



Research Article

Weed Seed Species Inventory of Wheat Imported through Tanjung Perak Port

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ABSTRACT

Wheat seeds importation has the potential of weed seeds that can harm Indonesia's biodiversity. This study aims to determine the types and morphological characters of weed seeds carried by imported wheat from Australia, Canada, and Ukraine through the port of Tanjung Perak-Surabaya for January–June 2018. The research was started by collecting weed seeds from wheat samples, observing using a SMZ 1270 stereo microscope and identifying them using a reference book. The weed seeds were successfully identified as 13 families with 20 species originating from Australia, Canada and Ukraine. The most common types of weeds are from the Poaceae family. Weed this family are often found in the form of florets, the seeds of which are called caryopsis are coated in lema and palea, as in grains. Weed seed species found in wheat commodities from the three countries, are: *Avena fatua*, *Brassica campestris*, and *Polygonum convolvulus*, are not classified as quarantine pest.

Keywords: morphology; Tanjung Perak Port; weed; wheat

INTRODUCTION

Wheat is an important commodity in the global economy due to its role as a main Cerealia crop that provides daily calorie and protein needs for approximately 60% of the global population and also for livestock (Shehzad *et al.*, 2012). According to BPS (2017), wheat importation volume and value of Indonesia was 11.5 million tons and predicted to value as much as 2.6 billion USD in 2017. Based on these values, wheat seed importation is used as much as 8 million tons for the flour industry and 3.8 million tons for livestock feed.

Countries that export wheat to Indonesia through the Agricultural Quarantine Major Service of Surabaya (BBKP Surabaya) include Australia, Canada, India, Ukraine, USA, Moldova, Russia, Uruguay, Turkey, Pakistan, Brazil, Rumania, Argentine, France, Bulgaria, Latvia, and China (BBKP Surabaya, 2016). Until 2016, volume of wheat seeds that entered Tanjung Perak Port reached 2,823,205 tons with Australia, Canada, India, and Ukraine being the biggest exporters (BBKP Surabaya, 2016). The high volume of wheat seeds that enter through Tanjung Perak Port possess a great threat of quarantine pest to enter Indonesia, including weed species. According to the Agriculture Ministry of Republic Indonesia's

Ministerial Regulation number 31/PERMENTAN/KR.010/7/2018, targeted weed quarantine pest from Australia include: *Agropyron repens* L., *Alopecurus myosuroides* Hudson, and *Cirsium arvense* L.

Based on these considerations, the goal of this research is to define the types and morphological characters of weed seeds that are potentially brought with wheat seeds from Australia, Canada, and Ukraine that enter through Tanjung Perak Port, Surabaya.

MATERIALS AND METHODS

Research was done in the Laboratory of Plant Quarantine BBKP Surabaya during January–June 2018. Weed seeds were first collected from wheat seeds (\pm 2 kg/sample) placed on plastic trays and sifted using a 10 mesh without any replications. Sample collecting was done by following sampling guidelines from the BARANTAN (2011). Samples tested were working samples, weed seeds were separated using a magnifier lamp on a sorting plate. Observations were done using a SMZ 1270 stereo microscope and documented using a Nikon DS-Fi3 camera. Identifications were done by comparing sample morphologies to guideline images and their descriptions. Identification references used as guideline in this study included: "An Illustrated

Taxonomy Manual of Weed Seeds” (Delorit, 1970), “Seed Identification Manual” (Martin & Barkley, 2000), “Identifying Weed and Their Seeds” (Zolinger & Harstad, 2017). Identification was also done using online references from PaDIL (www.padil.gov.au) and Identification Technology Program (ITP) (www.idtools.org).

RESULTS AND DISCUSSION

Observations showed that weed seeds collected from Australia, Canada and Ukraine consisted of 13 families and 20 species. Some weed seeds were not able to be identified to species levels included *Brassica* spp. and *Centaurea* sp. due to abnormal seed characters and limited information regarding to these weed species based on commodities from origin country. Weed species frequently found from all 3 countries include *Avena fatua* L., *Brassica campestris* L., and *Polygonum convolvulus* (Table 1). Highest weed species richness was found Ukraine wheat (14 species) that may be due to several factors, such as wheat growing ecosystems and sorting processes. Contamination of weed seeds in post-harvest seed product is an essential issue due to it affecting product quality and several weed seeds contain harmful toxins (GTA, 2018).

Morphological Description of Weed Seeds

1. *Cenopodium album* L. (Fam. Amaranthaceae)

Seeds were circular shaped with coarse surfaces but glossy. Lengths were 1–2 mm with grooved bulges towards the inside of the seeds which are the micropylar endosperms or micropyle of the seed. According to Western Australian Herbarium (1998), *C. album* fruits are achene (seeds covered by thin pericarps). Seeds were almost circular and had thick border lines, were oval shaped when viewed transversally, possess concave sides, glossy, black and possess a diameter of 1.5×1.4 mm with weight of 1.2 mg.

2. *Centaurea* sp. L. (Fam. Asteraceae)

Seeds found were cypsela shaped, which are seed or achene that possess pappus. Seeds were cylindrical with white to yellowish color, shrunken and curved hook-like ends, white smooth surfaces, pappus are white to purple, with length of 2.5–5 mm. Seed appeared like shaving brushes.

3. *Lithospermum arvense* L. (Fam. Boraginaceae)

Seeds had coarse and bulgy surfaces, hard and crusted wall, and 2–4 mm in length. Seeds were hood-shaped with erected ends. Seeds had wide bases as they were cut and tapered upwards. There are central ridges on dorsal sides. Base had two small bulges and collar-like perimeters. Seeds were brown greyish to brown (Delorit, 1970).

4. *Brassica campestris* L. (Fam. Brassicaceae)

Seeds are round to irregularly round, reddish brown, purplish brown, black with 1.5–2 mm in length. Seeds are grooved on one side toward the hilum.

5. *Descurainia sophia* (L.) Webb ex Prantl (Fam. Brassicaceae)

Descurainia sophia seeds had oval ends, flat with rectangular shapes, had clear concave grooved along the seed, had the size of 3×1×0.6 mm. Seeds were brown. Seeds are reddish brown and 1/32 inch in size (Zollinger & Harstad, 2017).

6. *Thlaspi arvense* L. (Fam. Brassicaceae)

Seeds were dark brown or black to greyish, 1/16 inch in length, oval and flat. There have tubulgy ridge on their surfaces and circular concentric similar to finger prints (Zollinger & Harstad, 2017).

7. *Convolvulus arvensis* (Fam. Convolvulaceae)

Seeds were round to triangular, have rounded ends, and 3–4 mm in length. Seed skin surfaces were coarse as covered with sand and greyish. Seeds also may appear dull and coarse, two from three sides of the seed seem flat. Seeds were 1/8 inch in length, seed shapes were similar to *Calystegia sepium*, but being larger and having coarser surfaces (Zollinger & Harstad, 2017). *C. arvensis* seeds were oval, appeared like a triangle and had a hilum that narrows towards the end. Hilum were orange, oval, while *C. sepium* hilum were D-shaped and oval (CFIA, 2017).

8. *Linum usitatissimum* L. (Fam. Linaceae)

L. usitatissimum seeds were oval, have concave on one end and round, thin walls, flat, length 4 mm, brown and shiny.

9. *Glaucium flavum* Crantz (Fam. Papaveraceae)

G. flavum seeds were round on one end, thin, blackish brown with shiny surface with rigged patterns that were short (GTA, 2018).

Table 1. Weeds species collected from wheat seed shipments that entered Tanjung Perak Port during January-June 2018 and their relation quarantine pest host and Invasive Alien Species database

No	Family	Species	Finding Frequency during January-June 2018			Potential Quarantine Pest	Species within determine genus that are included in the Global Invasive Species Database
			Australia	Canada	Ukraine		
1	Amaranthaceae	<i>Cenopodium album</i>	-	16	15	x	x
2	Asteraceae	<i>Centaurea</i> sp.	-	-	2	x	<i>C. diffusa</i> , <i>C. melitensis</i>
3	Boraginaceae	<i>Lithospermum arvense</i>	-	22	11	x	x
4	Brassicaceae	<i>Brassica campestris</i>	145	88	45	x	x
		<i>Descurainia sophia</i>	-	-	1	x	x
		<i>Thlaspi arvense</i>	-	-	1	x	x
5	Convolvulaceae	<i>Convolvulus arvensis</i>	-	15	-	<i>Acraea acerata</i> Hew. Lepidoptera: Nymphalidae; sweet potato butterfly	x
6	Linaceae	<i>Linum usitatissimum</i>	-	7	-	x	x
7	Papaveraceae	<i>Glaucium flavum</i>	-	-	1	x	x
8	Poaceae	<i>Avena fatua</i>	159	45	15	x	x
		<i>Echinochloa crusgalli</i>	-	-	12	x	x
		<i>Lolium rigidum</i>	75	23	34	x	x
		<i>Panicum miliceum</i>	-	-	6	x	x
		<i>Setaria pumila</i>	-	-	5	<i>S. verticillata</i>	x
9	Polygonaceae	<i>Polygonum convolvulus</i>	55	30	48	x	<i>P. cuspidatum</i>
		<i>P. lapathifolium</i>	5	19	-	x	x
10	Ranunculaceae	<i>Delphinium virescens</i>	-	2	-	x	x
11	Resedaceae	<i>Reseda lutela</i>	-	-	5	x	x
12	Rubiaceae	<i>Galium aparine</i>	5	15	-	x	x
13	Malvaceae	<i>Malva parviflora</i>	10	3	-	x	x

10. *Avena fatua* L. (Fam. Poaceae)

A. fatua seeds were frequently found in floret shapes, which are caryopsis covered in lema and palea. This species' seed type is caryopsis, which is similar to rice species. All to parts of floret surfaces are covered with hair with hair structures tufted structure on their base. Florets were 11.0–14.0 mm long, 2.0–2.5 mm wide. Seeds were sometimes brownish, greyish black, or yellow with elliptical and narrowing shapes. Rachilla (stems that connect between floret) are 3–4 mm long with occasionally dense hair. Awn twisted, threaded structures on the lemma's dorsal, were slightly on the ends. Disarticulation scar (hole structures on floret's base) were tilted oval, perimeters were concave or had collars (Delorit, 1970). Strong rachilla, have diamond shape ends. Tilted disarticulation scar, round, egg-shaped or triangular (Scher *et al.*, 2011). Considered as a caryopsis seed type.

11. *Echinochloa crusgalli* (L.) P. Beauv. (Fam. Poaceae)

Lemma were 2.6–4.4 mm long (not including awn, if present). Ends were strongly tapered or with awn structures that were 1–40 mm long, and rarely had additional structures (Tahir, 2016). Seeds appeared to be strongly curved from their sides, 3.0–3.5 mm long and 1.8–2.4 mm wide (Delorit, 1970). Considered as a caryopsis seed type.

12. *Lolium rigidum* Gaudich. (Fam. Poaceae)

L. rigidum seeds were relatively flat, 4–6 mm long, and seed embryo were frequently visible through outer structures. Considered as a caryopsis seed type.

13. *Panicum milaiceum* L. (Fam. Poaceae)

Seeds of *P. milaiceum* were ovoid, 3 mm×2 mm in size, had various colors, but white was the most frequently observed color, and could fall out (Cavers & Kane, 2016). Considered as a caryopsis seed type.

14. *Setaria pumila* (Poir.) Roem. & Schult. (Fam. Poaceae)

Most florets were elliptical or roundly oval with tapered ends. Lateral views showed curved dorsal and flat ventral (D-shaped). Lengths were 1.5–3.5 mm, width were 1.5–2.0 mm, and with the diameter of 1.2–1.5 mm. Florets were greyish yellow to brown. Lemma palea were hard. Lemma had lateral wrinkled patterns. Perimeters of lemma are rolled exceeding the sides of palea. In general, caryopsis were oval and round on their ends. Caryopsis were 1.4–2.0 mm

in length, 0.9–1.1 mm in width, and 1.1–1.4 mm in diameter. Caryopsis colors were greyish white, smooth, and dull (ISTA, 2018).

15. *Polygonum convolvulus* L. (Fam. Polygonaceae)

P. convolvulus seeds were triangular (3 sided), had coarse and dull surfaces, 5–4 mm length, black, dark or light brown (Martin & Barkley, 2000).

16. *Polygonum lapathifolium* L. (Fam. Polygonaceae)

Seeds were circular to oval shape with tapered flat ends and slight concave in the middle. Seed surfaces are smooth and shiny. Seeds were black or reddish brown, 1.5–2.5 mm in length and 1.3–1.8 mm in width (Delorit, 1970).

17. *Delphinium virescens* Nutt. (Fam. Ranunculaceae)

D. virescens seeds were irregular shaped, 2–3 mm in length, seed surfaces were ridged, scaly, and wing shaped.

18. *Reseda lutela* L. (Fam. Resedaceae)

Description of *R. lutela* seeds are oval and round shaped, there are peach hilum with smooth surfaces. Seeds were blackish brown to black.

19. *Galium aparine* L. (Fam. Rubiaceae)

G. aparine seeds are globose to sub globose shaped with holes or cavities in the middle of the adaxial, has tubercle and is like a small thorn on the abaxial, length 1–3 mm.

20. *Malva parviflora* L. (Fam. Malvaceae)

Seeds were reniform, flat or globos, appeared curved, had wide cotyledons, thin and covered. Seeds were brown, round with curves on their white hilum. Seeds were covered by sheaths of snail-shaped light brown paper-like structures. Each capsule-like structure may contain >9 individual capsules (GTA, 2018).

Weed Roles in Wheat Cultivation

Weeds are a limiting factor in wheat cultivation that decrease their productivity. Weeds compete for light, moisture, soil nutrition, space, and CO₂. Competition will cause field efficiency to decrease, increase in pest management costs, increase in water management cost, and decrease human resources efficiency (Qureshi & Bhatti, 2001). According to Duali & Yaduraju (2005), yield loss due to *Phalaris minor* in wheat cultivation may reach 25–50%. Weed species that frequently infest wheat fields from year to year are *Avena fatua* L., *Convolvulus arvensis* L.,

Cyperus rotundus Pers., *Fumaria parviflora* Lamk., *Phalaris minor* Ritz. and *Solanum nigrum* L. (Mahmood *et al.*, 2012).

Weeds as Host for Other Quarantine Pest

Weed can serve as hosts for other quarantine pests. According to The Republic of Indonesia's Ministry of Agriculture ministerial regulations No 31 (2018), in general, weeds that infest wheat seed shipments do not serve as host for other quarantine pests. However, there is 1 weed species that also serves as a host of the quarantine pest *Acraea acerata* Hew (Lepidoptera: Nymphalidae) or sweet potato butterfly, which is the weed *Convolvulus arvensis* (Table 1). Thus, the probability of weed species from Australia, Canada, and Ukraine to serve as host of other quarantine pest is relatively low.

The Potential of Weed as Invasive Alien Species

Global agriculture product trading is one of the ways weed seeds from other countries may enter Indonesia and become invasive alien species (IAS). Factors that cause weeds to become IAS include their quick reproduction, high survivability, their allelopathic compounds, and their ability to tolerate extreme soil and climate conditions. From all species found during this study, *Centaurea* (species *C. diffusa*, *C. melitensis*) and *Polygonum* (species *P. cuspidatum*) are the only genera included in the Global Invasive Species Database (Table 1). Therefore, the potential of wheat seeds from Australia, Canada, and Ukraine to bring weeds seeds considered as IAS can be categorized as moderate.

Based on types and morphological characteristics of weed seeds brought with wheat seeds from Australia, Canada, and Ukraine that went through Tanjung Perak Port, Surabaya during January–June 2018, 20 weed species were identified. Weed species found from Australia, include *Brassica campestris*, *Avena fatua*, *Lolium rigidum*, *Polygonum convolvulus*, *P. lapathifolium*, *Galium aparine*, and *Malva parviflora*. Weed species from Canada were *Cenopodium album*, *Lithospermum arvense*, *B. campestris*, *Convolvulus arvensis*, *Linum usitatissimum*, *Avena fatua*, *P. convolvulus*, *P. lapathifolium*, *Delphinium virescens*, *G. aparine*, and *M. parviflora*; while from Ukraine, weed species found included *C. album*, *Centaurea* sp., *L. arvense*, *B. campestris*, *Barbarea verna*, *Thlaspi arvense*, *Glaucium flavum*, *A. fatua*, *Echinocloa crusgalli*, *Panicum miliceum*, *Setaria pumila*, *P.*

convolvulus, and *Reseda lutela*. The high frequency and species richness of weed seeds found in this study emphasizes the importance to increase monitoring during quarantine checking, especially on carrying medium when brought into Indonesia.

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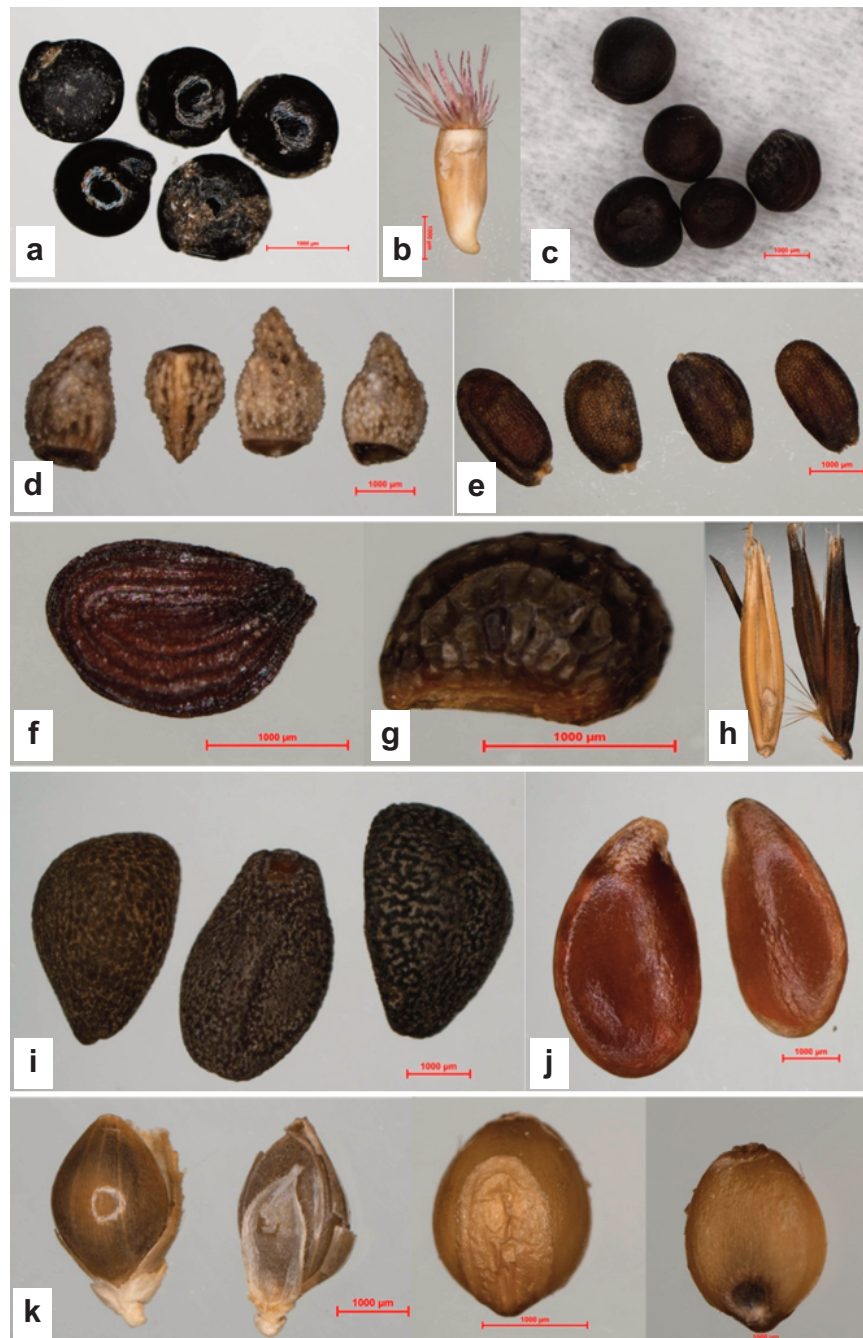
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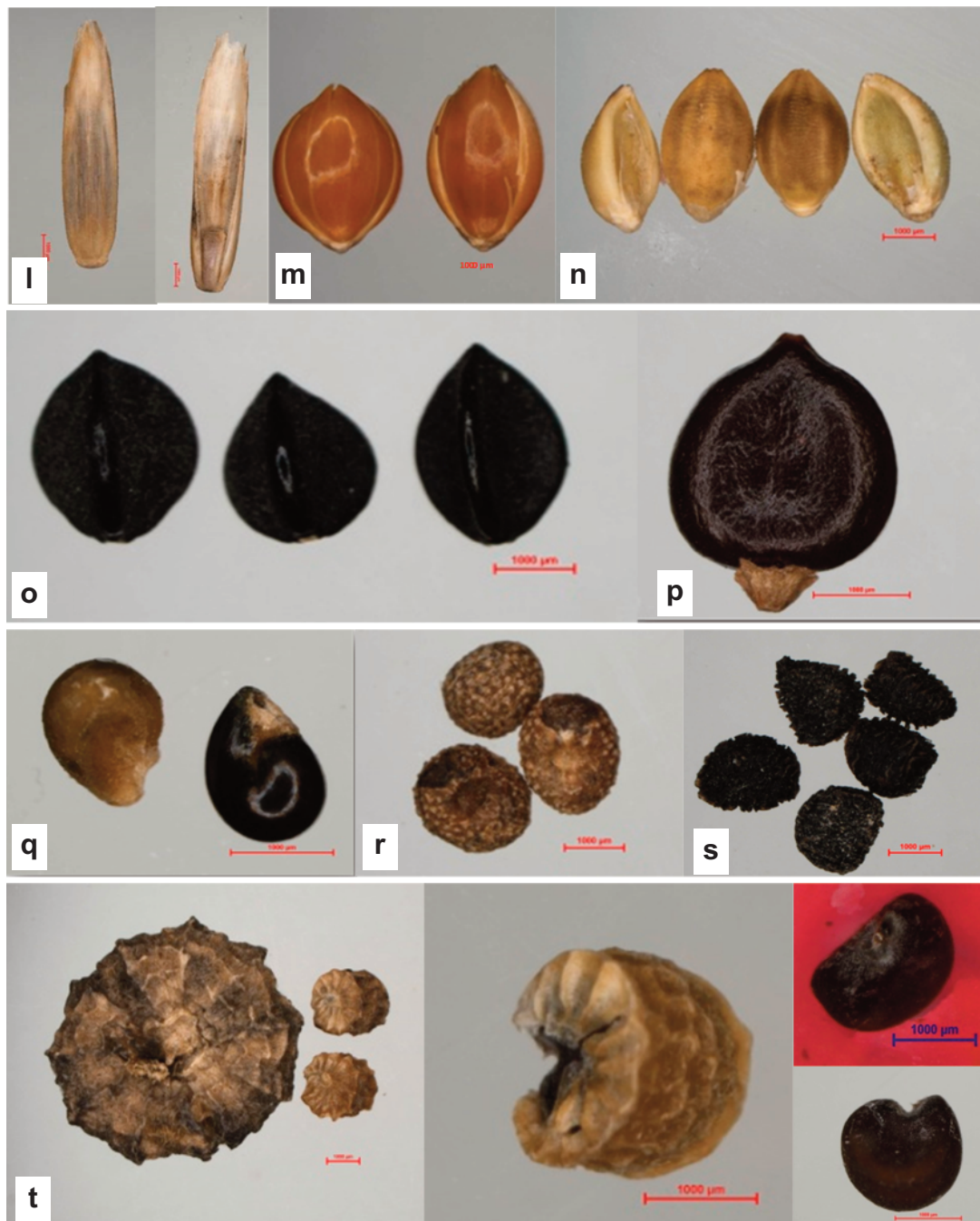
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Appendix 1. Picture of weed seed characteristics



Annotation: (a) *Chenopodium album*; (b) *Centaurea* sp.; (c) *Brassica campestris*; (d) *Lithospermum arvense*; (e) *Barbarea verna*; (f) *Thlaspi arvense*; (g) *Glacium flavum* (h) *Avena fatua*; (i) *Convolvulus arvensis*; (j) *Linum usitatissimum*; (k) *Echinochloa crusgalli* (lemma; palea; caryopsis adaxial; caropsis abaxial)

Appendix 1. (continued)



Annotations: (l) *Lolium rigidum*; (m) *Panicum miliaceum*; (n) *Setaria pumila*; (o) *Polygonum convolvulus*; (p) *Polygonum lapathifolium*; (q) *Reseda lutea*; (r) *Galium aparine*; (s) *Delphinium virescens*; (t) *Malva paviflora* (Pods/large capsule; individual capsule, upper-bottom seed/silica)