

WEED MANAGEMENT: A CASE STUDY FROM NORTH-WEST PAKISTAN

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Abstract

Alien and exotic plant invasions are threatening the floral diversity around the globe and affect ecological processes. Weed invasion has been documented in North-West Pakistan. A total of 16 weeds were reported as invasive. These were *Xanthium strumarium*, *Ipomoea eriocarpa*, *Alternanthera pungens*, *Trianthema portulacastrum*, *Tagetes minuta*, *Imperata cylindrica*, *Amaranthus hybridus* subsp. *hybridus*, *Robinia pseudo-acacia*, *Broussonetia papyrifera*, *Ailanthus altissima*, *Pistia stratiotes*, *Phragmites australis*, *Parthenium hysterophorus*, *Cannabis sativa*, *Galium aparine* and *Emex spinosus*. Among these *Robinia pseudo-acacia*, *Broussonetia papyrifera* and *Ailanthus altissima* are trees and were purposely introduced as they later became invasive. They were aggressive in nature and replaced or suppressed the local vegetation. Their distribution, history of invasion and management has been discussed here. The behaviour and association of the 36 problem weeds with different crops has also been outlined as they perspired from the farmers.

Introduction

Invasive plants lack natural predators in addition to their adaptive nature in alien environments. In many cases they have prolific reproduction, easy to pollinate, high seed output with staggered dormancy and in certain cases allelopathic in nature as well. Like many other ecological issues, weed invasion has been under serious debate for about three decades in this part of the world. In majority of the cases the origin of invasiveness has not been traced, as the nature and extent of invasiveness of one species differ from another. Even same species have reportedly different origins in different parts of the world (Etherington, 1982). As a result of natural selection plants were adapted to disturbed environments and consequently all the ecological niches were filled with native plants evolved through several stages of succession, spread over thousands of years (Larcher, 1980). Many present day weeds (being alien and invasive) did not exist in the wilderness some years back. The concept of weed originated when man first started to grow plants for food, hence undesired plants were eradicated from fields. The need for weed control got extraordinary importance as technological advances prevailed (Marwat & Hashim, 2002). Weeds were either brought by different invaders inadvertently or through seed import. Moreover some ecological disturbances like disease, fire and cleaning of land etc. made changes at micro and macro level, opened up niches for new alien and invasive weeds (Marwat *et al.*, 2004). According to Marwat (1984) a total of 284 weeds were reported from KPK, but some of the important weeds like, *Phragmites australis*, for example was not a problem weed at that time, which was reported later on (Marwat, 1993); which suggest that weeds can change their habit and become aggressive for certain reasons.

The term invasive species refers to those species, which establish themselves in an area outside their natural range, exponentially increase their population, thus out-competing the native species of that area and usually bring changes in the function of ecosystem. Ecologically each species occupies a niche in the ecosystem. According to

Gause's competitive exclusion principle, the two species occupying the same niche can not survive simultaneously forever. The more aggressive one thrives and the poor competitor vanishes. In order, for the two species to co-exist they should have separate niche requirements (Radosevich & Holt, 1984). Thus in the above definition of invasive species whereby they establish in new habitat away from their natural habitat, their establishment is encouraged due to the lack or absence of concerned predators and parasites in the new environment. Thereby in the absence of their natural enemies, some of the alien plants became invasive, affecting the bio-diversity of our natural ecosystem, disturbing the ecological balance in the new habitat.

Keeping in view the impact of invasive weeds on environment, article 8(h) of the Convention on Biological Diversity (CBD) signed by 161 countries at the Earth Summit in 1992 urges the parties to "prevent the introduction of, control, or eradicate those alien species which threaten ecosystem, habitat or species" (Hussain *et al.*, 2000) and Pakistan being a member of CBD, has to play its role judiciously.

Invasive species have altered biodiversity, caused economic loss and risk to human health. Invasive weedy species cannot protect the soil, the way native plants do, thus erosion increases which can affect the composition of our local flora and fauna (biodiversity), while some are choking water streams, thus affecting fish population and water quality (Quentin *et al.*, 1995).

The massive migration of Afghans to Pakistan and within Pakistan migration of locals due to war against terror caused high ecological disturbance. During this period, i.e. from late 1970s till date, invasive weeds have become a problem and several attempts have been made to document the invasiveness of some of the prominent ones. During this course, some evidences other than above were; weeds resistance against certain herbicides and ecotypic changes due to climate change are a few to mention (Marwat *et al.*, 2004).

Thus, keeping in view the importance of the issue concerted efforts is required to generate a good insight into the problem and suggest remedial measures. The research base in the country is very weak on this subject. Only sporadic studies have been undertaken in the past. The meager studies so far undertaken list 700 and 4500 species of vascular plants as alien and indigenous species, respectively (Khatoon & Ali, The Herald annual, January 1999 after Hussain *et al.*, 2000).

Keeping the scenario into consideration, the studies were undertaken with the objective of making an inventory of important weed species of the area.

The study area (Khyber Pakhtunkhwa, formerly known as NWFP)

It borders Afghanistan to the north-west, Gilgit-Baltistan to the north-east, Azad Jammu and Kashmir to the east, the Federally Administered Tribal Areas (FATA) to the west and south and Punjab to the south-east (Fig. 1). It has an area of 74,521 km². The region varies in topography from dry rocky areas in the south to forests and green plains in the north.

According to the 1998 census, the population of the province was approximately 17 million of whom 52% are males and 48% are females (Anon., 2010). The population density is 187 per km². Geographically two famous mountain ranges i.e. Hindu Kush and Himalaya meet here. According to the climatic data (Anon., 2008) the average maximum temperature is 34.3C° while the average minimum temperature is 3.4C° with snowfall in the mountains. Rainfall is mainly during monsoon and winter with average of 1200mm annually. The climate can be extreme with intensely hot summers to freezing cold

winters. Agriculture is the main source of income, although cattle rearing are also practiced in the mountains. Wheat, rice, maize, sugarcane and tobacco are the main crops in addition to vegetables and fruits. Phytogeographically three distinct regions are recognized in the study area i.e. Irano-Turanian, Sino-Japanese and Saharo-Sindian (Ali & Qaiser, 1986).



Fig. 1. Location map of the study area.

Materials and Methods

Comprehensive field studies were conducted throughout the study area from time to time spread over several years. Plant specimens were collected along with extensive field notes including habit, habitat, life form, phenological status, and abundance etc. In each smaller valley local inhabitants were interviewed regarding the local names etc. Origin, nature and extent of invasive weeds were determined by field studies and interviews from the locals. Uses/abuses and nature of threat to the local flora was also documented as per modification from Marwat & Hashim (2002). All the collected plants are properly

pressed, dried and mounted on standard herbarium sheets and the voucher specimens are deposited at Herbarium Weed Science Department. Specimens were identified with the help of pertinent Floras and confirmed with the authentically identified specimens already present in the Herbarium. The nomenclature is based on Flora of Pakistan (Nasir & Ali, 1970-1979; Nasir & Ali, 1980-1989; Ali & Nasir, 1989-1992 and Ali & Qaiser, 1993-2009).

During the studies personal observations were also recorded regarding different weeds. The data obtained from these questionnaires and personal observations is presented in the form of table and discussed accordingly. Seventeen weeds are reported as invasive or aggressive out of total of a total of 36 weeds studied (Table 1).

Results and Discussion

It is interesting to note that invasive species were only reported from disturbed sites, mainly agricultural lands or wastelands. Some of the plants for example *Broussonetia papyrifera*, *Ailanthus altissima*, *Robinia pseudo-acacia*, *Cannabis sativa* were from roadside areas which were again disturbed. Though the plantation of *Broussonetia* was not supported by evidence during the survey, but the later ones (*Ailanthus* and *Robinia*) were planted through campaign of forest department. The survey was conducted in several phases to cover the different seasons and in the pre-testing, only agricultural land had a promise of invasive weeds therefore majority of the visit were made to farmer fields in different areas.

Plants which invade an established plant community and interfere with the biodiversity, have usually prolific reproduction, wide adaptability and can escape common control measures are considered invasive. *Xanthium* and *Pistia* are not alien (Stewart, 1972) but they have become invasive in the recent past. The evolutionary changes might have modified the genotypes resulting in more suitable ecotypes for these habitats. According to Hussain *et al.*, 2000, among the 700 alien species 5 or 6 could be recognized as high-impact invasive. These include 'Paper mulberry' (*Broussonetia papyrifera*), 'Mesquite' (*Prosopis juliflora*), 'Water hyacinth' (*Eichhornia crassipes*), and 'Congress grass', (*Parthenium hysterophorus*). Out of these species some of the alien invasive ones like, *Broussonetia papyrifera* are not only reducing the land value and causing economic loss to agriculture communities, but are also a source of allergy and related health problems in Islamabad and Peshawar. Similarly the name *Parthenium* as allergy causing species frequently comes in the national print media (Khalid, 2000). The infestation of the water bodies by *Eichhornia* and *Salvinia* has not been highlighted despite its economic importance. Similarly, the harms of *Prosopis juliflora* could be witnessed in the railway tracks and linear plantations on roads as well as in waste lands. *Eucalyptus* is another example highlighting the invasive behavior in farm forestry due to its aggressiveness and release of allelo-chemicals into the environment (Hussain *et al.*, 2000). *Xanthium strumarium* and *Phragmites australis* are also considered as new emerging weeds which have invaded areas out of their natural habitat (Marwat, 1993).

Total of 36 invasive weeds were found in wastelands, roadside, orchards or agricultural fields etc. where 17 were more invasive and aggressive. Botanical description, distribution and detailed comments regarding behavior of these invasive plants are reproduced as follows:

1. *Ailanthus altissima* (Mill.) Swingle, (Simarubaceae) Jour. Wash. Acad. Sci. 6: 495. 1916. Stewart, Ann. Cat. Vas. Fl. Pak. & Kash. 440. 1972.

Distribution and habitat: Baluchistan, Malakand; Gilgit; Hazzara; Abbotabad; Nathiagalli; According to Stewart (1972) it is cultivated in the hills but does not do well below 5000 ft. However, this tree has been found doing well in lower altitudes as well.

History of invasion: Forest department planted this tree as a source of firewood along the road side in Swat and Hazara. But now it has invaded the wasteland because of its prolific reproduction and has replaced the local vegetation.

Management: The management recommended for *Robinia pseudo-acacia* can work here.

2. *Alternanthera pungens* Kunth (Amaranthaceae) in H.B.K., Nov. Gen. Sp.2: 206, 1817; Stewart, Ann. Cat. Vasc. Fl. W. Pakistan. 229. 1972. (Syn: *Achyranthes repens* L., *Alternanthera achyrantha* (L.) Sweet; *Alternanthera repens* (L.) Link.)

Common name: It-sit (farmers confuse it with *Trianthema portulacastrum*)

Distribution and habitat: Common weed of wasteland and vegetables throughout the province.

History of Invasion: A native of tropical America, now widespread as a weed of waste ground etc. in the tropics and subtropics of both Old and New Worlds. Seems to thrive in bare, heavily trodden places.

Management: Since it is a weed of vegetables mainly, therefore, mechanical control as is a general practice helps its management. However, for more effective management, it should be supplemented with herbicides registered for vegetables.

3. *Amaranthus hybridus* L. subsp. *hybridus* (Amaranthaceae) Sp. Pl. ed. 1: 990. 1753; Townsend in Fl. W. Pak. 71: 11-12. 1974. (Syn. *A. chlorostachys* Willd.).

Common names: Eng: Prince of Wales, Hindko: Chalwera.

Distribution and habitat: Weed of cornfields throughout the province; less represented in the southern districts; a spontaneous naturalized weed in the warmer regions of the world; frequent in temperate regions as well.

History of invasion: Weed of new as well as old world. Birds, FYM and wind seem to have played major role in its dispersal.

Management: Composting of FYM and crop rotation can reduce the weed problem to a great extent. Where these interventions are not possible, then maize and vegetable herbicides integrated with other methods can be used effectively for its management.

4. *Broussonetia papyrifera* (L.) L'Herit. ex Vent (Moraceae). Tabl. Veg. 3: 547.1794. FBI 5: 490. Stewart, Ann. Cat. Vas. Fl. Pak. & Kash. 191. 1972

Common name: Paper mulberry, Gul toot.

Distribution and habitat: A native of South East Asia. It is distributed from Lahore to Peshawar valley through Salt range, but worst affected are the federal capital Islamabad, parts of Rawalpindi and campus of Peshawar University, Peshawar. The introduction of this species in subcontinent is more than 100 years old. According to Parker (1956) it was first introduced in 1880 at Saharanpur and until 1924 it has spread up to Lahore along irrigation channels and into Shahdara Plantation. Parker at that time predicted that this tree would become common in the sub Himalayan tract as well as in the more heavily irrigated portions of the plains especially the places where any prior vegetation was scant (Hussain *et al.*, 2000).

History of invasion: Paper mulberry is the most problematic invasive in northern Pakistan. It has the typical features of invasiveness by fast growth rate, seed dispersal through birds, and ability to vegetative propagation. Its fruits are relished by crows and other birds who thus acts as the vector for its seed dispersal; therefore both crows and paper Mulberry are promoting each other. The increased population of crows has become a nuisance for the residents of affected areas. It was introduced in Islamabad to make capital green. In less than thirty years period it became a highly invasive species in the natural ecosystem of Himalayan foothills. Around Rawal Lake it has replaced the entire natural vegetation. Margalla Hills is National Park representing good examples of Himalayan foothill vegetation. This invasive species is a growing threat to the natural vegetation of National park and other valleys in the East of Islamabad up to south Azad Jammu and Kashmir. Besides threatening the natural vegetation, it is also a human-health hazard. In a report of Pakistan Medical Research Council (1995), about 45.5% of allergic patients in Islamabad and Rawalpindi showed positive sensitivity to the pollen of *B. papyrifera*. The newly sprouting shoots from trees stumps and ground covers are being cut and burnt. First phase of this operation in Islamabad started from Faisal Avenue and the trees are being replaced with better timber trees. This operation started in 1992 but is not effective as it continues to stage a comeback due to its invasive nature.

Management: There are several ways to cope with this noxious tree, through eradication of its male plant, which would stop pollinating the female one, thus new addition of saplings through seed would stop. Mechanical cutting of the trees associated with application of non selective herbicide, like glyphosate as spray in case of small plants and through injectors in case of big trees would control it.

5. *Cannabis sativa* L. (Cannabaceae). Stewart, Ann. Cat. Vas. Fl. Pak. & Kash. 195. 1972. Qaiser in Fl. W. Pak. No 44: 1-5, 1973.

Common name: Hemp, Mirijuana, Bhang.

Distribution and habitat: Distributed in northern Punjab and KPK. It is not much aggressive with a medium degree of invasiveness. It invades waste areas, fence rows around farm building usually on bottomland soil. A very adaptable herb from plains to 1000 ft, found along the roadside (Qaiser, 1973), in northern Punjab and KPK.

History of Invasion: Appears to be an ancient introduction. May be it was initially cultivated for fiber use/ ropes and or drug purposes, which later escaped from cultivation and became wild.

Management: All efforts including mechanical and use of herbicide may be employed to combat this weed. Biological control can also be tried in research trials.

6. *Emex spinosus* (L.) Campd. (Polygonaceae) Monogr. Rumex, 58, t.1(1819); R.A. Graham in Turrill & Milne-Redhead, op.cit.3 (1958); Tutin in Tutin et al., op.cit.1:89 (1964); J.Cullen in Davis, op.cit. 2:293 (1966); Rechinger & Schiman-Czeka in Rechinger. op. cit. 2(1968). (Syn. *Rumex spinosus* L.; *Emex spinosus* L. Sp. Pl. 337 (1753); Bhopal & Chaudhry in Pak. Systematics, 1(2):97-98, 1977.

Common name: Prickly dock; Kafir kanda.

Distribution and habitat: S. Europe, Mediterranean Coastal countries and SW Asia. Very common weed of wheat throughout the irrigated plains.

History of invasion: It has been accidentally introduced recently from Afghanistan & Iran (Bhopal & Chaudhry, 1977), probably through goats and sheep.

Management: It is a very competitive weed of wheat, thus wheat herbicides (broad-leaf) combined with crop rotation will show promising results.

7. *Galium aparine* L. (Rubiaceae) Sp. Pl. 108, 1753. Stewart, Ann. Cat. Vas. Fl. Pak. & Kash. 684. 1972.

Common name: Catchweed, bedstraw.

Distribution and habitat: Widely distributed in Pakistan from plains to 12000 feet. It is a troublesome weed in winter crops, mainly wheat. It interferes with harvesting, encourages lodging, and sometimes smothers an entire crop.

History of Invasion: It is a native of Europe. Apparently old introduction probably came with crop seed. The small size of the seeds enhances their mixing with crop seeds: small hooks on the seed coat also provide a special mechanism for attachment to fur, bags and clothing which help in transportation of the weed seeds from one to other place.

Management: As it is weed of wheat, therefore rotation with other crops combined with broad-leaf herbicides of wheat can reduce the problem.

8. *Imperata cylindrica* (L.) Raeuschel. (Poaceae) No., Bot., ed. 3, 10. 1797; Cope in Fl. Pak. 143: 252: 1982. (Syn. *Lagurus cylindricus* L., *Saccharum cylindricum* (L.) Lam. *I. arundinacea* Cyr.)

Common name: Engl. Sword grass, Blady grass.

Distribution and habitat: Found mainly in orchards and wastelands throughout the province - It is a dangerous weed, as its rhizomes are tenacious and if a fragment of its rhizome is left, a new plant can regenerate - Pakistan, throughout the old world tropics, extending to the Mediterranean and the Middle East.

History of invasion: Not known, but seems an old introduction.

Management: Since it is major weed of orchards, therefore, intercropping of legumes, like barseem, guar and alfalfa would be the best way for controlling such weed. In situations, where, intercropping is not possible then, glyphosate or any other nonselective herbicide, using shielded sprayer can be used for its selective control.

9. *Ipomoea eriocarpa* R. Br., (Convolvulaceae) Prodr. 484. 1810; Austin and Ghazanfar in Nasir and Ali F. Pak. 126: 41-43. 1979. (Syn. *Convolvulus hispidus* Vahl., *I. hispida* (Vahl) Roem. & Schultes).

Common name: Ilra.

Distribution and habitat: Found as weed of maize fields in Hazara, from tropical Africa and Madagascar through Indo-Pak to N. Australia. Fl. per. August - October.

History of Invasion: This seems an old native plant of the area and can not be considered as invasive per se, but for sure its frequency and density has been increasing as the farmers have suggested. Field observation also suggests its aggressiveness, but is restricted ecologically to a limited area.

Management: Since it is a major weed of maize, therefore maize herbicides can be used effectively against such weed. As it spreads through farm yard manure (FYM), therefore, in long term integrated weed management, including composting of FYM, crop rotation and mechanical control would be more promising.

10. *Parthenium hysterophorus* L. (Asteraceae), Sp. Pl 988 (1753).

Common name: White top, Congress grass, Carrot grass.

Distribution and habitat: It is a recent introduction in the subcontinent through unknown source, recorded first in 1956 from Poona (Maharashtra, India). In Pakistan, it was first recorded in 1980s. It is a recent introduction in Islamabad and is spreading to other areas in KPK and Punjab (Hussain *et al.*, 2000). It is a road side rare weed near Haripur. It may replace the *Cannabis sativa* in future. Although present in many parts of upper Punjab and KPK, more affected area is Islamabad and Potohar, where it is highly invasive and has invaded most of the open spaces roadside, etc and is threatening to indigenous biodiversity. This plant is competing with some of the alien species like *Cannabis sativa*, which does not grow in vicinity where *Parthenium* is growing i.e. a less aggressive invasive is giving way to a more problematic one.

Parthenium pollen has allelopathic effect on the stigma of other species, inhibiting their seed-set. This is how it out-competes indigenous species. The weed is reported noxious in the neighboring country India where it has invaded all types of pasture as well

as agricultural lands. It is also reported as a health hazard in India. It is responsible for causing disease like fever and asthma and allergic contact dermatitis in human. Animals may get skin rashes on their udders and whole bodies. *Parthenium* is responsible for bitter milk disease in cattle buffaloes and goats fed on grass mixed with *Parthenium* (Hussain *et al.*, 2000). Biological control of this weed has been achieved in some countries that involve various insects and fungus species. In Islamabad only mechanical removal of the weed is being done from roadside.

History of Invasion: According to Khalid (2000), it has spread over large area along roadside without mentioning its history of invasion.

Management: As it is a recent introduction, therefore, all efforts including mechanical and use of herbicide may be employed to combat this weed. Biological control can also be tried in research trials.

11. *Phragmites australis* (Cav.) Trin. ex Steud., (Poaceae) Nom.Bot., ed. 2,2: 324.1841; Clayton in Kew Bull. 21: 113.1967; Bor in Towns., Guest & Al-Rawi, Fl. Iraq 9: 374. 1968; Clayton in Taxon 17: 168, 1968; Bor in Rech. f., Fl. Iran. 70: 352. 1970; Tzvelev, Poaceae URSS 606. 1976; Tutin in Tutin *et al.*, Fl. Eur. 5: 253. 1980.

Common name: Common Ditch Reed, Nal.

Distribution and habitat: Pakistan (Punjab & Kashmir); temperate regions of both hemispheres in the Old and the New World. It is found on limestone slopes in open forest, in the mountains, margins of lakes and ponds and in shallow water in the plains. Flowering and Fruiting in July-October.

History of Invasion: According to Marwat (1993), it has emerged as a noxious weed of waterlogged and saline soils, however, its history of invasion is not known. It is found in wet soil in wheat and onion.

Management: Since it is a weed of waterlogged and saline soils, therefore manipulation soil pH may help reduce the problem. Moreover flooding of affected lands with water for several days in hot weather, after cutting the upper portion of the plant helps eradicate the weed. Non-selective control can also be accomplished through use of glyphosate in non-crop situation.

12. *Pistia stratiotes* L. (Araceae). Sp. Pl. 963. 1753. FBI 6: 496; Stewart, Ann. Cat. Vas. Fl. Pak. & Kash. 35. 1972.

Common name: Water cabbage; Jal kumbi

Distribution and habitat: It is an aquatic plant, weed of stagnant water, can be more of a problem in rice in the future. It is widely distributed in Pakistan and found in water reservoirs, ponds and marshes along the edges of lakes and in slow moving or stagnant waters. The weed disrupts navigation, plugs grills and interferes with fisheries by creating physical barriers and lowering the oxygen content and pH of the water. The species seriously interferes with rice crops through transpiration of water. Plants can float into paddy crops, take roots in the soil and competes with crop under shallow water conditions of the field (Hussain *et al.*, 2000). The plant serves as a preferred host for mosquitoes, vectors of malaria, encephalomyelitis and rural filariasis. The Anopheles

mosquito, which carries the parasite responsible for malaria, is frequently associated with *P. stratiotes* because the hydrophyte provides suitable shelter and breeding site (Holm *et al.*, 1977). In Pakistan this species in ponds and reservoirs has been shown to cause the decay of native hydrophytes.

History of Invasion: Not known, but according to Stewart (1972), it was reported from Razmak, South Waziristan, but now it is found all around the county upto 2500m altitude.

Management: Since it is a perennial weed of rice, therefore integration of crop rotation, puddling and use of rice herbicides can effectively control the weed.

13. *Robinia pseudo-acacia* L. (Papilionaceae) Sp. Pl.722.1753; Stewart, Ann. Cat. Vas. Fl. Pak. & Kash. 419. 1972.

Distribution and habitat: Native of US, cultivated and more or less naturalized in Europe. Cultivated as an ornamental tree in Punjab (Ali, 1977). Native of United States, cultivated and more or less naturalized in Europe and Japan. Cultivated as an ornamental tree in Punjab.

Fl. Per.: March-April.

It is native of USA, frequently cultivated, from plains to 10000 ft (Stewart, 1972)

History of invasion: Forest department planted this tree as a source of firewood along the road side.

Management: Since it is a roadside tree, therefore, the best way would be to control it mechanically which can be supplemented with injecting glyphosate through injectors in the trunks of big trees. Simultaneously, other local trees should be planted simultaneously to fill the micro-habitat after cutting these trees.

14. *Sorghum halepense* (L.) Pers. (Poaceae) Syn. Pl. 1:101. 1805. Blatter & McCann, Bombay Grasses 55. 1935; Bor, Fl. Assam 5:352. 1940; Sultan & Stewart, Grasses W. Pak. 1:97. 1958; Bor, Grasses Burma Ceyl. Ind. Pak. 222. 1960; Fl. Pak. No.143: pp. 1-678. 1983.

Common name: Johnsongrass; Dadam

Distribution and habitat: Found through out the province in wastelands as well as in crop lands a, having very strong underground rhizomes. Major weed of sugarcane, maize and emerging at later stages of wheat crop.

Management: Non selective herbicides with repeated application can control its spread.

15. *Tagetes minuta* L. (Asteraceae) Sp. Pl. 887. 1753. Stewart, Ann. Cat. Vas. Fl. Pak. & Kash. 785. 1972.

Common name: Gul-e-Sadbarg; Mexican marigold.

Distribution and habitat: Very common in Swat and Hazara districts of KPK, prefer cooler climates. It is mostly found in wastelands but also invades maize fields as well.

History of Invasion: Apparently seems to be an escape from cultivation. But during the past two decades, its population has been increased tremendously and is a major threat to our local vegetation in those areas.

Management: A weed of maize and wastelands can be managed through composting of FYM, while applying to the field, while simultaneously crop rotation and mechanical control can play a major role in its management. In severe cases, non selective herbicides and maize herbicides can be used in non crop and maize field, respectively.

16. *Trianthema portulacastrum* L., (Aizoaceae) Sp. Pl. 223. 1753; Nasir in Fl. W. Pak. 41: 3. 1973. (Syn. *T. obcordata* Roxb; *T. monogyna* L.).

History of Invasion: A common weed of kharif season throughout the country. Since there has been recent trend towards growing vegetables, therefore, continuous vegetable sowing for several years on the same field has given it a chance to become more aggressive than ever before.

Management: Since it is a weed of maize & vegetables, therefore, clean vegetable seed, crop rotation and mechanical weed control integrated with herbicides registered for these crops can reduce its population effectively; in non-crop situation, the non-selective herbicides can be used for its control.

17. *Xanthium strumarium* L. (Asteraceae) Sp. Pl. 987. 1753; Stewart, Ann. Cat. Vas. Fl. Pak. & Kash. 801. 1972.

Common name: Common cocklebur.

Distribution and habitat: From plains upto 2500m in the northern parts of the province. In Peshawar valley and Abbottabad, this is becoming very dangerous and it may spread in other areas too. In Sheikhul Bandi and Nawashahr area of Abbottabad, it covers the fields in such a way that no plant can compete with it. Flowering is from June to October.

History of Invasion: It is ubiquitous weed, found in orchards, maize fields and wastelands. The patches of *Xanthium strumarium* along the roadside and people's response suggest that its spiny fruit clinging to the wool of sheep/goats has been the major force of its spread. The nomad Afghans used to bring sheep herds in winter from Afghanistan and they had to make stay along the roadside throughout the N-West part of Pakistan, which resulted in small to large patches of aggressive weeds which ultimately escaped to cultivated fields with the passage of time. As cattle do not feed on this weed, neither it has fuel importance; therefore it remains unchecked, thus replaces the native plants accordingly. Its present importance value suggests that it is going to be one of most noxious weed of crop lands (Marwat, 1993) as is the case in US (Marwat & Nafziger, 1990).

Management: Since this weed is not of a problem in crops, therefore, mechanical control is recommended, but at places where it has replaced the total vegetation, then non-selective herbicides are recommended for its effective control. In certain cases it is a weed of maize, therefore, maize herbicides can be affectively used for its control. Certain biological agents have also been tried for its management successfully (Julien, 1992).

Table 1. Weeds list of the area and their association with crops.

No.	Names of Major Weeds	Family	Name of Crop	Weeds behaviour
1.	<i>Achyranthes aspera</i> L. var. <i>aspera</i>	Amaranthaceae	Maize	Old
2.	<i>Ailanthus altissima</i> (Mill.) Swingle	Simaroubaceae	Roadside	-do-
3.	<i>Alternanthera pungens</i> L.	Amaranthaceae	Vegetables	Old but increasing
4.	<i>Amaranthus hybridus</i> L. subsp. <i>hybridus</i>	Amaranthaceae	Maize/Vegetables	Increasing
5.	<i>Avena fatua</i> L. subsp. <i>fatua</i>	Poaceae	Wheat	Old but increasing
6.	<i>Broussonetia papyrifera</i> (L.) L'Herit. ex Vent.	Moraceae	Wasteland/Roadside	10 years old
7.	<i>Cannabis sativa</i> L.	Cannabaceae	Wasteland	Old but increasing
8.	<i>Carthamus oxyacantha</i> M. Beib.	Asteraceae	Wheat/Orchards	Old but increasing
9.	<i>Chenopodium murale</i> L.	Chenopodiaceae	Wheat/Vegetables	Old
10.	<i>Commelina benghalensis</i> L.	Commelinaceae	Maize	New
11.	<i>Convolvulus arvensis</i> L.	Convolvulaceae	Maize/Orchards/Wheat	Old but increasing
12.	<i>Coronopus didymus</i> (L.) Smith	Brassicaceae	Wheat/Vegetables	Old but increasing
13.	<i>Cynodon dactylon</i> (L.) Pers.	Poaceae	Ubiquitous weed	No shift reported
14.	<i>Cyperus rotundus</i> L.	Cyperaceae	Maize/Vegetables	Old
15.	<i>Datura fastuosa</i> L.	Solanaceae	Wasteland	Old
16.	<i>Echinochloa colona</i> (L.) Link	Poaceae	Maize	Old but increasing
17.	<i>Emex spinosus</i> (L.) Campd.	Polygonaceae	Wheat	New
18.	<i>Euphorbia helioscopia</i> L.	Euphorbiaceae	wheat/Vegetables	Old
19.	<i>Fumaria indica</i> (Hauuskn.) Pugsley	Fumariaceae	Wheat/Vegetables	Old
20.	<i>Galium aparine</i> L.	Rubiaceae	Wheat	New
21.	<i>Imperata cylindrica</i> (L.) Raeuschel.	Poaceae	Orchards	Old but increasing
22.	<i>Ipomoea eriocarpa</i> R. Br.	Convolvulaceae	Maize	New
23.	<i>Malvastrum coromendelianum</i> (L.) Garcke	Malvaceae	Wasteland	Old
24.	<i>Parthenium hysterophorus</i> L.	Asteraceae	Roadside	Recent introduction
25.	<i>Phragmites australis</i> (C`ay.) Trin. ex Steud.	Poaceae	Wheat	New
26.	<i>Pistia stratiotes</i> L.	Araceae	Rice	New, future weed of rice
27.	<i>Poa annua</i> L.	Poaceae	Wheat/Vegetables	Old but increasing
28.	<i>Ranunculus laetus</i> Salib. / <i>Ranunculus muicatus</i> L.	Ranunculaceae	Wheat	Old
29.	<i>Robinia pseudo-acacia</i> L.	Papilionaceae	Roadside	Foresters planted
30.	<i>Silybum marianum</i> (L.) Gaertn.	Asteraceae	Wheat/Orchards	New
31.	<i>Sisymbrium irio</i> L.	Brassicaceae	Wasteland	Old but increasing
32.	<i>Sorghum halepense</i> (L.) Pers.	Poaceae	Maize/Orchards	Old but increasing
33.	<i>Tagetes minuta</i> L.	Asteraceae	Maize/wasteland	Old but increasing
34.	<i>Trianthema portulacastrum</i> L.	Aizoaceae	Maize/Vegetables	New but increasing
35.	<i>Tulipa stellata</i> Hook.	Liliaceae	Wheat	Old but increasing
36.	<i>Xanthium strumarium</i> L.	Asteraceae	Maize/wasteland	New 12 years

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