Table 2. Comparison of different methods of oxidation of plant material for elemental analysis (means of 11 plant materials)

Element	Dry-ashing	Nitric acid	Di-acid (3 : 1)	Di-acid (10 : 1)	C.D. (5%)
P (mg/kg)	2807	2922	2679	3024	230
K (mg/kg)	16083	16957	8662	15281	3192
Ca (mg/kg)	10133	10320	9463	10203	308
Mg (mg/kg)	3673	3862	3487	3789	168
S (mg/kg)	2283	3058	2943	3083	218
Na (mg/kg)	631	635	553	638	59
Zn (mg/kg)	46.5	48 4	46 1	49.0	2.4
Cu (mg/kg)	7 65	8 04	7.34	7 87	0.42
Fe (mg/kg)	307	318	286	297	N.S.
Mn (mg/kg)	116	120	108	121	8 8
B (mg/kg)	30 8	31 5	27 4	30 5	2.5
Al (mg/kg)	271	232	228	229	16 2
As (mg/kg)	4 58	6 26	5.62	6 16	1.01
Pb (mg/kg)	3.96	6 57	6.62	6.53	0 99
Cd (μg/kg)	197	217	243	252	36
Co (μg/kg)	1283	1336	1328	1373	N.S.
Nı (μg/kg)	947	1020	1003	1096	N.S.

digest solutions does not interfere in these techniques. The use of nitric acid alone will not only save the expensive perchloric acid but also minimize potential dangers as it is explosive and improve the estimates of different elements. Both dry-ashing and wet digestions with mixtures of nitric and perchloric acids were not suitable for oxidation of plant materials for simultaneous estimation of different elements.

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Introduction of *Puccinia polysora*, Polysora rust of maize in India

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The rust found on certain maize cultivars in Karnataka in 1991 has been determined to be *Puccinia polysora* Underw., Southern or Polysora rust – a rust which caused widespread devastation in many countries of Africa in the fifties. A description of the rust found in India is provided. It is clear that steps should be taken to limit its spread.

WHILE on a visit to Karnataka, there was an opportunity to assess the state of maize cultivation in the Tibetan refugee colonies in Mysore district. Maize was introduced in the southern parts of the state about three decades ago (post-1960 period). What the farmers grow are materials (hybrids/composites) released by the All India Coordinated Maize Improvement Project and no local cultivars are planted. For a long period, the double-cross hybrid, Deccan, dominated the scene. Hybrid Ganga-5, which is a double-top or three-way cross, began its appearance in 1968. However, sorghum downy mildew (*Peronosclerospora sorghi*, maize-sorghum strain) proved very destructive[1] and gave way to newer hybrids such as Deccan 101, Deccan 103 and Deccan 105 and more recently Ganga-11 (which possesses a high level of resistance to downy mildew). It is during the last five years or so that these materials have reached a sizeable proportion of farmers. Meanwhile, under the liberalized seed import policy, hybrids developed in private sector abroad began to be introduced under various tie-ups with indigenous seed companies or independently under the original brand names. Karnataka has a sizeable area under seed production programmes of both public and private sector companies. In this context, disease occurrence and incidence assumes greater significance than is the case where only commercial maize production is prevalent.

Of the three rusts that occur on maize, only the common rust (*Puccinia sorghi* Schw.) has been recorded from India[2]. Among the other two, viz *Physopella zeae* (Mains) Cumm. & Ramac. (Tropical Rust) and *Puccinia polysora* Underw. (Southern or Polysora Rust), the latter proved quite destructive in Africa in the fifties[3].

Maize cultivation was given a fillip by the Tibetan refugees settled in Karnataka, especially in the interior of Mysore district. The maize area in this part of the state amounts to as much as 14,000 ha. In the Kailashpura Colony near the town of Byelkuppa, in a field of a hybrid of a private sector seed company, a rust on foliage was observed. Subsequently, while visiting Arbhavi in Dharwad district, a similar rust was found on cv Prabha of maize. A study based on these two collections forms the subject of this communication. Since the rust has been determined to be Southern or Polysora rust, a complete description based on these collections, follows.

Puccinia polysora Underw., *Bull. Torrey bot. Cl.* 24:86, 1897.

Uredinia: mostly epiphyllous, gregarious, round to small, oblong or lenticular, non-coalescent, cinnamon-brown, without chlorosis in material from Kailashpura Colony but surrounded by chlorotic halos in Arbhavi material, 1.5–2.0 mm long and 1.0–1.5 mm broad; urediniospores ovate to ellipsoid (prolate/subprolate), length : breadth ratio 1:1.43 (Kailashpura material), 1:1.48 (Arbhavi material), yellowish to golden brown, wall hyaline, echinulate, up to 2.0 µm thick with 4 or 5 equatorial germ pores, 26–41 (44.5) × 18.5–30.0 µm.

Telia: like the uredinia in shape and size and developing in old uredinia, mostly epiphyllous, non-erumpent, somewhat agglutinate, separate, dark; teliospores two-celled, angularly obovoid, ellipsoid, clavate or irregular, short stubby type, brittle, with obtuse or truncate apex, slightly or moderately constricted at the septum, one-celled mesospores present, wall smooth, apically thickened up to 3.5 µm, pedicellate, 26.0–41.0 × 18.5–26.0 µm; pedicels yellowish brown, 11.0–44.0 µm.

On living leaves of *Zea mays* Linn., 'DDH hybrid'?, Kailashpura Tibetan Refugee Colony near Byelkuppa, Karnataka, September 1, 1991, Leg. M. M. Payak; cv Prabha, Arbhavi (Dharwad), September 27, 1991, Leg. M. M. Payak (HCIO nos. 40,831 and 40,830).

In uredinial and telial morphology, the rust closely resembles *P. polysora*. The scattered clustering of non-coalescent sori on the upper leaf surface is characteristic of this rust. The urediniospores have a slightly greater length:width ratio than occurs in the urediniospores of *P. sorghi*. The spores in Indian collections, however, appear to be somewhat larger than those found in African[4], American[5] or Taiwanese[6] materials. But they are nearer in length to those found in Mauritius material of the rust[3]. The apical thickening in the upper cell of teliospores is slightly greater than was reported in *P. polysora*. However, these are minor variations. Considering the major characters, the identity of the rust as *P. polysora* is clearly established.

The rust was earlier found in the Philippines, Taiwan and Thailand in Asia. However, the Indian sub-continent, which includes India, Pakistan, Nepal and Bangladesh, has so far been free of infection by this rust. As far as known, it has not been recorded from Sri Lanka either though it does occur in Madagascar, Reunion and further east in Mauritius in the Indian Ocean. In the east of the sub-continent, *P. polysora* is known from Thailand, but whether it is present in Burma (= Myanamar) is not known. It is not clear as to what probable route it might have followed to reach Karnataka in southern India. However, there is little doubt that close vigilance is required so that its further spread can be prevented and its potential for destruction may remain unrealized.

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