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EXOTIC GRASSES IN MAHARASHTRA STATE (INDIA): A CENSUS AND IMPLICATIONS

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ABSTRACT:

Exotic species are both ecologically and economically a growing problem worldwide. This communication is an attempt to prepare an up-to-date account of exotic grass flora of the state of Maharashtra (India). Total 74 grass species belonging to 43 genera of the family Poaceae have been investigated, of which 19 species are found under cultivation, while others run wild. The continents which share maximum exotic grasses are *viz*., Africa (29 species), America (25) species and Asia (Excl. India) (15 species). Interestingly, some ancestors of food grain crop species of modern period occur in this region. These are desired to utilise in crop improvement programme. Also, *Eragrostis tef* (Zuc.) Trotter, which is thought as a source of superfood grains can be brought under cultivation. Apart from nativity of exotic grass species, their ecological and economic impacts are discussed in brief. This is the first exclusive inventory of exotic grasses for the state of Maharashtra. Studies on invasion of exotic grasses in Indian agricultural land and need of the hour. Studies on invasion of exotic grasses in Indian agricultural land are need of the hour.

KEYWORDS: *Plant Invasion, Exotic Grasses, Nativity, Maharashtra.*

INTRODUCTION:

Graminae (Poaceae) is one of the largest family of seed plants. Members of this family are the most widely distributed and are in greater abundance than any other group of flowering plants. They inhabit marshes, deserts, prairies and woodlands, on sand, rock and fertile soil, besides alkaline or saline soils. They are found from tropics to the polar regions and from sea level to attitudes of perpetual snow. Thus they are distributed in various climates, soils and elevations on the surface of the globe. Their occurrence in every nook and corner obviously indicate their great ecological role. They are of greater importance economically also being the sources for fodder for domestic and wild animals, food and shelter for mankind, industrial uses and even as ornamentals. It is doubtless that without grasses not only human population but also the very survival of animals would seems to be obscured.

The grasses are specialised morphologically and advanced along many lines. They also acquired a terminology peculiar to themselves and hence their study is called 'agrostology'. Jain (1980) opined that 'the study of grasses has not attracted desired attention as the group is erroneously considered difficult for identification'. Even there is a general tendency to bypass grasses in floristic studies and teaching in tertiary education. Some exotic grasses, whether wild or cultigen, invaded foreign lands, but their exotic status is hardy mentioned in floristic accounts. The present author had made headway in exotic group of plants (Patil, 1990, 1995, 2017). It appeared that the grass species particularly are not earmarked carefully for their exotic status as far as Indian continent in ancient past and even in modern period (Patil, 2020a, 2021). The present paper communicates exotic grasses occurring in the state of Maharashtra (India) hitherto not limelighted.

METHODOLOGY:

Occurrence of grass species have been widely documented during pre-and-post independence period of India and have appeared in the form of regional, state and district floras by the scientists in Botanical Survey of India and research workers in universities and academic institutions. These were studied critically apart from literature on exotic flora in Indian territory. All these literary sources are enlisted in Table-1. Table-1 includes names of exotic plant species, their nativity along with literature consulted and their status (wild or cultigen).

RESULT AND DISCUSSION:

Floral Elements in India and Maharashtra:

Flowering plants constitute the main richest natural source and man's prime companion. India harbours one of the richest and most diverse flora. Singh *et al*. (2015) enumerated a total of 4381

taxa under 1007 genera and 176 families endemic to India, inclusive of Gymnosperms and Pteridophytes. So far, the state of our knowledge on the exotic vascular plants has yet remained scattered. The present author endeavoured to collate information on the exotic plants with particular emphasis on angiosperms especially in the state of Maharashtra (India). Singh *et al*. (2000) informed a total of 3869 species of angiosperms, inclusive of 844 cultivated ones in Maharashtra state. The family Poaceae (Graminae) is pointed out as the largest family in the state with a total of 373 species (including infraspecific taxa) belonging to 104 genera (Singh *et al*., *loc.cit*.).

Floristic Composition of Exotic Grasses in Maharashtra:

Indigenous flora of Maharashtra state have been subjected to alteration due to the deliberate and incidental introduction of exotic species from various parts of the world (Patil, 1990, 1995, 2017; Kshirsagar and Patil, 2002). The present attempt revealed as many as 74 species belonging 43 genera of exotic grasses, inclusive of cultivated ones. The largest exotic genus is *viz*., *Penninsetum* (05 species), others in descending order are *Paspalum* and *Setaria* (04 species each), and *Chloris*, *Cymbopogon*, *Digitaris*, *Echinochloa*, *Eragrostis* and *Panicum* (03 species each). Another 33 genera contributed for just 01 or 02 species in this state. Of these, 54 species run wild in the state, whereas other 19 species of grasses are found under cultivation.

Nativity of Exotic Grasses:

Origin-wise status of exotic species is tabulated in the Table-1. These exotics are hailed from various parts of New and Old Worlds. Maximum number of exotics belong to Africa (29 species), various parts of the American continent (25 species) and different parts of Asia (exclusive of India) (15 species). Five species have invaded from Europe also. The exotic species also invaded from other nearby and distant countries or geographical regions such as China (03), Mediterranean region (02), Fertile Crescent (01), Ceylon (Si Lanka) (02), Malaya (01), Myanmar (01), Indonesia (02), Java (01), Eurasia (02), West Indies (01), Austro-Asian (01), Afro-Asian (03), Ethiopia (01), Abyssynia (01) and Australia (02), etc.

Geographical Influence:

Human influence either internationally (for cultivated species) or unintentionally (weeds naturalised) has subjected to alteration of indigenous flora of the state of Maharashtra. The trade and communication by human societies are rather obvious amongst the countries of the Old World in past. However, the distant American continent (New World) which has been said to have discovered only after Columbian period, also considerably contributed (15 out total 57 species) to this part of Indian subcontinent. Their ways and means of introduction, naturalisation, domestication, migration

and dissemination need further critical studies. The dominance of American exotic floral elements is also demonstrated earlier (c*f*. Patil, 2017; Nagi and Hajra, 2007; Sharma *et al*., 2005).

Cultigens As Exotic Weeds:

A fair number of exotic grass species (19 species) are found under cultivation in the Maharashtra State. These are obviously intentional introductions for food, shelter and other miscellaneous human daily needs. However, it is worth to note few wild exotic grass taxa such as *Echinochloa crus-galli*, *E. colonu* and *Eragrostis tef*. These are the grasses yielding small-seeded edible grains generally termed as 'millets'. These are being cultivated in some parts of the world. Interestingly, *Eragrostic tef*, commonly called 'Teff' or 'Lovegrass', once a food grain source of poor people, is now being considered and utilised as 'superfood grains' because of its nutritionally important nutraceuticals. It is now one of the most nutritious alternative grains as it offers a rich source of calcium, protein and antioxidants (Patil, 2019). It can be brought under cultivation in the agricultural zone of Maharashtra. It is simply reported as 'introduced' at Bombay by Sharma *et al*., (1996). Other species of the genus *Echinochloa viz*., *E.frumantacea* Link, called 'Barnyard Millet' is being cultivated on minor scale in Japan and India (called 'Barti'). The weedy species *viz*., *Echinochloa crus-galli* and *E.colonum* are regarded its ancestors (Patil, 2019). It is, therefore, worth to try these species in the improvement programme of Barnyard millet itself.

Impact:

Some of these exotic weedy grasses have ecological and economic impacts. They have potential to alter ecosystem structure and function. Some grass species cultivated in other regions or in this region also behave as weeds and cause interference in agricultural activities e.g. *Setaria viridis*, *Paspalum scrobiculatum*, etc. Introduction of new species decrease the ecosystem process (Sala *et al*., 1996) and can lead to deleterious effects. The state of Maharashtra still needs a complete inventory of exotic plants. The next step of investigation like ecological impact can be them extended. Thus this region of India is far from serious studies on the abundance and impact of exotics. Secondly, the economic impact especially of invasive exotic species are direct and indirect (Bigsby and Whyte, 2001). The former reflects the effect of the invader and the latter implies general effects that are caused by the occurrence of invader. Economic impacts can be on production, price and markets, trade, food security and nutrition, health and environment, etc. In a nutshell, public awareness and concern for the development of sustainable system of land use hand-in-hand awareness of effects about invasive exotic species on the system should be promoted for the well-being of mankind.

Archaeobotanical Evidence:

Out of total 74 exotic grass species, 19 species are being cultivated for food and fodder. This warrants their intentional introduction on Indian landmass. Their period of introduction can not be exactly inferred. However, Patil (2020a) highlighted occurrence of some of the useful grasses in Indian territory unearthed from various archaeological sites e.g. *Avena sativa, Cymbopogon martinii, Echinochloa crus-galli, Echinochloa colona, Eleusine coracana, Panicum miliaceum, Paspalum scrobiculatum, Pennisetum americanum, Sorghum bicolor, Triticum aestivum, Zea mays*, etc. Study of on their period may be deciphered (approximately) by further scientific investigation on archaeological remains in the forms of seeds, floral parts or plant remains.

Dispersal of Grasses:

However, majority of exotic grasses are wild, naturalised and became an integral part of Indian biodiversity. Probably, these are brought in India negligently along with the propagules or seeds of cultivated grass species. There is also another possibility by natural dispersal. The seeds of grasses are generally fairly small and light and can be easily carried with the air currents from place to place or country to country or even continent to continent. Even the dry propagules contained in inflorescences can be lifted up and migrate eventually. Grasses, in general, have adapted better for natural dispersal. Plants are dispersed by as many as 24 different methods in nature (Patil, 2020b). A new classification of plant dispersal has been put forth by Sadlo *et al*., (2018) which categorises them into total nine types. Of the species included in this contribution, Phragmites type is mentioned in this new classification which runs as "Phragnites Type: Anemochory, Hydrochory, Autochory, Endozoochory, Epizoochory". Thus a single plant species is dispersed involving different methods of dispersal in nature. Other grass species obviously need investigations in this realm of science on the line of this new categorisation of plant dispersal by Sadlo *et al*. (*loc.cit*.).

CONCLUSION:

There are always weeds with man. Mankind started agriculture and invaded newer areas with newer crops for his easy sustenance. Weeds developed mostly simultaneously with agricultural activities. The grasses are almost omnipresent and have minute seeds or florets. They are dispersed with air-currents or storms (Patil, 2020b, 2021). Cultivated plants are carried mostly with some soil with the roots which also contain grass seeds. This is how exotic grasses moved from one place to another. Present author particularly noticed some exotic grasses (*) in cultivated fields. As many as 21 species belong 16 genera are found generally in agricultural fields (c*f*. Patunkar, 1980; Naik, 1998; Sen, 1981). Studies especially on invasion of grass species exclusively in agricultural lands are mostly wanting in India (Sen, 1981). These are expected to pay more attention from economic point view.

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Table-1: Exotic floral elements of Poaceae

Sr. No.	Plant Species	Native Region/ Country	Status	
			Wild (W)	Cultigen (C)
1.	**Aristida adscencianis* L.	North Africa Maheshwari & Paul, 1975	W	--
2.	**Arthraxon lancifolius* Hochst.	Africa Reshi, 1984.	W	--
3.	*Arundo donax* L.	Africa & Europe Steward, 1972.	W	--
4.	*Avena sativa* L.	Mediterranean Region, Ethiopia, Abyssinia Patil, 2019.		
5.	*Axonopus compressus* (Swartz.) P. Beauv.	Tropical South America Mohanan & Sivadasan, 2002. South America Garg, 2018-2019.	--	C
6.	*Bambusa vulgaris* Schrad.	Java, Tropical East & West Indies, Africa, Central & South America Graf, 1980. Ceylon (Sri Lanka) John, 1891.	--	C
7.	*Bothriochloa pertusa* A. Camus	Asia (Excl. India) & Africa Reshi, 1984.	W	--
8.	*Brachiaria mutica* (Forssk.) Stapf	Africa Dogra *et al*., 2010. Tropical Africa & America Panda & Das, 2004.	W	--
9.	*Capillipedium parviflorus* Stapf	Asia (Excl. India) & Australia Stewart, 1972.	W	--
10.	**Cenchrus ciliaris* L.	Tropical Africa Sheikh & Dixit, 2017.	W	--
11.	**Chloris barbata* Sw.	Tropical Africa Rajagopal & Panigrahi, 1965; Chandra Sekar, 2012. Tropical America Beena Kumari *et al*., 2016.	W	--
12.	*Chloris gayana* Kunth ex Stapf	Africa Stewart, 1972.	W	--
13.	**Chloris virgata* Sup.	Tropical America Naik, 1998. America Kotresh & Siddeshwari, 2020.	W	--
14.	*Coix lacryma-jobi* L.	Tropical Asia Singh *et al*., 2015.	W	--
15.	*Cymbopogon citratus* (DC.) Stapf	Malesia or Ceylon Purseglove, 1968. South Asia, South-East Asia & Australia Singh *et al*., 2015.	--	C

Sr. No.	Plant Species	Native Region/ Country	Status	
			Wild (W)	Cultigen (C)
16.	*Cymbopogon martinii* (Roxb.) Wats.	Afro-Asian Naik, 1998. Africa Yadav & Sardesai, 2002.	W	--
17.	*Cymbopogon winterianus* Jowitt	Indonesia Katiyar *et al*., 2011.	--	C
18.	*Cynodon barberi* Rang. & Tad.	Tropical America Sainkhediya, 2016.	W	--
19.	**Cynodon dactylon* (L.) Pers.	Tropical Africa Debnath & Debnath, 2017; Srivastava, 2014; Wagh & Jain, 2015; Panda *et al*., 2018.	W	--
20.	**Dactyloctenium aegypticum* (Linn.) P.Beauv.	Warner Regions of Old World. (Introduced in India) Bhandari, 1978.	W	--
21.	*Dactylotenium australe* Steud.	South Africa Singh *et al*., 2001.	--	C
22.	*Dendrocalamus giganteus* Munro.	Malaya Graf, 1980. Southern Myanmar & North-Western Thailand Singh *et al*., 2015	--	C
23.	*Dendrocalamus strictus* Nees	Myanmar Negi & Hajra, 2007.	W	--
24.	*Dichanthium foveolatum* (Del.) Roberty (Syn.*Eremopogon foveolatus* Stapf)	Afro-Asian Naik, 1998.	W	--
25.	**Digitaria adscendens* (H.B.&K.) Hern.	Asia (Excl. India) & Africa Stewart, 1972.	W	--
	[Syn.**D. ciliaris* (Retz.) Koel.]	Probably North Africa Rajagopal & Panigrahi, 1965	W	--
26.	*Digitaria longiflora* (Retz.) Pers.	Africa Kaul, 1986.	W	--
27.	*Dimeria connivens* Hack.	Australia Naik, 1998.	W	--
28.	**Dinebra retroflexa* (Vahl.) Panz.	Tropical South America Reddy, 2008; Patil, 2017; Chandra Sekar, 2012.	W	--
29.	**Echinochloa colona* (L.) Link	Europe Stewart, 1972. Tropical America Debnath & Debnath, 2017. South America Veerasamy & Arumugan, 2014; Panda *et al*., 2018; Srivastava *et al*., 2014.	W	--

Sr. No.	Plant Species	Native Region/ Country	Status	
			Wild (W)	Cultigen (C)
30.	**Echinochloa crus-galli* (L.) Beauv.	Tropical South America Reddy, 2008; Chandra Sekar, 2012; Debnath & Debnath, 2017. South America Panda *et al*., 2018; Srivastava *et al*., 2014; Asia (Excl. India) Kaul, 1986.	W	--
31.	**Echinochloa stagnina* (Retz.) Beauv.	Tropical America Sainkhediya, 2016.	W	--
32.	*Eleusine coracana* Gaertn.	Africa Singh & Nigam, 2017. Tropical Africa Gaikwad & Garad, 2015.	--	C
33.	**Eleusine indica* (L.) Gaertn.	Africa, Temperate & Tropical Asia USDA-ARS, 2014.	W	--
34.	**Eragrostis poaeoides* P. Beauv.	Asia (Excl. India) & Africa Reshi, 1984.	W	--
35.	*Eragrostis tef*. (Zucc.) Trotter	Ethiopia Seytu, 1997; Patil, 2019.	--	C
36.	**Eragrotis pilosa* P. Beauv.	Africa Kaul, 1986.	W	--
37.	*Erianthus ravennae* P. Beauv.	Europe Stewart, 1972.	W	--
38.	*Hordeum vulgare* L.	Europe & North America Dar *et al*., 2002.	--	C
39.	**Imperata cylindrica* (L.) Racuscha.	Tropical America Reddy, 2008; Debnath & Debnath, 2017. Chandra Seker, 2012; Wagh & Jain, 2018. Asia (Excl.India & Europe) Kaul, 1986.	W	--
40.	*Iseilema laxum* Hack.	Tropical America Naik, 1998.	W	--
41.	**Lolium temulentum* L.	Europe Kaul, 1986. Mediterranean Region Qureshi *et al*., 2014.	W	--
42.	*Oryza sativa* L.	Asia (Excl. India) Stewart, 1972.	--	C
43.	**Panicum antidotale* Retz.	China Sainkhediya, 2016.	W	--
44.	*Panicum maximum* Jacq.	Tropical Africa to Subtropics of South Africa Dogra *et al*., 2010; Maheshwari & Paul, 1975.	W	--

Sr. No.	Plant Species	Native Region/ Country	Status	
			Wild (W)	Cultigen (C)
45.	*Panicum miliaceum* L.	Asia (Excl. India) Kaul, 1986. Transcaucasia & China Singh & Nigam, 2017.	--	C
46.	*Paspalidium geminatum* (Forssk.) Stapf	Africa, North-South America & Asia (Excl.India) Kaur *et al*., 2014.	W	--
47.	*Paspalum dilatatum* Poir.	Tropical America Negi & Hajra, 2007.	W	--
48.	*Paspalum paspaloides* Scribner	North America Stewart, 1972.	W	--
49.	**Paspalum scrobiculatum* L.	Tropical Africa Singh & Nigam, 2017.	W	--
50.	*Paspalum vaginatum* Swartz.	North America Kohli *et al*., 2012.	W	--
51.	*Pennisetum americanum* (L.) K. Schum. (Syn. *P.glacum* R.Br.)	Tropical America Gaikwad & Garad, 2015. Sahel-Africa Singh & Nigam, 2017. Tropical Africa Purseglove, 1972. Central Tropical America Naik, 1998.	--	C
52.	*Pennisetum orientale* Rich.	Asia (Excl. India) & Africa Kaul, 1986	W	--
53.	*Pennisetum pedicellatum* Trin.	Tropical America Sainkhediya, 2016.	W	--
54.	*Pennisetum polystachyon* (L.) Schult.	Tropical Africa Debnath & Debnath, 2017.	W	--
55.	*Pennisetum purpureum* Schum.	Tropical America Reddy, 2008; Patil, 2017; Chandra Sekar, 2012; Garg, 2018-2019. Sub-Saharan Africa Negawo *et al*., 2017.	W	--
56.	*Phularis minor* Retz.	Europe Qureshi et al., 2014. America Sainkhedia, 2016.	W	--
57.	*Pharagmites vallatoria* (Pluk. ex L.) Veldk.	Africa Qureshi *et al*., 2014. North America Garg, 2018-2019.	W	--
58.	*Polypogon monspeliensis* Desf.	Europe Kaul, 1986.	W	--
59.	*Rhynchelytrum repens* (Willd.) C.E. Hubb.	Tropical America Reddy, 2008.	W	--

Sr. No.	Plant Species	Native Region/ Country	Status	
			Wild (W)	Cultigen (C)
60.	**Saccharum spontaneum* L.	Tropical West Asia Reddy, 2008; Chandra Sekar, 2012; Patil, 2017.	W	--
61.	*Setaria italica* Beauv.	Near East (China) Singh & Nigam, 2017.	--	C
62.	*Setaria paniculifera* (Steud.) Fourn. ex Hemsl.	Tropical America Sharma *et al*., 1996.	W	--
63.	*Setaria pumila* (Poir.) Roem. ex Schult.	Eurasia Naik, 1998. Asia (Excl. India) & Africa Steward, 1972.	W	--
64.	*Setaria viridis* P. Beauv.	Asia (Excl. India) & Africa Kaul, 1986. Tropical America Sheikh & Dixit, 2017.	--	C
65.	*Sorghum bicolor* (L.) Moench.	North-Eastern Quadrant of Africa / Ethiopia Singh & Nigam, 2017.	--	C
66.	*Sorghum controversum* (Steud.) Snowden	Africa Naik, 1998.	W	--
67.	*Sorghum halepense* (L.) Pers. (Syn.S.halepensis L.)	Mediterranean Region & North Africa Dogra *et al*., 2010. Tropical America Bor, 1973; Rajagopal & Panigrahi, 1965. Europe Kaul, 1986.	W	--
68.	*Sorghum nitidum* Pers.	Asia (Excl. India) & Australia Kaul, 1986.	W	--
69.	*Sporobolus capillaris* Miq.	Australia Sainkhediya, 2016.	W	--
70.	*Sporobolus indicus* (L.) R.Br. [Syn.*S.diander* (R.Br.) Beauv.]	Austro-Asian Naik, 1998.	W	--
71.	*Triticum aestivum* L.	Fertile Crescent Singh & Nigam, 2017.	--	C
72.	*Triticum durum* Desf.	Mediterranean Region & South-West Asia Singh & Nigam, 2017.	--	C
73.	*Zea mays* L.	Central America Purseglove, 1972; Backer & Brink, 1968. South America Stewart, 1972.	--	C

***** Weeds in cultivated fields.