



POPULAR ARTICLE

Effective management of herbicide-resistant littleseed canarygrass (*Phalaris minor Retz.*) in wheat

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Intricacies of the subject

Wheat (*Triticum aestivum* L.) is a major cereal crop and an important source of food and nutritional security worldwide. Among the various factors affecting wheat productivity, weed infestation, particularly by littleseed canarygrass (*Phalaris minor Retz.*), is a major concern in the rice–wheat production system of north-western India. The weed exhibits strong competitive ability and resembles wheat during early growth stages, making its identification and control difficult. Intensive and repeated use of herbicides has resulted in the development and spread of herbicide-resistant populations, including resistance to isoproturon and, subsequently, ACCase- and ALS-inhibiting herbicides. The occurrence of multiple-herbicide-resistant *P. minor* populations has therefore reduced the effectiveness of conventional weed control practices. Herbicides such as pyroxasulfone, pendimethalin, flumioxazin, trifluralin and flufenacet offer useful alternatives for managing resistant populations. Nevertheless, dependence on herbicides alone may accelerate resistance development. Hence, an

integrated weed management approach involving suitable herbicide combinations, crop rotation, timely sowing, competitive wheat cultivars, residue management, conservation tillage and effective control of weed seed production is required for sustainable suppression of *P. minor* and stable wheat production.

Introduction

Wheat (*Triticum aestivum* L.) is an important staple food crop grown extensively across the world and plays a major role in ensuring food, feed and nutritional security. Increasing wheat production under changing climatic conditions requires efficient management of available resources and constraints affecting crop productivity. Among biotic stresses, weed infestation is one of the major factors limiting wheat production and productivity. This constraint can be addressed through timely adoption of effective and sustainable weed management practices. Little seed canarygrass (*Phalaris minor Retz.*), an annual grass belonging to the family Poaceae, is one of the most troublesome weeds of wheat, particularly



in the rice-wheat cropping system of north-western India. Its close morphological similarity with wheat and similar growth requirements makes its identification and removal difficult during the early stages of crop growth. Although characteristics such as a prominent ligule, purplish-orange sap, light-green leaves, tillering and branching habit and smaller ear head help distinguish *P. minor* from wheat, these features are often difficult to recognize at early growth stages. The weed is highly competitive and severe infestations can cause substantial yield losses and, under heavy infestation, even complete crop failure. The narrow row spacing of wheat, scarcity and increasing cost of labour, and limited time available for weed removal have resulted in widespread dependence on herbicides for *P. minor* management. However, continuous and repeated use of herbicides has exerted selection pressure, leading to the evolution of herbicide resistance. Resistance was first reported against the Photosystem-II inhibitor isoproturon, and subsequently resistance to ACCase- and ALS-inhibiting herbicides has also developed in northern India. Consequently, multiple-herbicide-resistant populations of *P. minor* have become a major challenge for wheat production. Alternative herbicides, including pyroxasulfone, pendimethalin, flumioxazin, trifluralin and flufenacet, can provide effective control of resistant populations. However, long-term reliance on herbicides alone is not sustainable. Integrated management involving alternative herbicides, herbicide mixtures, crop rotation, competitive varieties, timely sowing, weed seed management, residue mulching and conservation tillage is essential for sustainable control and delaying further evolution of herbicide resistance.

Herbicide resistance

It is the ability of some plants to survive a dose that kills the others, and it is not a fault of the

product. In any weed population a few plants are naturally less susceptible, and repeated use of the same herbicide, or of herbicides with the same mode of action, lets these plants survive, set seed and multiply until most of the population is resistant. In wheat, isoproturon was widely used from the late 1970s, and after more than a decade of use with faulty spraying and rice-wheat monocropping, resistance appeared in the early 1990s, the world's first serious case in *P. minor*; by 1993 resistance affected 0.8-1.0 million ha, mainly in Haryana and Punjab. Fenoxaprop, clodinafop, sulfosulfuron and tralkoxydim were recommended in 1997-98, and they began to fail after 8-10 years. Pinoxaden and mesosulfuron + iodosulfuron followed, but some populations resisted them even without prior exposure, and metribuzin, now used alone or with clodinafop or pinoxaden, has begun to fail in some populations. Wild oat (*Avena ludoviciana*) and *Rumex dentatus* have also become resistant to some herbicides. Table 1 lists the herbicides to which *P. minor* has become resistant, together with the way each one kills the weed, which is called its mode of action. Resistance to one herbicide often brings resistance to others in the same group (cross-resistance), and populations resistant to two or more groups are multiple-resistant; in India this now covers photosystem II, ACCase and ALS inhibitors.

Management of herbicide resistant *Phalaris minor*

Preventive methods

Prevention is cheaper than cure, because an established resistant population is very hard to remove. The first aim is to keep resistant seed from entering or leaving a field. Sow pure, weed-free seed, clean combines and machinery before moving to a clean field, and keep bunds, channels and roadsides free of the weed. Mark fields where a herbicide has failed



and inspect each field 10-15 days after every spray. Before blaming resistance, rule out a

wrong dose, late spraying, dry soil and poor coverage.

Table 1. Herbicides to which *Phalaris minor* is resistant, and their mode of action

Herbicide	Chemical group	Mode of action (group)
Isoproturon	Phenyl urea	Photosystem II inhibitor (Group 7)
Diclofop-methyl	Aryloxyphenoxypionate	ACCase inhibitor (Group 1)
Fenoxaprop-P-ethyl	Aryloxyphenoxypionate	ACCase inhibitor (Group 1)
Clodinafop-propargyl	Aryloxyphenoxypionate	ACCase inhibitor (Group 1)
Pinoxaden	Phenylpyrazoline	ACCase inhibitor (Group 1)
Sulfosulfuron	Sulfonylurea	ALS inhibitor (Group 2)
Mesosulfuron + iodosulfuron	Sulfonylurea	ALS inhibitor (Group 2)
Metribuzin	Triazinone	Photosystem II inhibitor (Group 5)
Tralkoxydim	Cyclohexanedione	ACCase inhibitor (Group 1)

Cultural methods

Cultural methods make the field less favourable for the weed and help the crop compete better. They are low-cost practices and can be used along with any herbicide programme. In a stale seedbed, one or two irrigations are given before sowing, and the first flush of weeds is destroyed by shallow tillage or a non-selective herbicide before wheat is sown. Timely sowing at the end of October, a higher seed rate of about 125 kg/ha, narrow row spacing of 15–17.5 cm and use of an early vigorous variety help wheat suppress the weed. Fertilizer should be placed close to the crop rows rather than broadcast, which gives wheat a competitive advantage. Growing crops such as berseem, mustard, potato, sugarcane or sunflower instead of wheat for one to three years can also help in reducing *P. minor*. Crop rotation allows the use of different herbicides and helps reduce its short-lived seed bank in the soil. Burning rice residue increases *P. minor* emergence by 31-83%, whereas zero-till sowing with a Happy Seeder in retained residue can reduce weed emergence. Where crop residue is retained, the recommended volume of water should be used during herbicide spraying so that sufficient spray reaches the soil, as the residue can intercept soil-applied herbicides.

Physical and mechanical methods

Wheat is sown in close rows, so hoeing between the rows is not possible once the crop is up, and physical methods work mainly before sowing and just before the weed sets seed. Tillage before sowing destroys weeds that have already germinated and is the second step of the stale seedbed. Survivors can be pulled out by hand at ear emergence, when the ear-head of the weed can be told apart from wheat, and the pulled plants should be removed from the field and destroyed, weedy patches harvested last and the combine cleaned afterwards.

Herbicidal (chemical) method

Herbicides remain the main tool, but they must be used in a planned way. In a sequential programme, pre-emergence herbicide (sprayed just after sowing) is followed at 30–35 days by a post-emergence herbicide from a different group (Table 2). In a tank-mix, two herbicides are applied together in one spray, which is generally more effective than rotation. As most post-emergence herbicides are failing, pre-emergence products have gained importance. The post-emergence spray should be applied while the weed has only 2–4 leaves. Products should be mixed only if each controls the weed, and the group, not just the brand, should be changed, since clodinafop and pinoxaden act alike. The label dose should be used, because low doses leave half-killed plant



that set seed. Herbicides should not be mixed with urea or sand. In field studies, sequential programmes and tank-mixes outperformed a single spray of clodinafop or sulfosulfuron. Pendimethalin + pyroxasulfone followed by mesosulfuron + iodosulfuron gave the lowest infestation. Pre-emergence pyroxasulfone, pendimethalin, trifluralin, flumioxazin and flufenacet controlled multiple-resistant populations, as did metribuzin tank-mixed with clodinafop or pinoxaden. Some wheat varieties are sensitive to metribuzin, and flumioxazin can damage wheat if rain falls within 1-2 weeks of sowing. Clodinafop, fenoxaprop, sulfosulfuron and isoproturon used alone often fail on resistant fields, and

pyroxasulfone should be rotated or mixed and not used alone every year. Pinoxaden works best after a pre-emergence herbicide, mesosulfuron + iodosulfuron is unreliable alone and should not be followed by maize or sorghum, and the tolerance of the variety to metribuzin should be checked. For broadleaf weeds, metsulfuron (4 g/ha) or triasulfuron (20 g/ha) can be added, as pyroxasulfone is weak on *Rumex dentatus* and *Medicago denticulata*. Acclonifen (875 g/ha, post-emergence), cinmethylin (250 g/ha, pre-emergence) and bixlozone (750 g/ha) are further options. Sprays should use a calibrated sprayer with a flat-fan nozzle and full water volume, and pre-emergence products need moist soil.

Table 2. Herbicides for resistant *Phalaris minor* in wheat

Herbicide	Dose per acre	Dose(g a.i./ha)	When to apply
Pre-emergence herbicides (1-3 days after sowing)			
Pyroxasulfone 85 WG	60 g	127.5	Pre-emergence, or 1 day before first irrigation (18-20 DAS)
Pyroxasulfone 85 WG + pendimethalin 30 EC (tank-mix)	60 g + 1300 ml	127.5 + 1000	Pre-emergence
Flufenacet 41 SC	244-292 ml	250-300	Just after sowing, or early post-emergence (EPO)
Metribuzin 42% + clodinafop 12 % WG	200 g	270	Post-emergence

Integrated weed management

Integrated weed management (IWM) combines preventive, cultural, physical, and chemical methods so that no single practice is used repeatedly. Different methods act on the weed in different ways, reducing its ability to adapt and helping to extend the effective life of herbicides. An IWM programme should begin before sowing by identifying fields with a history of herbicide resistance, using clean seed and machinery, and preparing a stale seedbed. The first weed flush should be destroyed by shallow tillage. Wheat should be sown on time with the recommended seed rate and closer row spacing. Where suitable, a Happy Seeder can be used with retained residue. A suitable pre-emergence herbicide,

such as pyroxasulfone + pendimethalin or pendimethalin + metribuzin, should be applied on moist soil. At 30–35 days after sowing, a post-emergence herbicide from a different mode of action, such as pinoxaden or mesosulfuron + iodosulfuron, can be used when required. Heavy infestations or multiple-resistant populations require stronger integration of herbicides, crop rotation and removal of surviving plants. Common mistakes such as repeated use of the same herbicide, late spraying, application on dry soil, increasing the dose of a failed herbicide and allowing survivors to produce seeds should be avoided. Field-wise records of herbicide use and surviving weeds should be maintained to guide future management and delay further resistance.



Conclusion

Herbicide-resistant *P. minor* is a management problem, not a lost cause. Farmers who succeed treat weed control as a yearly plan and not a single spray. If they stop seed moving between fields, help the crop outcompete the weed, remove the survivors, and change the

herbicide group and follow the crop rotation in each season, *P. minor* can be managed. Because few new herbicide modes of action are available, we must protect the existing ones. This approach can cut weed numbers enough to give yields close to weed-free levels, even in fields where the weed once took a large share of the crop.

Reference

1. Mahajan, G. and Brar, L.S. 2019 Integrated management of *Phalaris minor* in wheat: Rationale and approaches-A review. Agric. Rev., 23(4):241-251.
2. Kaur, T., Bhullar, M.S. and Kaur, S. 2019. Control of herbicide-resistant *Phalaris minor* by pyroxasulfone in wheat. Indian J. Weed Sci., 51(2):123-128.
3. Soni, J.K., Nibhoria, A., Punia, S.S. and Hota, S. 2021 Herbicide-resistant *Phalaris minor*: A challenge for sustainable wheat production. Indian Farming, 70(9).
4. Chhokar, P.K. *et al.* 2025 Management practices to control multiple herbicide-resistant *Phalaris minor* in wheat. Weed Biol. Manag. doi:10.1111/wbm.70006.