion tested for resistance studies against *S.oryzae* obtained from different districts of Telangana region.

Sr. No.	Place/district	Concentrations (%)
1.	Karimnagar	0.1,0.07,0.05,0.03,0.01,0.005 and 0.001
2.	Nizamabad	0.3,0.1,0.09,0.07,0.05,0.03 and 0.01
3.	Medak	0.5,0.3,0.1,0.07,0.05,0.01 and 0.007
4.	Hyderabad	0.09,0.07,0.05,0.03,0.007,0.005 and 0.003

Abott's formula (Abott,1925) and then subjected to probit analysis (Finney, 1971). The LC_{50} and LC_{90} values were calculated. The relative resistance of *S. oryzae* population to malathion collected from the four districts was calculated separately by deviding the LC_{50} values obtained from different districts with that of LC_{50} values obtained from most susceptible strains.

Data obtained from the survey samples were subjected to square root transformation before subjecting it to statistical analysis. Statistical computation using two factorial CRBD procedures was done to determine significant differences between the locations, pests and their interaction.

To find out the role of abiotic factors on *S.oryzae*, the weather parameters were correlated with *S.oryzae* population and pest infestation. simple Linear regression and multiple linear regression analysis was also done to find out the most important weather factor as well as the combined effect of all the weather factors responsible for population build up of *S.oyzae* and infestation by storage pests.

OBSERVATIONS AND ANALYSIS

To find out the effect of weather parameters on storage pest infestation and *S.oryzae* population, the data were subjected to correlation and regression analysis Correlation co-efficients worked out between storage pest infestation and weather parameters prevailed during April 2008 revealed that *S. oryzae* population and storage pest infestation were highly influenced by weather parameters. Among the weather parameters morning relative humidity (0.84) and evening relative humidity (0.75) showed highly significant and positive effect on *S. oryzae* population while maximum temperature showed negative and significant effect (-0.64). Minimum temperature (-0.13) did not show any significant influence on *S. oryzae* population. The weather parameters prevailed during April, 2008 also significantly influenced the infestation of maize samples by storage pests. During July month, maximum temperature showed highly significant and negative influence on pest infestation (-0.71) while morning and evening relative humidity (0.65 and 0.58, respectively) showed positive and significant effect on infestation. Minimum temperature (-0.32)It is clear from the data furnished in that the population of *S. oryzae* was collected from Karimnagar was relatively more susceptible as compared to the populations of Medak, Nizamabad and Hyderabad districts because of low LC_{50} value of 0.006%. The population of Hyderabad with an LC_{50} value of 0.017 was slightly more resistant to the tune of 2.8 times more than the population of Karimnagar. The population of Medak with an LC_{50} of 0.05% was 8.3 times more resistant compared to the population of Karimnagar. Similarly the population of Nizamabad district with an LC_{50} value of 0.65 was 10.8 times, more resistant than the population of Karimnagar. At LC_{90}, the population of Hyderabad (with an LC_{90} of 0.24%) was relatively more susceptible compared to the populations of Karimnagar, Medak and Nizamabad. The population of Nizamabad district with an LC_{90} of 0.34% was slightly more resistant to an extent of 1.4 times as compared to the population of Hyderabad. The population of Karimnagar and Medak with an LC_{90} value of 0.44 and 0.65% showed 1.8 and 2.7 times resistance than the population of Hyderabad.Therefore, the studies were done to determine the insecticide resistance to malathion in *S. oryzae* collected from four places of Telangana region *viz.*, Karimnagar, Medak, Nizamabad and Hyderabad. The results indicated that, the *S. oryzae* population of Karimnagar was relatively more susceptible to malathion at LC_{50} compared to the populations of the other three districts. It recorded an LC_{50} value of 0.006 per cent closely followed by Hyderabad population (0.017%). The populations of Medak and Nizamabad recorded LC_{50} values of 0.05 and 0.065 per cent, respectively. The resistance ratios of *S. oryzae* population from different places indicated that Nizamabad population showed 10.8 folds resistance to malathion followed by Medak (8.3), while the Hyderabad population showed only 2.8 folds resistance. There was a slight change in the trend of malathion resistance at LC90% where in the Hyderabad population was more susceptible to malathion (LC_{90} value 0.24%) followed by Nizamabad (LC_{90} of 0.34%) which showed 1.42 fold resistance. The populations of Medak (0.65%) and Karimnagar (0.44%) exhibited slightly high levels of 1.8 and 2.7 fold resistance, respectively compared to the populations of Hyderabad. The results clearly indicated that the populations of *S. oryzae* developed resistance to malathion. However the degree of resistance varied with the localities and the resistance ratios varied from 2.8 to 10.8 fold at LC_{50} level, 1.4 to 2.7 fold at LC_{90} level. The results are in concurrence with the findings of Wang and Ku (1982) who found that field collected strains of *S. zeamais* from Taiwan was 4-6 times resistant over the susceptible laboratory strain. Giga and Mazarura (1990) also reported 4-6 fold resistance of *S.zeamais* to malathion compared to a susceptible laboratory strain.

The development of resistance to malathion by *S. oryzae* in the present study could be attributed to the wide spread use of malathion to control *S. oryzae* because of its low cost, moderate toxicity and optimal residual activity in storage. The level of high resistance (10.8 fold) recorded in Nizamabad cultures at LC_{50} value could be attributed to the fact that *S. oryzae* of Nizamabad culture was collected from the (Andhra Pradesh State Seed Development Corporation) godowns in Nizamabad, while the populations from other places were collected from the maize samples stored by the farmers. The usage of malathion as a precautionary measure would be more in the APSSDC godowns compared to the farmers which might have resulted in the development of higher level of resistance.

From the present findings it is evident that based on LC_{50} values, *S. oryzae* population of Nizamabad and Medak showed higher levels of resistance to malathion while at $LC_{90,}$ Medak and Karimnagar populations were more resistant to malathion. In view of this there is a need to replace malathion with less toxic and ecofriendly insecticides like spinosad for effective management of *S. oryzae*, the most prevalent and serious pest of maize and other cereals in storage.

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