

Weedy rice is a serious threat to rice farming. With the current crop management practices including direct seeding of rice, weedy rice infestation is likely to increase and will threaten sustainability of production systems in the country. Due to high competitive ability, these weeds can remarkably affect rice yields. Multiple approaches need to be integrated to reduce weedy rice infestation in fields. Further research is urgently needed to determine the impact of different tillage systems, water management and herbicide practices on weedy rice growth and control. Integrated crop management programs with different varietal aspects, such as crop plant density, row spacing, cultivars with good initial vigour and purple culm base need to be exploited as a component of integrated weed management in weedy rice control. Introduction of herbicide-tolerant varieties which allow the selective post-emergence control of weedy rice infestation can also be explored.



Complete devastation by Weedy rice



Weedy Rice : A Threat to Rice Farming and its Control

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Weedy Rice A Threat to Rice Farming and its Control

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Weedy rice (*Oryza sativa* L. f. *spontanea*) belongs to the same genus and species as cultivated rice. It is very similar to cultivated rice at vegetative growth phase which makes it hard to distinguish and differentiate. Weedy rice is not affected by selective herbicides used in rice. It grows faster; produces more tillers, panicles and biomass; makes better use of available nitrogen; shatters easily; has better resistance to adverse conditions; and possess longer dormancy in soil. Because of its high competitive ability, it becomes a serious threat to rice growers worldwide. The spread of weedy rice became significant mainly after the shift of rice cultivation from transplanting to direct seeding due to shortage of water and labour scarcity. The spread has further aggravated due to use of commercial seeds that contain grains of the weedy rice and through the machines used in rice cultivation specially the tillage implements and mechanical harvesters. For farmers, weedy rice becomes a difficult-to-control, aggressive weed that increases the costs of production, reduces yield, lowers the market value of their harvest and, when not controlled properly, can render the infested land unfit for rice production. Due to these reasons, it has been posing cancerous threat to the farmers in major rice growing areas of the country.

At present, no single management technique can effectively control weedy rice. Preventive measures are essential along with some cultural, mechanical or chemical control measures. This bulletin is intended to create awareness about this problem weed and appropriate management options to minimize its spread.

How Weedy rice develops?

Weedy rice is produced either by spontaneous mutation from domesticated rice or through hybridization with wild *Oryza* species (viz., *O. nivara*, *O. rufipogon* and *O. longistaminata*) which share the same genome 'AA' as cultivated rice. They easily cross with the cultivated *O. sativa* and *O. glaberrima* species and lead to development of natural hybrids i.e., weedy rice. Since phylogenetically the weedy form is closely related to cultivated rice, therefore, the weedy plants share most of the features of the two cultivated species viz., Asian rice (*Oryza sativa*) and African rice (*O. glaberrima*).



Oryza nivara and *O. rufipogon*, two abundantly occurring wild rices of eastern India

How does Weedy rice look like?

Weedy plants show a wide variability of anatomical, morphological and physiological features. One group includes plants with a black hull, purple apex and long awns, showing evidence of wild traits while the other group has straw hull and apex and no awn mimicking cultivated varieties. Identification of weedy rice is possible only after tillering when several morphological differences are visible with respect to cultivated rice such as numerous, longer and more slender tillers, leaves often densely pubescent on both surfaces, tall height, pigmentation of several plant parts and easy seed dispersal. It is very competitive with cultivated rice as its seeds have dormancy and its grains shatter easily that enrich soil seed bank. The seeds of most weedy types of *O. sativa* and *O. glaberrima* have pigmented pericarp due to the presence of varying levels of anthocyanins, catechins, and catecholic tannins. Due to this reason, the term 'red rice' is commonly adopted in international literature to identify these wild plants. This term, however, does not seem very appropriate as red-coat seeds are also present in some cultivated varieties, but absent in some weedy forms.

- Green manuring by *Sesbania* in rainfed lowlands helps in successfully smothering weedy rice.
- Winter flooding can also help in controlling weedy rice infestation by promoting weed seed decay, animal predation or germination.
- Rouging removal of weedy rice panicles by hand picking/cutting at heading/flowering stage.

C. Mechanical control

Several techniques using implements can be applied to control weedy rice, such as

- i. Operation of blade or rotary harrow under both dried and flooded soils, just before sowing/planting of rice.
- ii. Sowing or planting of rice in rows to remove the weedy rice seedlings grown between rows by using mechanical tools like finger weeder, cono weeder etc.

D. Chemical control

The close anatomical and physiological similarity to cultivated varieties makes the control of weedy rice plants very difficult with selective post-emergence herbicides. The most successful management technique is based on herbicide application before crop sowing/planting both before and after emergence of these weeds. It includes

- Application of pretilachlor at 1.5 kg ha^{-1} at least 20 days before rice planting or Pre-sowing application of anti-germinative herbicides viz., molinate at 7.2 kg ha^{-1} to prevent germination of weedy rice seeds
- Spraying of Maleic hydrazide on weedy rice plants at the heading stage helps in reducing seed viability. However, it should be done before milky-stage of cultivated rice to avoid its negative effects on the yield and seed viability.
- In continued flooded monocultures, adoption of stale seed bed technique followed by spraying of the graminicides viz., dalapon (12 kg ha^{-1}) or total herbicides viz., glyphosate ($1-1.5 \text{ kg ha}^{-1}$), paraquat (0.8 kg ha^{-1}) and oxyfluorfen (0.8 kg ha^{-1}) once the weeds have reached 2-3-leaf stage helps to reduce weedy rice.



Collection of Weedy rice in Ganjam district, Odisha

Weedy rice infestation. Incomplete control of the weed for a given year could lead to eliminating the results of several years of good control. An appropriate combination of different methods including preventative, cultural, mechanical or chemical practices can reduce the chances of weedy rice infestation.

A. Preventive measures

Prevention is the basic means of reducing weedy rice infestation and can be done by following methods

- Use of certified seeds or 'Clean seed' from a known source that is free from weedy rice seeds.
- The seeds of weedy rice can be introduced by combine harvesters, or through mud on tractors or in other implements. Use of 'Clean machinery', particularly, if it is coming from infested fields can prevent its introduction.
- Canals and irrigation channels should be cleared from infestations of wild/weedy rice.

B. Cultural methods

A cultural strategy of weedy rice control includes

- Burning of rice stubbles/ straw in dry rice fields after harvest to destroy weedy rice seeds on the soil surface.
- Good land preparation with mould board plough to reduce 'Soil seed bank'.
- Proper crop rotation by growing soybean, groundnut, maize, wheat, sunflower, sorghum, mungbean etc. as these crops allow alternative herbicide treatments and cultivation practices which would help to suppress weedy rice.
- Adoption of 'Stale seed bed' techniques to avoid infestation. In heavily infested areas, it should be repeated to incrementally deplete the soil seed bank of weedy rice.
- Use of weed-suppressing (semi-tall) and submergence tolerant varieties in rainfed lowlands for greater competitiveness.
- 'Water seeding' or 'wet seeding' can also be adopted in places where water is available.
- Flooding in well-levelled soils limits weedy rice germination. Puddling combined with the presence of a thin layer of water over well-levelled soil maintains the anaerobic conditions in the top soil and prevents weedy plants from becoming established.
- If feasible, 'Manual or mechanical transplanting' could be a suitable alternative method of crop establishment to prevent weedy rice infestation.



Panicle of Weedy rice

Variability in awn length in Weedy rice seeds

Other important characteristic features of Weedy rice

i. Dormancy and seed longevity

Weedy rice seeds show a variable degree of dormancy. The duration of dormancy varies according to the biotypes (*O. sativa* and *O. glaberrima*) and the storage conditions of the seeds. Environmental conditions during seed formation, moisture and the storage temperature are considered to be the main factors that can affect the length of dormancy. Viable seeds with red pericarp may remain dormant up to two years or more. The seeds can last up to 12 years; however, it is largely influenced by burial depth. It may remain viable by 90% after two years of burial and up to 20% after seven years. The seeds dug up after one year requires less time to germinate than those buried for two years.

ii. Emergence

Weedy rice seeds are not able to emerge from soil just after shattering, even under favourable environment. Shattered seeds require at least 70 days under favourable temperature and moisture conditions before germination starts. The emergence is also greatly influenced by the soil texture, the presence of water in the field and the depth of seed burial. However, tillage operation in relation to 0-10 cm seed bank plays an important role in emergence of seeds. The seeds buried at a depth of 4-5 cm shows a delay in germination of 15 days in comparison to the seeds that are nearer to the soil surface. Emergence from 0-1 cm layer is completed in 14 days in the moist soil and in 18 days in the flooded soil. No emergence occurs from the seeds buried at more than 10 cm.

iii. Shattering

Early seed shattering is a specific characteristic of weedy rice. It starts nine days after flowering and continues gradually for 30 days until complete development of the panicle. Shattered and non-shattered

seeds are found viable at about nine days from the beginning of flowering, with a germinability of about 20%. This increases quickly and reaches about 85% at 20 days after flowering. In general, the shattered grains show a lower germinability up to 24 days after flowering, in comparison to that of non-shattered seeds. The seeds that shatter after 15 days from flowering contain nearly filled and physiologically matured grains.

Recent threats to rice cultivation in the country

Indian weedy rice belongs to *indica* group similar to wild type and these weedy rice strains may have originated from hybridization between wild and cultivated rice. *O. sativa f. spontanea* is considered a weedy species in cultivated rice in the country. The country has been identified as the centre of origin of rice and many wild and weedy relatives are present in major rice-growing areas of the country. The Western Ghats region of South India is rich in biodiversity of wild species including *O. rufipogon* and *O. nivara*. Similarly, in Eastern India (Eastern Uttar Pradesh, Bihar, Odisha, West Bengal, Assam and Manipur) where wild and weedy relatives are common, *O. nivara* and *O. rufipogon* are abundantly found in the lowlands, swamps and marshes, in open ditches as well as in swampy grasslands. Among the different wild species present in India, *O. nivara* and *O. rufipogon* share the same genome AA as cultivated rice and easily crossed with cultivated *O. sativa*. In contrast, other wild species such as *O. officinalis* (CC), and *O. granulata* (GG), present in India with genomes different from AA are difficult to cross with the cultivated rice. However, in Northwestern States of India (e.g. Haryana and Punjab), wild and weedy relatives are not present, thus, there are very low risks of development of weedy rice.

What problems does Weedy rice pose?

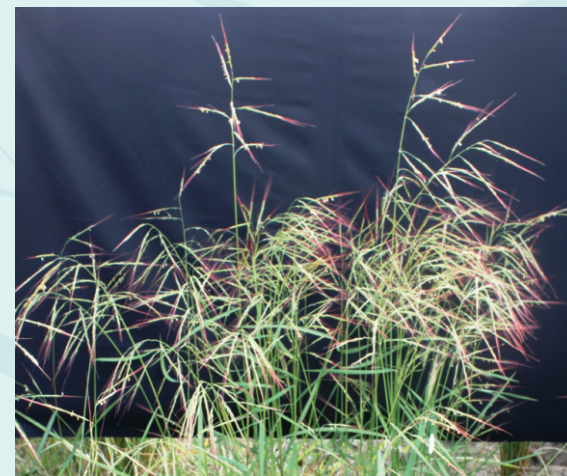
Weedy rice is dispersed in rice fields and grows alongside cultivated rice, making its identification and control very difficult because of its similarity with cultivated rice at early vegetative stage. Growth and competitive ability of weedy rice may vary considerably due to differences in plant height, tiller number and leaf area. Dwarf varieties are usually more susceptible to weedy rice competition than tall ones. Interference between cultivated varieties and weedy rice begins three weeks after rice emergence. The important traits of weedy rice that make it more competitive than cultivated varieties are rapid vegetative growth, taller canopy, high tillering capacity, spreading growth habit with long drooping leaves, voracious consumption of fertilizer, tolerance to shade, asynchronous maturation of seeds, tendency to lodge because of weak culm that disturbs the micro-environment, seed dehiscence, seed dormancy and red pericarp. The close

similarity between weedy rice and the commercial varieties has prevented the application of herbicides that are able to selectively control the weed. It reduces the value of the harvest by contaminating the crop with grains of colored pericarp.

How does it spread in cultivated rice field?

Weedy rice seems to have inherited the high reproductive ability from modern rice varieties and seed shattering and dormancy of wild rice, which contribute towards build up and persistence of its seed bank in the soil. As it is very difficult to distinguish weedy plants from the crop at vegetative stage, it grows along with cultivated rice, competes with crop, produces huge quantity of seeds and finally reduces crop yield. Farmers cannot harvest the grain of weedy rice as it tends to mature earlier and to shatter readily. Instead of flowering and producing seed once a year like traditional rice varieties and local wild rice, weedy rice produces seed year round just like photoperiod insensitive modern rice varieties.

The early and heavy shattering of seeds is an important mechanism for its quick dispersal and spread. Substantial portion of the seeds produced by a plant are scattered to the surface of the soil where they can be spread further by wind and water before being consumed by animals, harvested with the grain or eventually falling to the ground in a clump along with the plant. These seeds can be transferred from heavily infested field to the neighboring fields by the combined harvester or other machines used in rice cultivation. It may also transmit by the commercial seeds contaminated with weedy rice.



Close-up of Weedy rice introgressed with *O. rufipogon*

How can we prevent Weedy rice infestation?

Control of weedy rice is much more difficult because of its great morphological variability, particular growth behaviour and high biological affinity with cultivated varieties. However, in the present situation, it is very important to protect rice field from contamination of