

Herbicide resistant Jungle rice

in soybean growing belts of Madhya Pradesh

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Soybean, an important oilseed crop of central India, is grown during rainy season. The *Echinochloa colona*, one of the major weeds of soybean, causes significant yield loss and quality deterioration. Herbicide resistance is becoming major issue due to continuous use of single herbicide. Cases of imazethapyr resistance were observed in *E. colona* at soybean growing belts of Madhya Pradesh. The study was taken up to evaluate herbicide resistant *E. colona* biotypes against imazethapyr in soybean. A survey was conducted in 20 soybean growing districts of Madhya Pradesh and 93 *E. colona* biotypes were collected. The collected biotypes were grown in pots and imazethapyr was applied at 100 (1×), 200 (2×) and 400 (4×) g/ha at 4-5 leaf stage during 2017 and 2018. Thirty-six biotypes in second generation remained resistant up to 4× dose of imazethapyr. Further, highest number of imazethapyr-resistant biotypes were identified from Indore (11) followed by Dhar (8), Bhopal (5) and Ujjain (4). Relying on a single mode of action of herbicide may enhance the possibility of weed species to become resistant to particular herbicide. Therefore, there is an urgent need to tackle the imazethapyr-resistant *E. colona* weeds and find out an alternate strategy to control the problem.

Key words: *Echinochloa colona*, Herbicide resistance, Jungle rice, Soybean

SOYBEAN is grown in Madhya Pradesh, Maharashtra, Rajasthan, Andhra Pradesh, Chhattisgarh, Gujarat and Karnataka. Madhya Pradesh and Maharashtra produce around 85% of the total soybean production of India. In India, it is cultivated in 108.36 lakh ha with the annual production of 114.83 lakh tonnes. Madhya Pradesh contributes 54 lakh ha of soybean cultivated land with production of 59 lakh MT and 1.10 t/ha of productivity (SOPA). As soybean is grown during rainy season, weed is the major biological constraint of soybean production, which causes a reduction in the yield of soybean from 58-85%, depending upon the types and intensity of weed infestation. In India, among 10 major crops, the actual yield loss due to weeds are of about USD 11 billion,

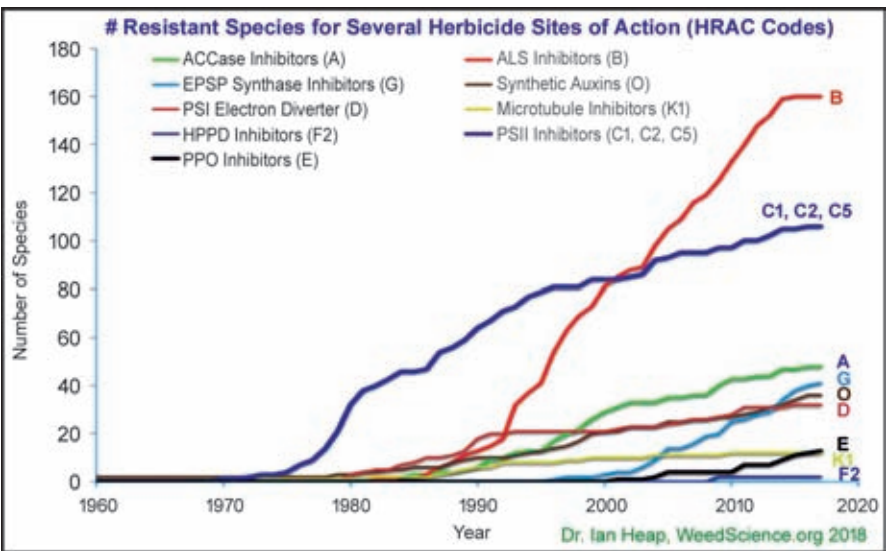
of which soybean (USD 1,559 million) is third highest after rice (USD 4,420 million) and wheat (USD 3,376 million). The major weed flora present in soybean are *Echinochloa colona*, *Commelina communis*, *Commelina benghalensis*, *Alternanthera paronychioides*, *Eclipta prostrata*, *Cucumis pubescens*, *Dinebra retroflexa* and *Celosia argentea*. Among the different weed flora *E. colona* is one of the most dominating weeds in soybean which is native to India and commonly known as jungle rice. Previously, farmers were mainly practicing hand weeding or mechanical weeding with different cultural practices to manage weeds in soybean. But from 2005-06, farmers became aware about the use of herbicides in soybean crop. It was mainly due to the increase in labour

scarcity due to migration of rural labourers to urban cities for higher wages. As a result, the percent share of herbicide consumption among pesticide significantly increased from very low amount in 2003-04 to considerable amount in 2016-17. On the other hand, repeated use of the same herbicide over years may cause herbicide resistance in weeds. Herbicide resistance is the inherited ability of a individual plant to survive a herbicide application that would kill a normal population of the same species. Whereas, herbicide tolerance is the inherent ability of a species to survive and reproduce after herbicide treatment at a normal use rate. Globally, there are currently 495 unique cases of herbicide resistant weeds, with 148 dicots and 107 monocots species. Weeds have

evolved resistance to 23 of 26 known herbicide sites of action and 163 different herbicides. Herbicide resistant weeds have been reported in 92 crops in 70 countries. In India till now five cases of herbicide resistance have been reported in 2 weed species i.e. *Phalaris minor* and *Rumex dentatus* (Table 1). First case of herbicide resistance in *P. minor* against isoproturon herbicide was reported in wheat crop. Now, *Phalaris minor* has evolved multiple herbicide resistance (MHR) across three modes of action: photosystem II site A, acetyl-coA-carboxylase (ACCase) and acetolactate synthase (ALS) inhibition. A recent case of herbicide resistance in India was reported in *Rumex dentatus* against ALS inhibitor (metsulfuron).

In soybean imazethapyr, an ALS inhibitor herbicide, was commercialized and continuously used in last 10-12 years for controlling the weeds in central India (Madhya Pradesh). Hence, there was a considerable chance for the development of herbicide resistance. Herbicide resistance occurs when a weed could no longer be controlled by an herbicide at rates that were previously effective.

To evaluate the selection pressure of imazethapyr for *E. colona* in soybean, we surveyed and collected 93 *E. colona* biotypes from 20 soybean growing districts of Madhya Pradesh from Indore (12), Ujjain (9), Dhar (9), Ratlam (9), Shajapur (7), Bhopal (7), Sagar (7), Chhattarpur (5), Dewas (6), Damoh (3), Harda (3), Mandsaur (3), Guna (2), Agar (2),



Global scenario of herbicide resistant weeds against different site of action of herbicides

Hoshangabad (2), Raisen (2), Tikamgarh (2), Ashok Nagar (1), Rajgarh (1) and Sehore (1) during *kharif* 2016.

Simple random sampling was used to collect the weed seeds under study. Only physiologically mature seeds were collected. Seeds were collected from 5-7 locations in each field and bulked together to make single sample. The GPS coordinates were noted down at every location throughout the survey. We collected the samples by interacting with the farmers, where imazethapyr efficacy was less. After interaction with farmers, we came to know that, they are also using other herbicides, viz. quizalofop, chlorimuron ethyl, propaquizafop, imazamox + imazethapyr, acifluorfen + clodinafop-propargyl for controlling of resistant *E. colona* biotypes. Even, farmers are using double and triple

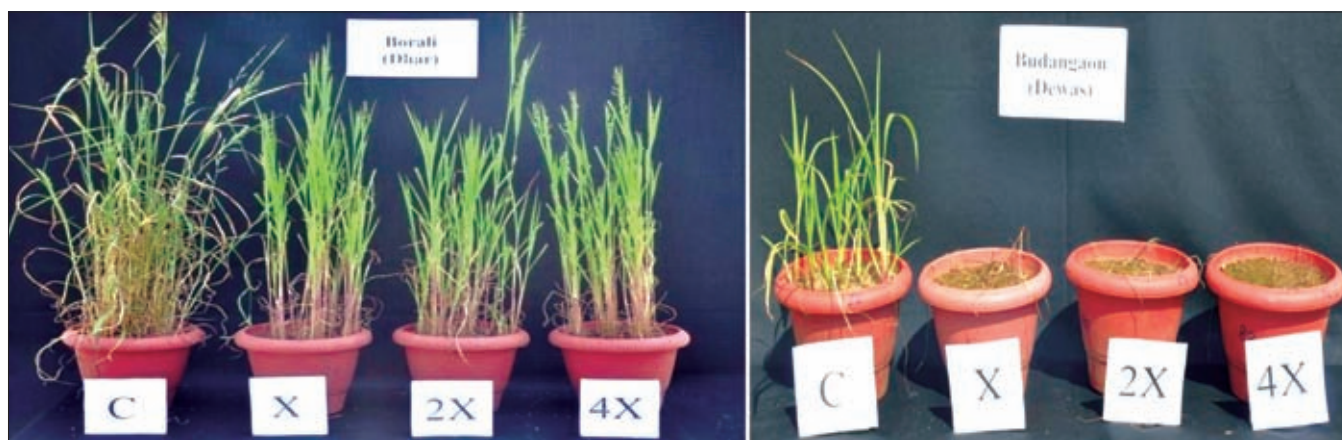
dose of imazethapyr repeatedly to control it, but still unable to control the resistant biotypes with higher dose of imazethapyr. During *kharif* 2017, a net-house experiment was conducted at ICAR-DWR, Jabalpur. The collected seeds of *E. colona* (93 biotypes) were sown in plastic pots of 20 cm diameter and 22 cm height. The tested herbicide (imazethapyr) was applied at 100 (×), 200 (2×) and 400 (4×) g/ha at 4-5 leaf stage of *E. colona* biotypes. During 2017 forty-five biotypes from 15 districts, viz. Indore (11), Dhar (8), Bhopal (5), Ujjain (4), Sagar (3), Shajapur (2), Dewas (2), Harda (2), Hosangabad (2), Chhattarpur (1), Ashok Nagar (1), Damoh (1), Ratlam (1), Guna (1) and Raisen (1) were found to have variable level of resistance against imazethapyr. For confirmation of resistance in *E. colona* biotypes, the harvested seeds of resistant biotypes (*kharif* 2017) were again tested in *kharif* 2018. It was found that, 36 biotypes in second generation remained resistant up to 4× dose of imazethapyr.

The growth of some biotypes was stunted initially at higher dose (2× and 4×) but they were able to produce seeds at maturity. Among the 20 districts of Madhya Pradesh, the biotypes of Indore, Dhar, Bhopal and Ujjain were found with highest level of resistance against imazethapyr. Results indicated that relying on single herbicide to control weeds may enhance the possibility of its becoming resistant to a particular

Table 1. Cases of herbicide resistance registered from India

Weed	Year	Site of action	Herbicides
<i>Phalaris minor</i>	1991	PS II Inhibitor	• Isoproturon
<i>Phalaris minor</i>	1994	ACCase inhibitor	• Diclofop
<i>Phalaris minor</i>	2006	Multiple resistance: 3-sites of action • ACCase inhibitor • ALS inhibitor • PSII inhibitor	• Diclofop • Idosulfuron methyl • Mesosulfuron methyl • Isoproturon
<i>Phalaris minor</i>	2013	ALS inhibitor	• Idosulfuron methyl • Mesosulfuron methyl • Metsulfuron
<i>Rumex dentatus</i>	2014	ALS inhibitor	• Cross resistance • Metsulfuron+ pyroxsulam • Haluxifen+ florasulam

(Source: International Survey of Herbicide Resistant Weeds; <http://www.weedscience.org>)



Resistant and susceptible biotype of *E. colona* against imazethapyr.

herbicide. Therefore, there is an urgent need to tackle the imazethapyr resistant *E. colona* weeds in farmers' field and find out the alternate strategy to control this weed in soybean. The possible ways to mitigate the development of herbicide resistance is, use of herbicide at right dose, at right time, right source and at right place. Herbicides are considered only a temporary solution and, a sort of technology that comes along once every century or so.

Hence, instead of surmising the development of new potent herbicides, the integrated weed management approaches should be adopted, viz. crop rotation, curbing the spread of weed seeds, mechanical weeding etc.

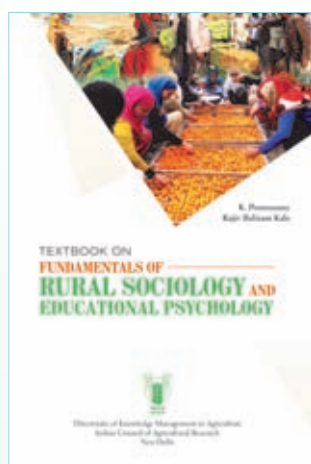
SUMMARY

The problems of herbicide resistance in *E. colona* were observed in Madhya Pradesh. The survey was conducted to collect biotypes of *E.*

colona from different districts of Madhya Pradesh. Thirty-six *E. colona* biotypes were found resistant against imazethapyr at 4-times of recommended dose. The possible way to manage the herbicide resistant weeds is by adopting the integrated means of weed management.

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TECHNICAL SPECIFICATIONS

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