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Interception of Weed Seeds in Rice Seeds Imported from Different Countries

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***Abstract*:** The Regional Plant Quarantine Stations in the country and Division of Plant Quarantine at ICAR-National Bureau of Plant Genetic Resources (NBPGR), New Delhi conducts seed quarantine tests of incoming and outgoing rice seeds. Fifteen percent of the incoming rice seed shipments were found contaminated with weed seeds. Twenty-five weed species were intercepted and identified as rice seed contaminants out of which *Echinochloa crus-pavonis* is a quarantine weed for India and listed in Schedule VIII of Plant Quarantine (Regulation of Import into India) Order (2003). *Echinochloa* spp. were the most frequent, with as many as 436 seeds per seed-lot. Seeds of *Echinochloa* spp. were found to harbour saprophytic fungi like *Curvularia lunata*, *Fusarium semitectum*, *Phoma* sp., *Cladosporium* sp. and *Alternaria longissima* that can cause grain discoloration in rice grains were detected at high levels. Plant pathogenic seed borne fungi like *Bipolaris oryzae* which causes leaf spot of rice and *Fusarium moniliforme* that causes bakanae disease of rice were detected at low levels. More care in processing imported rice seeds for research and propagation purpose is needed to prevent weed seed contamination and spread.

Keywords: Weed seeds, seed shipments, quarantine weed, germplasm exchange.

INTRODUCTION

The importation of rice seeds from one country to another and among research institutions is indispensable in rice improvement and production. However, rice seeds are potential carriers of weed seeds, insect pests, and diseases. Many noxious weeds in India are of foreign origin and have been introduced accidently through the importation of planting materials, especially seeds (Singh et al., 2022). The most effective means of dealing with the weed seed contaminants in crop seeds for planting are prevention and decontamination. Application of stringent plant quarantine regulations have proven to be the most inexpensive solution to this problem. The Regional Plant Quarantine Stations in the country and Division of Plant Quarantine at ICAR-National Bureau of Plant Genetic Resources (NBPGR), New Delhi conducts seed quarantine tests of incoming and outgoing rice seeds. Germplasm materials originating from research institutions may carry noxious weed seeds despite treatment and certification (Sastroutomo, 1992). The dispersal of weed seeds is ensured when weed seeds are present in seed of agricultural crops (Wellington, 1960). *Echinochloa crus-galli* is hard to distinguish from the rice plant in the early stages and the seed usually is carried as an impurity in rice grain (Ramiah, 1937). Cung (1981) reported that the most common contaminant in rice seed in Vietnam was *E. crus-galli*. In the Philippines, *E, glabrescens,*

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*Fimbristylis minacea, Scirpus supinu*s, and *E. oryzoides* were common contaminants in farmers' seed (Rao and Moody. 1990). Farmers are aware that *Echinochloa* spp. are spread via contaminated rice seeds (Fujisaka et al., 1993). Weeds that mature with the crop tend to be spread as contaminants in the harvested crop and in subsequently planted seed (Bayer, 1991). Seed contaminated with weed seeds may introduce new species to a given field or add to an existing weed population. Rao and Moody (1990) reported a positive correlation between weed dry weight at rice harvest and the total number of weed seeds that contaminated rice seed immediately after threshing and after processing of the threshed rice by farmers. It is recommended that rice seeds be thoroughly cleaned for weed seeds as rice seed is one of the sources of weeds. Seed certification and related seed control measures are also proven systems for preventing the contamination of crop seeds (Sastroutomo, 1992). Sanitation procedures have been adopted at ICAR-NBPGR to meet phytosanitary certification requirements of germplasm. Seed health testing is a procedure in assessing the health status of rice seed under plant quarantine regulations. The plant quarantine procedures employed for rice seed health testing of imported and exported rice germplasm include dry seed inspection, routine seed health testing, and seed treatment. This study was conducted to determine the movement of weed seeds in rice seeds, to identify weed seed contaminants, and to identify seed borne fungi in weed seeds.

MATERIALS AND METHODS

The imported rice seeds were examined as per provisions of the Plant Quarantine (Regulation of Import into India) Order, 2003 notified under Destructive Insects & Pests Act (1914). Weed seeds were separated from rice seed with the help of sieves and then samples were spread in a thin uniform layer on a clean white drawing sheet and examined with the help of illuminated magnifier and all weed seeds were separated by mechanical cleaning. Weed seeds were counted and results are expressed as number of seeds found in the quantity of seeds examined. Weed seeds were segregated into different types on the basis of their shape, size, colour, texture and the presence of any attachment. All intercepted weed seeds were identified to species level based on their morphological characters by consulting reference collection of weed seeds and weed seed identification keys. The quarantine inspection records of Regional Plant Quarantine Stations and the Division of Plant Quarantine from 2015 to 2019 were compiled, tabulated, and reviewed for weed seed interceptions. Seed borne fungi of weed seeds were determined using the blotter method (ISTA, 1985). One hundred seeds were used for testing. Twenty-five seeds were distributed evenly on moistened filter paper in plastic Petri dishes. The Petri dishes were incubated at 21^0 C for 7 days in alternating cycles of 12h darkness and 12h near ultraviolet light. Seed borne fungi were detected and identified after incubation using a stereoscopic binocular microscope.

RESULTS AND DISCUSSION

The Regional Plant Quarantine Stations and Division of Plant Quarantine at ICAR-National Bureau of Plant genetic Resources, New Delhi, processed 306143 incoming rice seed-samples in 374 consignments from 5 countries during 2015 to 2019 (Table 1). Twenty-seven percent came from China, 21% from Italy, 34% from Philippines, 5% from Thailand, 9% from USA and 4% from Vietnam. An average of 91 shipments and 7574 seed samples were examined per year for weed seed contamination (Table 2). Fifteen percent of the consignments were found contaminated with weed seeds at an average of 77 (1.1%) seed-lots a year. Seventy-one percent of the contaminated consignments contained *Echinochloa* spp. seeds. The highest number of consignments and

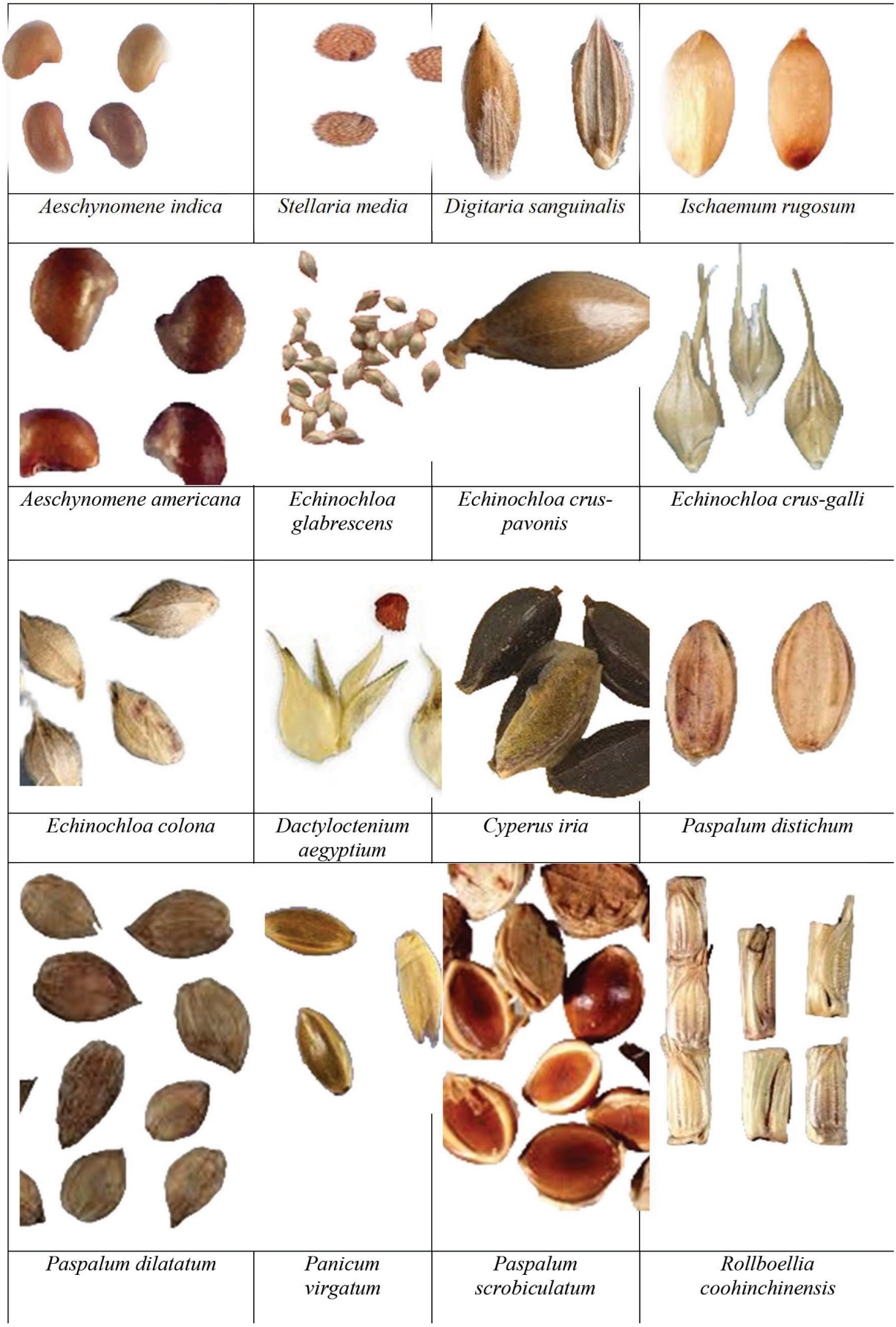

Figure 1: Weed seeds intercepted in imported rice seeds during 2015-2019

Table 1: Origin of rice seeds imported in India during 2015 - 2019

Country	Total shipments (No.)	Total seed samples (No.)
China	101	134210
Italy	79	2128
Philippines	128	162862
Thailand	19	2891
USA	32	3181
Vietnam	15	871
Total	374	306143

Table 2: Number of shipments and seed samples of imported rice seeds contaminated with weed seeds

Year	*Shipments (No.)*		*Seed samples examined (No.)*	
	Total	*Contaminated with weeds*	*Total*	*Contaminated with weeds*
2015	88	11	6752	31
2016	124	20	10481	94
2017	96	13	9536	32
2018	75	07	4832	85
2019	73	19	6270	142
Average	91	14	7574	77

Table 3: Weed seeds intercepted in imported rice seed samples during 2015-2019

Weed species	*Family*	*Contaminated seed samples (no.)*				
		2015	*2016*	*2017*	*2018*	*2019*
Broadleaved weeds						
Aeschynomene americana	Fabaceae	00	02	00	01	00
Aeschynomene indica	Fabaceae	01	00	00	03	00
Stellaria media	Caryophyllaceae	00	01	00	00	01
Sedges						
Cyperus compactus	Cyperaceae	00	35	00	00	00
Cyperus difformis	Cyperaceae	00	00	01	00	00
Cyperus iria	Cyperaceae	00	00	00	00	03
Cyperus rotundus	Cyperaceae	00	01	00	00	00
Fimbristylis ferruginea	Cyperaceae	00	00	02	15	07
Fimbristylis miliacea	Cyperaceae	00	07	00	02	08
Scripus juncoides	Cyperaceae	00	00	00	07	00
Scripus maritimus	Cyperaceae	00	00	00	01	02
Scripus supinus	Cyperaceae	07	13	04	00	08
Grasses						
Dactyloctenium aegyptium	Poaceae	00	00	01	00	01
Digitaria sanguinalis	Poaceae	05	00	00	01	00
Echinochloa colona	Poaceae	09	04	03	11	27
Echinochloa crus-galli	Poaceae	14	11	11	17	40
Echinochloa crus-pavonis	Poaceae	12	10	08	07	32
Echinochloa glabrescens	Poaceae	12	09	03	15	31
Ischaemum rugosum	Poaceae	21	05	00	03	01
Panicum virgatum	Poaceae	02	00	00	00	00
Paspalum conjugatum	Poaceae	03	00	01	00	00
Paspalum dilatatum	Poaceae	02	00	01	00	00
Paspalum distichum	Poaceae	00	00	00	02	00
Paspalum scrobiculatum	Poaceae	02	00	02	09	02
Rollboellia coohinchinensis	Poaceae	24	00	03	00	00

Table 4: Fungi identified from seeds of *Echinochloa* spp. collected from imported rice seeds

Fungi	*E. crus-galli*	*E. colona*	*E. crus-pavonis*	*E. glabrescens*
Acremoniella atra	00	00	00	01
Alternaria sp.	01	02	04	02
Alternaria longissima	19	19	24	13
Bipolari's oryzae	02	00	01	00
Chaonephora sp.	22	00	01	01
Cladosporium sp.	63	23	16	10
Curvularia lunata	93	87	91	95
Drechslera monoceras	04	20	05	08
Drechslera rostrata	03	00	01	05
Fusarium moniliforme	01	01	02	02
Fusarium semitectum	48	23	37	60
Nigrospora sp.	28	07	02	04
Penicillium sp.	00	01	01	02
Phaeotrichoconis crotalariae	02	00	01	00
Phoma sp.	39	31	31	24
Pithomyces sp.	07	04	02	02
Pyricularia sp.	00	01	00	00
Triohoconis padwickii	00	01	01	00

seed-samples with weed seeds was recorded in 2019, with 26% and 2.3% contamination, respectively. Weed seeds of 12 genera from four families, Poaceae, Cyperaceae, Fabaceae, and Caryophyllaceae, were identified as contaminants in rice seeds (Table 3). Twenty five weed species were intercepted out of which *Echinochloa crus-pavonis* is a quarantine weed for India and listed in Schedule VIII of Plant Quarantine (Regulation of Import into India) Order 2003).

The most common weed seeds encountered (Figure 1)were species of *Echinochloa*. Other important species were *Fimbristylis* spp. *Scirpus* spp. and *Ischaemum rugosum*. The average weight of rice seeds that contained *Echinochloa* spp. seeds ranged from 34g to 1.5kg (Table 4). Eighty-two percent of infected seed-lots weighed less than 100 g. Highest contamination was 436 seeds in 460 g rice seeds. The average number of *Echinochloa* spp. seeds ranged from 4 to 18 per seed sample. The number of weed seeds intercepted varied regardless of the amount of rice seeds.

Echinochloa crus-galli, *E. colona*, *E. crus-pavonis* and *E. glabrescens* collected from imported rice seeds were tested for seed borne fungi using the blotter method. Eighteen species of fungi were detected from imported *Echinochloa* spp. seeds (Table 4). Saprophytic fungi like *Curvularia lunata*, *Fusarium semitectum*, *Phoma* sp. *Cladosporium* sp. and *Alternaria longissima* that can cause grain discoloration in rice grains were detected at high levels (Table 4). Plant pathogenic seed borne fungi like *Bipolaris oryzae* which causes leaf spot of rice and *Fusarium moniliforme* that causes bakanae disease of rice were detected at low levels.

CONCLUSION

The Regional Plant Quarantine Stations and Division of Plant Quarantine at ICAR-National Bureau of Plant genetic Resources, New Delhi conducts seed quarantine tests of imported rice seeds. All seed samples are critically examined according to seed quarantine sanitation standards for best quality seeds.

This study dealt with weed seed contamination in imported rice seed shipments and seed borne fungi associated with weed seeds. Fifteen percent of incoming shipments were found contaminated with weed seeds.

Echinochloa spp. were the most frequently intercepted weed seeds.

Seeds of *Echinochloa* spp. were found to harbour saprophytic fungi like *Curvularia lunata*, *Fusarium semitectum*, *Phoma* sp., *Cladosporium* sp. and *Alternaria longissima* that can cause grain discoloration in rice grains were detected at high levels. Plant pathogenic seed borne fungi like *Bipolaris oryzae* that causes leaf spot of rice and *Fusarium moniliforme*, which causes bakanae disease of rice, were detected at low levels.

The results indicate the inadequacy in eliminating weed seeds from the country of origin of rice seeds. To avoid further importation and spread of undesirable weed species in rice seed shipments, the following steps are needed:

Strict compliance of the import requirements and national seed certification regulations;

A detailed post-entry inspection of all rice seed shipments;

Continuous dialogue among rice seed importers, exporters, and quarantine service personnel to improve the quality of rice seed shipments.

Elimination of weed seeds from rice seed shipments can be achieved by (a) commitment to a shared responsibility and accountability among seed users and the national quarantine service, and (b) the shipment of high-quality rice seeds only.

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