Indian Journal of Entomology 83(2021) Online published Ref. No. e20303 DoI No.: 10.5958/0974-8172.2021.00096.1

DETECTION OF HIDDEN INFESTATION OF CIGARETTE BEETLE *LASIODERMA SERRICORNE* F. IN TURMERIC RHIZOMES BY X-RAY RADIOGRAPHY

K Ravi Kumar* and C Narendra Reddy

*Department of Entomology, College of Agriculture, Rajendranagar,
PJTSAU, Hyderabad 500030, Telangana, India
*Email: katrojuravikumar@gmail.com (corresponding author)

ABSTRACT

An experiment was conducted to detect the hidden infestation of *Lasiderma serricorne* F. in the turmeric rhizomes by X-ray radiography. Six varieties viz., Duggirala, Pratibha, Armoor, Salem, Kasturi and Tekurpeta were selected based on their size. Standardization of X-ray radiography values were done by subjecting the fingers to 120 combinations of voltage (KV), current (mA) and exposure period (s). The results revealed that the hidden infestation was detected as accurately as possible with 22 to 25 KV voltage, 3 mA to 5 mA current with 10 sec of exposure.

Key words: Turmeric, rhizomes, fingers, varieties, *Lasioderma serricorne*, X-ray, Voltage (KV), Current (mA), exposure period, radiation, infestation, developer, fixer, detection

Turmeric is a rhizomatous herbaceous perennial plant belonging to the ginger family (Zingiberaceaae), botanically known as *Curcuma longa* L., originated from Tropical south Asia (India). Various insects infest dry turmeric, of which the Coleoptera, include cigarette beetle (*Lasioderma serricorne* F.), drugstore beetle (*Stegobium paniceum* L.), red flour beetle (*Tribolium castaneum* Herbst), lesser grain borer (*Rhyzopertha dominica* F.), saw toothed grain beetle (*Oryzaephilus surinamensis* L.) and coffee bean weevil (*Araecerus fasciculatus* DeG.). Among these *L. serricorne* is serious, with the quantitative weight loss at three and six months after storage being 7.15 and 22.75% (Vidya and Awaknavar, 2004). Quarantine is the last defense against an unwanted imported non invasive alien pest. It is well known that X-rays can penetrate most materials. In addition to its application in industry and for medical examinations, X-ray radiography method can effectively be employed to detect the hidden insect infestation in stored grains (Karunakaran et al., 2003a). Electromagnetic waves with wave lengths ranging from 1 to 100 nm are called soft X-rays. The low penetration power and ability to reveal the internal density changes made soft X-rays suitable for agricultural products. The soft X-ray method is rapid and takes only a few seconds (3 to 5 sec) to produce an X-ray image.

X-ray radiography is one such great technological application in the area of plant quarantine and is an official standard method in USA for detection of hidden insect infestation in seed without destructing the high value genetic material. National Bureau of Plant Genetic Resources (NBPGR) which is a nodal organization in India is responsible for exchange of germplasm where compact X-ray machines are being used to detect the hidden insect infestation especially in case of germplasm. For standardization of X-ray radiography input factors like voltage (KV), current (mA) and exposure period (s) are required as these factors differ from one commodity to other. Some research was carried out to detect hidden infestation of insects in commodities (Karunakaran et al*.,* 2003a; Maharajan et al., 2005; Fornal et al*.,* 2007; Ramakrishnan et al., 2012; Boniecki et al., 2014; Chelladurai et al., 2014). However, very limited work has been done to detect the *L. serricorne* infestation in turmeric. The present investigation was undertaken for standardization of methodology for the detection and to fix the exact values of x-ray radiation related to infestation in six varieties of turmeric.

MATERIALS AND METHODS

For standardization, both infested and healthy samples were used in X-ray radiography studies to compare and analyze the X-ray images visually in order to determine and arrive at the right image of the infested ones from that of the healthy ones. A single disinfested variety of 'Duggirala' was taken as healthy one and varieties with eggs of *L. serricorne* were taken separately and maintained in separate glass jars. The X-ray film for obtaining standard images was used and

small samples (5-10) of the cured turmeric varieties were placed over the adhesive tape to pick out and separate the samples with internal (hidden) infestation while looking at the corresponding X-ray image. The cured turmeric samples were arranged in such a manner, where one row of infested ones alternated with that of healthy ones. After the exposure of these samples to radiation, the X-ray film was processed with the help of silver halide for image development and sodium thiosulphate for image fixing. After fixation, washing was done to remove the exhausted chemicals from the emulsion and to prevent the image deterioration. Finally, the X-ray film was thoroughly air dried to remove the excess moisture. After the image was fixed on the X-ray film, it was exposed to the X-ray radiation of different combinations, to find out the hidden infested areas.

The X-ray machine consists of three important factors i.e., kilovoltage (KV) is the measure of voltage potential, milliamperage (mA) is the measure of the current applied to the tube and exposure duration is the time during which the sample is exposed to the X-rays for making the radiograph. Standard cabinet X-ray machine of Faxitron series consists of a maximum of 45 kilo voltage (KV) and 15 milliamperage (mA) current. At a given voltage levels varying from 20 to 26 KV, there were 120 treatment combinations by changing of current as 2, 3, 4, 5 mA and exposure periods of 2,4,6,8 and 10 sec. Image analysis was taken up with 120 combinations to find out and standardize the right current, voltage and exposure period for detection of hidden infestation in the test samples. The hidden infestation was observed at the X-ray radiation of 25 KV and 5 mA current and 10 sec exposure period. Adjustments in combinations of current and exposure periods were made based on the preliminary image results while working in the laboratory. A highly infested variety "Duggirala" was used as the check for the standardization of current, voltage and exposure periods. The six varieties were selected based on size, which are mostly popularized and mostly cultivated by farmers for X-ray radiography studies viz., Duggirala, Pratibha, Armoor, Salem, Kasturi and Tekurpeta.

RESULTS AND DISCUSSION

Quarantine workers in India traditionally used only a range of values from 10 KV to 30 KV and a current of 4 milli ampere (mA) to 12 mA with an exposure period of 10 to 25 sec for cereals and leguminous seed materials. Ramakrishnan et al. (2012) reported that high voltage and current were required for dense seed materials to ensure adequate penetration of radiation compared to light seed materials. At different combinations of voltage, current and exposure periods, the best combination was observed by exposing to X-ray radiation of 25 KV and 5 mA for 10 seconds. Exposure to 22 KV, 4 mA for 6 seconds and at 26 KV, 4 mA for 10 sec exposures resulted in lighter and darker images, respectively. A disinfested and healthy one of Duggirala variety exposed to X-ray radiography at 25 KV and 5 mA for 10 sec, resulted in a good image. Based on these values, the combination of treatments in different turmeric varieties was standardized.

These results reveal that the current, voltage and exposure periods varied with varieties and ranged from 22 KV 5 mA 10 sec to 25 KV 5 mA 10 sec. The fingers of Pratibha which were heavily infested were selected for the investigation. Exposure of fingers to X-ray radiation of 23 KV and 4 mA for 10 sec was found to be the best combination to detect the hidden infestation. The other combinations viz*.,* 20 KV, 4 mA for 8 sec showed lighter image and 25 KV, 2 mA for 10 sec showed darker images. Exposure to 22 KV and 5 mA for 10 sec clearly detected the hidden infestation in infested 'Armoor' variety. Other combinations like 20 KV, 5 mA for 6 sec and 24 KV, 3 mA for 8 sec resulted in lighter and darker images. With the variety Salem, best images were obtained when exposed to 24 KV and 5 mA for 10 sec, thus can be considered as standardized values for Salem. The other combinations like 22 KV, 2 mA for 8 sec exhibited lighter image and at 26 KV, 2 mA for 6 sec exhibited darker image. Among the combinations of voltage, current and exposure periods evaluated, it was observed that exposure to 25 KV and 3 mA for 10 sec clearly detected the hidden infestation of *L. serricorne* in Kasturi. Exposure to 23 KV and 2 mA for 6 sec resulted in lighter image, while a darker image was observed at 26 KV and 2 mA for 8 sec. With the variety Tekurpeta, these values were 24 KV and 3 mA for 10 sec for a clear image; and 20 KV and 2 mA for 8 sec and 25 KV and 4 mA for 10 sec resulted in lighter and darker images, respectively.

These observations indicate variation in radiation and voltage to acquire clear image with the turmeric varieties, and this variation might be due to their size, shape and thickness; voltage ranged from 22 to 25 KV. These results agree with those of Ramakrishnan et al. (2012). This study had reported that when the size of the commodity increases, the voltage value also increases- the standardized value for paddy was 15 KV, 12 mA for 25 sec and for maize it was 25 KV, 8mA for 20

sec; while for greengram and soybean the values were 20 KV, 10 mA and 25 seconds and 25 KV 10 mA and 20 sec, respectively. The present results reveal that for the better X-ray images of hidden insect infestation a minimum of 3 mA current is required. The period of exposure to radiation was also an important factor, and exposure to < 8 sec and > 10 sec resulted in lighter and darker images, respectively. Kumarasamy et al. (2002) on Sabal uresana seeds, Karunakaran et al. (2003b) on western red spring wheat, Masetto et al. (2008) on cedar seeds evaluated the radiation for detection of hidden infestation. In quarantine stations during germplasm exchange by Sarath Babu (1997), Manju et al. (2002), Gupta et al. (2004), Bhalla et al. (2008) and Bhalla et al. (2009) reported that the voltage, current and exposure periods varies depending upon the material.

REFERENCES

Bhalla S, Gupta K, Manju L K, Charan Singh, Naresh Kumar, Lal B Khetarpal R K. 2008. Assessment of insect pests intercepted in imported planting material. Indian Journal of Plant Protection 36 (2): 9-14.

Bhalla S, Gupta K, Manju L K, Charan Singh, Naresh Kumar, Lal, B, Khetarpal R K. 2009. Detection of insect pests in indigenous germplasm. Indian Journal of Agricultural Sciences 79 (5): 129-134.

Boniecki P, Piekarska B H, Swierczynski K, Koszela K, Zaborowicz M, Przyby J. 2014. Detection of the granary weevil based on X-ray images of damaged wheat kernels. Journal of Stored Products Research 56 (5): 38-42.

Chelladurai V, Karuppiah K, Jayas D S, Fields P G, White N D G. 2014. Detection of *Callosobruchus maculatus* (F.) infestation in soybean using soft X-ray and NIR hyperspectral imaging techniques. Journal of Stored Products Research 57 (2): 43-48.

Fornal J, Jelinski T, Sadowska J, Grundas S, Nawrot J, Niewiada A, Warchalewski J R, Blaszczak W. 2007. Detection of granary weevil *Sitophilus granarius* eggs and internal stages in wheat grain using soft X-ray and image analysis. Journal of Stored Products Research. 43 (2): 142-148.

Gupta K, Bhalla S, Manju L K, Lal B, Charan Singh, Meenakshi, Baloda R S, Naresh Kumar. 2004. Insect pests intercepted in exotic planting material during quarantine processing in 2002. Indian Journal of Plant Protection 32 (3): 49-52.

Karunakaran C, Jayas D S, White N D G. 2003a. X-ray image analysis to detect infestations caused by insects in grain. Cereal Chemistry 80 (2): 553-557.

Karunakaran C, Jayas D S, White N D G. 2003b. Soft X-ray inspection of wheat kernels infested by *Sitophilus oryzae*. Transactions of the American Society of Agricultural Engineers 46 (3): 739-745.

Kumarasamy M, Latha S, Sathyanarayana N, Reddy O R. 2002. Interception of palm seed weevil (*Caryobruchus gleditsiae*) on seeds of *Sabal uresana* imported from Germany. Indian Journal of Plant Protection 30 (2): 67-68.

Maharajan A, Latha S, Sathyanarayana N, Reddy, O R. 2005. X-ray analysis: A non- destructive detection of stone weevil, *Sternochetus mangiferae* in mango fruits. Indian Journal of Plant Protection 33 (4): 164-166.

Manju L K, Bhalla S, Verma B R. 2002. Bruchids associated with *Cassia spp.* seeds and their quarantine significance. Indian Journal of Entomology 64 (1): 471-474.

Masetto T E, Faria J M R, Queiroz, S E E. 2008. Evaluation of the seed quality in *Cedrela fissilis* (Meliaceae) by X-ray test. Ciencia e Agrotecnologia. 32 (1): 1708-1712.

Sarath Babu B. 1997. Detection of insect pest of quarantine significance in screening of germplasm under exchange programme during 1989-1995 in India. Journal of Entomological Research 21 (3): 295-297.

Vidya H, Awaknavar J S. 2004. Host suitability of different spices to cigarette beetle, *Lasioderma serricorne* Fabricius (Coleoptera: Anobiidae). Insect Environment 10 (4): 176-177.

(Manuscript Received: November, 2020; Revised: January, 2021;
Accepted: January, 2021; Online Published: May, 2021)
Online published (Preview) in www.entosocindia.org Ref. No. e20303