



Appearance of new weeds in Punjab

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ABSTRACT

Weed monitoring and survey was conducted to detect appearance of new weed species during decade of 2008-2017. Ten new weed species namely *Galium spurium* Linn. (family Rubiaceae), *Geranium nepalense* Sweet (family Geraniaceae), *Lamium amplexicaule* Linn. (family Lamiaceae), *Evolvulus nummularius* (family Convolvulaceae), *Euphorbia thymifolia* Linn. (family Euphorbiaceae), *Oenothera laciniata* Hill (family Onagraceae), *Soliva anthemifolia* (Juss.) R. Brown (family Asteraceae), *Verbesina encelioides* (Cav.) Benth. and Hook. f. ex A. Gray (family Asteraceae), *Nicotiana plumbaginifolia* Viv. (family Solanaceae) and *Portulaca oleracea* L. (family Portulacaceae) have been recorded in the last decade from different places of Punjab State. Out of these, weed species namely, *O. laciniata*, *L. amplexicaule*, *S. anthemifolia* and *G. nepalense* were mainly observed inhabiting the crop fields. Three weed species namely, *G. spurium*, *N. plumbaginifolia* and *V. encelioides* were observed growing along roadsides, wastelands, canal banks and uncultivated areas. *P. oleracea* and *E. thymifolia* were observed growing on bunds of agricultural fields. *E. nummularius* is a serious weed of lawns and landscapes. These weeds have now domesticated in the studied ecological niche and may potentially harm the biodiversity of those areas.

INTRODUCTION

Punjab is a state in North-West region of India at latitude of 28°17' to 32°17' N and longitude of 74°04' to 77°06' E covering 50,362 square kilometer of area with 22 districts. Most of the Punjab lies in a fertile, alluvial plain with many rivers and an extensive irrigation canal system. Agriculture is the largest industry forms the backbone of the state economy. It is the leading producer of wheat (19.5%) and rice (11%), thereby contributing to the national food security (GOI 2017). It has earned the sobriquet of “Granary of India” or “India’s bread-basket”.

Weeds are more harmful pests of field crops as compared to other crop pests (insects, fungi, rodents, storage pests etc.) as far as their losses to crop produce are concerned. Weeds compete with the crop for limited resources and may also serve as alternate hosts for various insect and disease pests. Weeds are classified into annuals, biennials and perennials based on life cycle, and into grasses, sedges and broadleaved weeds based on their leaf morphology. The weed species found in the field generally reflect the history of agricultural activities in that field. Weeds are genetically diverse and can

readily take advantage of the variety of conditions created by any crop production system. Weedy and invasive species can easily adapt to changes in production practices in order to take advantage of the available niches as invasive weeds have phenotypic plasticity to suit the changing weather conditions. These plants have all the characteristics of the ‘pioneer plants’, the first to inhabit any new place. Invasive weeds are inclined to occupy the habitats with much rapidity in areas where same ecological demands are being fulfilled. Eventually, invasive weeds may displace the local flora to gain the foothold in local landscape ecology.

Invasive alien weeds are those plant species that are intentionally or unintentionally introduced to a location, area, or region where it does not occur naturally, and has established and spread or has the potential to do so, and which then threatens ecosystems, habitats and/or other species, potentially causing economic and/or environmental damage, or harm to human health. In the treaty of Convention of Biological Diversity, invasive alien weeds have been identified as the second worst threat (CBD 1992). Surveys help in predicting areas potentially subject to

weed invasion, understanding the biology of the invasion process and determining means by which weeds spread and to develop, implement and evaluate weed management plans, assess the economic impact of weed invasion and increase public awareness, education and weed management efforts. Weed monitoring provides information to tailor weed management efforts that reduce the impact of the weeds with greatest potential impact. In Punjab, this survey and surveillance study was planned to see the extent of distribution of new invasive alien weeds during decade of 2008-2017.

MATERIALS AND METHODS

The primary objective of weed surveying and mapping was to accurately identify and delineate land with populations of undesired plants. Weed monitoring involves repetitive surveys to track weed populations over time and appearance of new weed to that area is reported. A standardized system of weed surveying and mapping is followed to provide consistently reliable information that can be compared from year to year (McIntosh 1962). These surveys were conducted over the span of ten years during 2008 to 2018 in both, winter and rainy seasons to check for any new weed infesting the crop fields, waste lands, canal banks and roadside areas. Stoppage was made at 10 km and the caution was taken that survey spot was not near to any building or permanent structure. Invasion of new weed species, new emerging weed problem, shift in weed flora and reduced efficacy of used herbicide was specifically noted. The observation about growing habit and life

cycle of weed was noted and possible source of entry was also looked into. Weed survey was made every season for appearance of any new weed (s) and surveillance was done after five year of its first appearance at the designated GPS locations, and in this study, occurrence of new weeds has been reported.

RESULTS AND DISCUSSION

This is the first report of ten new broadleaf weed species (**Table 1**) recorded in the last decade from different places of Punjab State. Out of these, two species belonged to the advance dicotyledonous family, Asteraceae, and rests belonged to Rubiaceae, Geraniaceae, Lamiaceae, Portulacaceae, Convolvulaceae, Solanaceae, Euphorbiaceae and Onagraceae. All these weeds are potential invader in different parts of the world, hence, their introduction and subsequent naturalization in Punjab soil is found to be of great concern. The salient characteristics, distribution and control measures of these new weeds are as under:

***Galium spurium* Linn. (Rubiaceae):** It was observed for the first time in and around wheat fields of Ludhiana and Shaheed Bhagat Singh Nagar districts during winter season of 2014-15. Its common names include ‘False Cleavers’ and ‘Sticky Willy’. It is an annual procumbent herb, 30-50 cm high and with quadrangular stem. Leaves are narrowly oblong-lanceolate, up to 4 cm long, arranged in whorls of 4-8, sessile. Flowers are minute, 1-3 mm in diameter, yellowish green or

Table 1. Characteristics of new weeds observed in Punjab state in last decade

Weed species, Family	GPS Location of first observation	Occurrence	Season	Name of the domesticated location at present
<i>Galium spurium</i> Linn. RUBIACEAE	30°55'-30°57' N & 75°54'-76°32' E	Wheat fields and uncultivated areas	Winter Annual	Ludhiana and Shaheed Bhagat Singh Nagar districts
<i>Geranium nepalense</i> Sweet GERANIACEAE	30°55' N & 75°54' E	Rabi crop fields	Perennial	Ludhiana
<i>Lamium amplexicaule</i> Linn. LAMIACEAE	32°17' N & 75°42' E	Wheat fields	Winter Annual	Pathankot submontane areas
<i>Oenothera laciniata</i> Hill ONAGRACEAE	30°55' N & 75°54' E	Crop fields and wastelands	Annual or short- lived perennial	PAU, Ludhiana
<i>Soliva anthemifolia</i> (Juss.) R. Brown ASTERACEAE	30°55' N & 75°54' E	Wheat fields and lawns	Winter Annual	PAU, Ludhiana
<i>Verbesina encelioides</i> (Cav.) Benth. & Hook.f. ex A.Gray ASTERACEAE	30°55' - 31°12' N & 74°04' -77°06' E	Uncultivated areas, canal banks, roadsides	Annual	South-west Punjab
<i>Euphorbia thymifolia</i> EUPHORBIACEAE	31°23'N & 75°25' E	Paddy and vegetable fields	Annuals	Whole Punjab state
<i>Evolvulus nummularius</i> CONVOLVULACEAE	30°55'N & 75°54' E	Lawns	Annuals	PAU, Ludhiana
<i>Nicotiana plumbaginifolia</i> SOLANACEAE	30°55'N & 75°54' E	Uncultivated areas, canal banks, roadsides	Annuals	PAU, Ludhiana
<i>Portulaca oleracea</i> L. PORTULACACEAE	31°23'N & 75°25' E	Paddy and vegetable fields	Summer Annual	Whole Punjab state

white, arranged in terminal or axillary cymes. Fruits are capsular, hairy or glabrous, broadly reniform, and 1-3mm in diameter.

This plant is known to be cultivated at higher altitudes as ornamental herb in India; however, it has started naturalization at Ludhiana during last 3-4 years, indicating its transformation to a probable invasive weed in near future starting from the land of Punjab. It is a serious weed in western Canada, where 20% reduction in canola crop yield was reported by 100 plants/m² (Zhang and Bailey 2000). In addition, some populations of false cleavers have shown high resistance to imazethapyr (resistance factors greater than 100) and florasulam, both ALS inhibitors, but these populations were found to be susceptible to fluoxypry, a synthetic auxin (Beckie *et al.* 2012).

***Geranium nepalense* Sweet (Geraniaceae):** It is an erect and branched herb and was observed since winter 2008-09 at Ludhiana. A native of Himalayas distributed from Nepal and Bhutan to Sikkim, Arunachal Pradesh and Meghalaya towards North East, and Kashmir towards western India; however, in Nilgiris and Western Ghat, the species is cultivated. Beyond India, its distribution is extended to Afghanistan, Pakistan, China, Myanmar, Thailand, Indonesia and Sri Lanka. The usual distribution range of 'Nepal Geranium' is in between 1500 to 2900m altitudes. This species of *Geranium* is a perennial herb with vertical rootstocks, diffusely decumbent-ascending herb, 30-70 cm high, sometimes rotting at nodes. Leaves are palmately cleft into 5-7 lobes, opposite, petiolate and stipulate; segments are further cut into 6-12 lobes. The flowering occurred from April to September. Flowers are small, white with 5 spreading petals and have violet lines towards the base.

***Lamium amplexicaule* Linn. (Lamiaceae):** It was observed for the first time in and around rainfed wheat fields during winter season 2014-15 in sub-montaneous area of Pathankot. It is commonly known as 'Henbit Dead-nettle', 'Common Henbit', or 'Greater Henbit' and is a winter annual, herbaceous and broadleaved weed with quadrangular stem, usually hairy throughout, about 30cm high. It possesses opposite, rounded leaves with lobed margins which grasp the stem, however, its lower leaves are petioled and not associated with the flower. Flowers are bilabiate, purple or purple-red. Broadleaf herbicides namely metsulfuron at 4 g/ha, carfentrazone at 20 g/ha, premix of carfentrazone plus metsulfuron at 25g/ha gave excellent control of this weed in wheat fields (personal experience). A native of Europe and Temperate Asia, and taxonomically a variable taxon (Mennema 1989); introduced in to USA, Canada and South Africa as invasive weed,

especially in the croplands. In India the plant is known to occur in Sikkim at 2740 to 4270 m altitude (SMPB 2017) to Jammu & Kashmir.

***Oenothera laciniata* Hill (Onagraceae):** This weed was observed in wheat, spring maize, vegetables and *Brassica* fields in Research farm of Punjab Agricultural University, Ludhiana during late winters since 2008. Recently, it has started appearing in both cultivated and uncultivated lands starting from November-December and is one of the major summer weeds. It set small, dark-brown seeds abundant in early summer (April-May). This weed was found associating with some other rosette forming species *viz.* *Tribulus terrestris* and *Coronopus didymus* and few other weeds such as *Amaranthus viridis*, *Chenopodium album*, *Heliotropium eichwaldii* etc. in loose-textured sandy-clayey soil. Ploughing leads to elimination of plants unlike most other co-occurring weeds. This weed warrants attention for its potential for further spread as a weed of *rabi* and spring crops in the Indian region. The outbreak of Onagracean species belonging to *Ludwigia* genus as serious weed in India is also very recent (Barua 2010, Barua *et al.* 2017). It is an important alien invasive species whose occurrence (Khan *et al.* 1984, Sasidharan 2004) and spread must be monitored within the Indian region, taking into consideration, its wide global distribution and potential for spread as a crop contaminant, persistence in the soil seed bank and the high genetic diversity reported in the species (Ellstrand and Levin 1982).

O. laciniata is an erect or semi-erect annual or short-lived perennial, commonly known as "Ragged Evening Primrose" or "Cutleaf Eveningprimrose", a native of Northern America. The distribution range of the species included the islands of Hawaii to Japan, Taiwan and coastal China and Korea across the Pacific Ocean and Libya, France, Greece and some other regions of Europe and Africa around the Mediterranean Sea extending to Iran. In India the plant was first reported from Bijnor district of Uttar Pradesh by Khan *et al.* (1984), in Idukki district of Kerala by Sasidharan (2004) and during 2008 to 2010, it spread to the Agricultural fields of Delhi and Ludhiana (Nayar *et al.* 2012). In many parts of the world it is known for its invasiveness and potentially harmful nature, especially in cotton fields of USA (Culpepper *et al.* 2005) and pastures, as it is resistance to Glyphosate and responsible for deterioration of habitat quality (Montgomery *et al.* 2012).

***Soliva anthemifolia* (Juss.) R. Brown (Asteraceae):** It was observed for the first time in and around wheat fields during winter season 2008-

09 at Ludhiana. In Punjab, the species appeared as a winter annual infesting low growing thin lawns as well as wheat fields. *S. anthemifolia*, commonly known as 'Lawn Burweed', is an annual low herb, but stoloniferous, and with spreading stolons, it develops dense tufts. The diameter of the tufts varied from 10 to 30 cm. It has opposite, sparsely hairy leaves that are twice divided into narrow segments or lobes. It remains small and inconspicuous during the cold winter months and in the early spring, it undergoes rapid vegetative growth. Interestingly there is no pappus in this Asteracean species in the cypselae; instead the collar region possesses numerous white hairs. However, the persistent spinescent style helped the 2.8-3.0 mm long wingless cypselae to catch in footwear and cloths as well as puncture the skin.

In India, *Soliva anthemifolia* was first reported from Northern district of Uttar Pradesh in 1963 (Bhattacharya 1963), then spread to Delhi (1973) via Dehra Dun (1966), Jammu (1981), Himachal Pradesh (2009), Eastern India (2011), Maharashtra (2016) and Chattishgarh (Shukla, 2017). The present report is the first record of this species in Punjab.

***Verbesina encelioides* (Cav.) Benth. and Hook.f. ex A. Gray (Asteraceae):** This plant is commonly known as 'Golden Crownbeard' or 'Wild Sunflower', and is believed to be a native of United States and Mexico. It is a 30-60 cm tall broadleaved herb, minutely hairy throughout and produces flower heads of 2-5 cm diameter on long peduncles with golden yellow ray and orange yellow disc florets. It is often cultivated as garden plant in some places of India. Golden crownbeard was observed escaped in and around Rajasthan (India Biodiversity 2017) and believed to be migrated to Punjab or introduced from Rajasthan state along with land-fill and sand meant for road constructions. In Punjab climate, it is naturalized, found growing along roadsides, canal banks and vacant places and started replacing the resident plant species. The survey was conducted at different places of Punjab since August 2015 to study the occurrence of this weed and this weed was found profusely growing in South-west Punjab (Ferozepur, Fazilka, Bathinda, Barnala and Sangrur districts) and it was not recorded in Pathankot, Hoshiarpur, Jalandhar and Kapurthala districts till reporting of this study. Golden Crownbeard was found infested with mealy bug and yellow mosaic virus at few locations. Studies also revealed that *V. encelioides* possessed a toxic compound Galegine, which caused poisoning in livestock from ingestion of this plant including dullness and anorexia (Jain *et al.* 2008)

Kaul and Mangal (1987) studied the phenology and ecology of this weed and found that this weed

exhibits rapid seedling, vegetative and reproductive growth. Seed germination found to be occurred in varying soils except in gravel and significantly suppressed under drought and waterlogged conditions. Seedling emergence was the highest from surface-sown seeds and least in those sown at 2.5-cm soil depth, beyond which no emergence occurred. High phenotypic plasticity, ecological variability, phenological diversity, seed germination in varied soils and under diverse moisture regimes, quick seedling growth and subsequent establishment, coupled with versatile breeding system, contribute to the successful growth, propagation, and spread of this species in India. The species responds strongly to disturbances on suitable sites and retards the development of other local species. Research has identified its allelopathic effect on radishes (Inderjit *et al.* 1999) which may explain its ability to dominate other species in some locations. Bentazon and 2,4-DB alone provided e" 90% control of *Verbesina encelioides* while acifluorfen at 0.42 kg/ha and pyridate resulted in e" 80% control in groundnut at Texas (Grichar and Sestak 1998). Study conducted at Punjab also revealed that glyphosate at 1%, paraquat at 0.5% and 2,4-D ethyl ester at 0.25% gave excellent control of this weed in non-cropped areas (personal experience).

***Evolvulus nummularius*:** It is an invasive alien weed, native of tropical America. It was first observed and identified in 2009, growing profusely in poorly maintained lawns of Punjab Agricultural University, Ludhiana. The growth starts in spring season and remains green up to November-December. It is a perennial, low growing, slender broadleaved weed. Its methanol extract has been found to have antibacterial and antioxidant activity (Pavithra *et al.* 2009).

***Nicotiana plumbaginifolia*:** It was observed for the first time in and around wheat fields during Rabi 2014-15 at Punjab Agricultural University, Ludhiana. It is a species of tobacco plant and the species epithet, "*plumbaginifolia*", is from the leaves which bear similarity to those of the genus *Plumbago*. It is a flowering annual herb and can grow up to 1 meter tall. The species has small, white, 5-petal flowers that are tube-like in shape with the tube ranging from 3 to 4 cm in length and 1 to 1.5 cm wide (Khan 2008).

***Euphorbia thymifolia*:** It was observed for the first time in 2008 and look like *Euphorbia microphylla* except stem colour. Its stem is slender, smooth and green in colour and profusely branched resulting into a mat like growth. This is mainly found on bunds, in waste lands, along roadsides and wall sides under humid conditions in rainy season of whole Punjab

state. It is a small plant containing milky latex in it, belonging to the family Euphorbiaceae. Delicate, thin adventitious roots come out from nodes. It is widely used in ayurveda and possesses antibacterial, antiviral and antioxidant properties (Lin *et al.* 2002)

Portulaca oleracea: It is an invasive alien weed, native of tropical South America. It was found growing along the bunds of paddy fields and in the well-fed vegetable farms of whole Punjab state. *P. oleracea* thrives well on nutrient-rich soils with high clay content. It has spreading-type growth and forms a thick mat over the soil surface. Its growth is very fast and produces large number of seeds. The control of this weed in the vegetable fields is very difficult and can limit summer vegetable production. Various broadleaf herbicides are effective for controlling this weed and directed spray of non-selective herbicides in widely spaced crops may provide effective control of this weed (personal experience).

Early recognition of invasive weed populations and adoption of appropriate management strategies at their lag phases are highly essential to stop their further horizontal expansion, failing of which will cause great threat to the resident biodiversity of both cropland and non-cropland situations as well as great economic loss in restoration of edaphic, climatic and social land use systems. Interestingly, all these six weed species are still in their lag phases of population expansion, and hence, it is the high time to think for their effective control, including their already developed soil seed banks.

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