AQUATIC WEEDS IN PAKISTAN AND THEIR MANAGEMENT

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Aquatic plants can be found in, on and around water bodies. These plants range from microscopic organisms (plankton algae, which remains suspended in the water) to larger plants rooted in the bottom of ponds. Certain types of aquatic plants are essential for fish production. Nonetheless, the aquatic plants interfering with human interests are considered weeds. These plants invade lakes, ponds, rivers, canals and agricultural fields, which make them noxious. Abundance of these weeds creates hazards to aquatic life, act as breeding places for mosquitoes, cause hindrances to water sports, damage the environment and economy and deteriorate recreational and scenic beauty of the lakes. Aquatic weeds may be categorized into four groups viz. algae, floating weeds, emersed weeds (foliage above water) and submersed weeds.

Water hyacinth, cattail, giant reed, and water lettuce etc. are major weeds found in water bodies in Pakistan. Like terrestrial weeds, aquatic weeds may also be managed by following preventive, mechanical, biological and chemical means. The development of an aquatic weed management plan however depends on correctly identifying the problem weed(s) and selecting the most suitable control methods. This article gives an account of important aquatic weeds in Pakistan control thereof.

Water Hyacinth (Gul-e-Bakoli)

Water hyacinth or Gul-e-Bakoli (*Eichhornia crassipes*), though native to the Amazon basin and Brazil, became widespread throughout the world. It is considered one of the worst aquatic weeds in the world and is commonly found in Pakistan. The rapid increase and spread of the plant into new areas is particularly due to its ability to reproduce from its vegetative parts; a single plant can invade the whole lake or pond rapidly. Its rapid growth oftenly leads to dense mats across the water surfaces that affect the water quality by reducing the quantity of oxygen and sunlight penetration thus resulting in the death of fish and other aquatic organisms. These large mats also act as breeding places for mosquitoes.

Management

Different ways for managing water hyacinth will be discussed in the following lines. Out of different control methods, biological control is considered the long-term, sustainable, economic, and safe solution for large infestations. Many Arthropod species like Weevils (*Neochetina bruchi, Neochetina eichhorniae*), moths *(Xubida infusellus,* and *Niphograpta albiguttalis, syn. Sameodes albiguttalis)*, mites *(Orthogalumna terebrantis)* and bugs *(Eccritotarsus catarinensis)* can be used as biological control agents. They keep the weed under control by eating it. Once the plant infestation is reduced in size, the insect population dies down. When the plant begins to spread again, the insects naturally increase in number and the cycle continues.

Biological control alone is unlikely to be successful for controlling water hyacinth, so it is important to integrate it with other control techniques thus making it sustainable and affordable. Herbicides have long been used to control water hyacinth. Although the herbicides can effectively control large infestations, they do not provide a sustainable control and pose a potential threat of polluting the water. So the use of herbicides should be limited to areas of high infestations and treated water should not be used for drinking water. In case it becomes inevitable to use chemical then KWH02 (asexual reproduction inhibitor) can be used. Herbicide glyphosate, 2,4-D and paraquat (aquatic formulations) have been used for controlling water hyacinth in many parts of the world. The management of weeds mass killed by herbicides is very important because it can decrease oxygen in water that may affect fish populations.

Main problem in developing countries like Pakistan is lack of awareness about the harmful effects of this weed. In case of large-scale water hyacinth infestations, it will be necessary to reduce the coverage of the weed by means of chemical and/or mechanical control, and at the same time by introducing some biological control agents.

Cattail or Typha (Dibb)

Cattail (*Typha angustata)* commonly known as dibb, is an emergent aquatic weed and causes serious problems in the water carriageways of Pakistan. It is widely distributed in waterlogged areas and along irrigation/drainage channels threatening to impede the flow. Cattails spread rapidly by rhizomes and by small, airborne seeds that may remain viable for 5 years or more.

Management

Various methods can be adpted to control the infestations of cattail. Permanent management of cattail is its replacement with paragrass that can be used as fodder. Management with fire and physical removal in conjunction with flooding are considered most appropriate. In this practice cattails are burned after drainage with subsequent deep flooding. Similarly, effective control of cattail can also be achieved by a combination of manual or mechanical cutting of stems followed by submergence of the remaining stems. Shading of cattails with black polyethylene tarps is also considered another effective control method because these plants are highly sensitive to shade. At seedling stage the best possible method is manual or mechanical uprooting of the plants.

Different chemical control measures can also be used against cattails including use of chemicals like dalapon, glyphosate, atrazine and paraquat. Using herbicides when flowering has been found to cause the greatest stress in typha. Proper arrangements should be made for the removal of dead plants because they can cause water to go foul and unusable. The cost involved in the management of catail is so high for both the economy and ecology that economically sustainable and environmentally safe controls should be used in order to provide long-term solutions to heavy weed infestations. An integrated control program should be structured for its successful management.

Giant Reed (Nara grass)

Giant reed (*Arundo donax*) locally called nara grass, is a native to the countries surrounding the Mediterranean Sea. It can rapidly invade stream banks and roadside habitats from a few individuals. Once established, it has a strong ability to outcompete and completely suppress native vegetation. In some areas, it may totally invade irrigation ditches as to reduce their water-carrying capacity in addition to large volumes of water being used for its own growth.

Management

Since giant reed mostly spreads by dispersal of rhizome fragments so removal of the entire rootstock is necessary to overcome its populations. Its control measures involve prevention, eradication and control. Manual methods use hand labor to remove giant reed but these are very labor intensive due to large masses of rhizomes. Mechanized equipment can also be used to remove above ground plant parts. These methods are often non-selective because all the vegetation is removed. This method cannot be used in marshy or slopy areas or in soils susceptible to compaction or erosion. Tractor-mounted mowers or scythes can be used to remove the plants. It is faster and more economical than manual means but requires several cuttings before the underground parts exhaust their reserve food supply completely. If only a single cutting is to be made, the best time is at flowering. At this stage the reserve food supply in the roots is nearly exhausted, and new seeds have not yet been produced. In some parts of the world burning of the giant reed is done by prescribed burning or broadcast burning. This can be accomplished after herbicide application. As alone burning will not prevent resprouting so it should be followed by mechanical removal of rhizomes. Grazing by goats and sheep is also considered an effective control measure. Sheep are considered better than goats because they can survive extended periods on a strict diet of giant reed. Some biological control agents have also been reported for the management of giant reed. The green bug (*Schizaphiz graminum*) has been observed to feed on giant reed. In France *Phothedes dulcis* caterpillars feed on it. *Zyginidia guyumi* uses giant reed as an important food source in Pakistan. A moth borer *Diatraea saccharalis* has been reported to attack the plants of giant reed.

In addition to all these control measures there are several herbicide options available, but translocating herbicides are generally considered best. They are able to kill the rhizomes, and thus minimize the re-sprouting. Glyphosate is an easy and effective herbicide for spot-treatment that translocates to the rhizomes. Paraquat alone at 0.72 kg/ha can effectively be used for its control. The spray of chemicals immediately after cutting the stems gives better control than foliar spray due to efficient translocation.

Integration of all the above-mentioned control methods generally will give the most effective, economical, and environmentally sound long-term management of the weeds. In case several techniques to be used in combination, these should be compatible with one another.

CRISPR-CAS9 SYSTEM-A LANDMARK IN GENOME EDITING OF PLANTS

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From the smallest single celled organism to the largest creation on earth, every living thing is defined by its genes. The DNA contained instruction manual for our cells. Four building blocks called bases are strung together in precise sequences which tell the cell how to behave and form the bases forever every trait, but with recent advancements in gene editing tools scientist can change fundamental features in the organisms. They can develop resistance against diseases in crops. They can provide cure from genetic diseases. CRISPR is the fastest, easiest and cheapest of the gene editing tool, responsible for this new wave of science.

Surprisingly, CRISPR is actually a natural process that’s long functioned as a bacterial immune system, originally found defending single celled bacteria and arches against invading viruses. In 2012, American biochemist Doudna and French microbiologist Emmanuelle Charpentier were first to describe that CRISPR Cas9 could be used for genome editing in Bacteria against virus.

Naturally occurring CRISPR uses two main components, the first is small DNA sequences called Clustered Regularly Interspaced Short Palindromic Repeats or simply CRISPR, the second is Cas9 or CRISPR associated proteins which cut up DNA like molecular scissors. Once a virus invades a bacterium, Cas proteins cut out the segment of a viral DNA to stitch into the bacterium CRISPR region (Figure 1). Those viral codes are then copied into short pieces of RNA. In case of CRISPR, RNA binds to a special protein called Cas9.

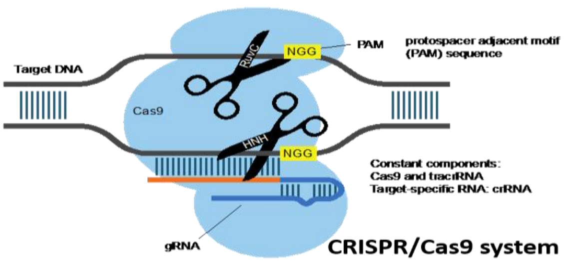

Figure 1: Mechanism of action of CRISPR-Cas9 system.

The resulting complexes act like scouts, lacking onto free floating genetic material and searching for matched to the virus. If the virus invades again the scout complexes recognize immediately and Cas9 swiftly destroys the viral DNA. Lots of bacteria have this type of defence mechanism but in 2012, scientist proposed that how to hijack CRISPR to target not just viral DNA, but any DNA in almost any organism. For editing, scientist works in the lab and designed a guide RNA to match the gene, they want to edit and attaches to Cas9 like the viral RNA in the CRISPR immune system. The gRNA direct Cas9 to the target gene and proteins molecular scissors cut the DNA. This is the importance of CRISPR power, just by injecting Cas9 bind to a short piece of custom gRNA scientist can edit practically any gene in the genome.

CRISPR/Cas9 method of gene editing has been adopted in nearly 20 crop species so far. For various traits including yield improvement, biotic and abiotic stress management. Many of the published articles are considered as proof-of-concept studies as they describe the application of CRISPR/Cas9 system by knocking out specific reported genes playing an important role in abiotic or biotic stress tolerant mechanisms. Biotic stress imposed by pathogenic microorganisms pose severe challenges in the development of diseaseresistant crops and account for more than 42% of potential yield loss and contribute to 15% of global declines in food production. CRISPR/Cas9-based genome editing has been utilized to increase crop disease resistance and also to improve tolerance to major abiotic stresses like drought and salinity. A brief detail of the use of CRISPR for genome editing in various crop species is presented here.

In rice, by targeting ethylene responsive factor gene OsERF922, resistance against its devastating diseases such as Bacterial blight and Rice Blast has been accomplished. In the same way, several genes of bread wheat such as TaMLO-A1, TaMLO-B1 and TaMLOD1 have been targeted to develop resistance against powdery mildews. In maize, *ARGOS8* gene has been subjected to mutations for the enhancement of grain yield under drought stress. Moreover, CRISPR-mediated targeting to ALS1 gene in potato has led to the resistance against herbicides. Recently, resistance to Verticillium dahliae infestation has been reported through gene editing of Gh14-3-3d gene. The resulting transgene-clean plants showed a high resistance and in future could be used as a germplasm to breed disease-resistant cotton cultivars. Nonetheless, genome editing through CRISPR-Cas9 system has been approved quit well and efficient source for the betterment of crops but this technology also raises big ethical questions.