Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 03, Issue: 06 (NOV-DEC, 2023)
Available online at http://www.agriarticles.com

4-Hydroxyphenylpyruvate Dioxygenase Inhibitors: A New generation Herbicides

(*Nitesh Samadhiya[1], Nishtha[2], Varsha Pandey[1] and Arpita Sharma[1])
[1]School of Agricultural Sciences GD Goenka University, Gurugram, Haryana, India
[2]Division of Genetics & Tree Improvement, Forest Research Institute, Dehradun, India
*Corresponding Author's email: niteshsamadhiya49@gmail.com

The continuous use of same mode of herbicide leads to the development of weed resistance against different mode of herbicides therefore the need for the development of new mode of action of herbicide was must and the continuous researches on various enzymes activities inside the plant are helpful for herbicidal discovery. The development of latest herbicides with new mode of action receiving considerable attention for controlling different weed flora.

In this research scientists found the 4-Hydroxyphenylpyruvate dioxygenase (HPPD) enzyme which is mainly engaged in photosynthetic activity and also in catalyzing the transformation of 4-Hydroxyphenylpyruvic acid (HPPA) to Homogentisic acid (HGA). HPPD inhibitors have shown their significant role in development of innovative herbicides with some superiority including broad spectrum weed control, excellent crop selectivity, low application rates etc.

Introduction

The latest herbicides of tri-ketonic group example- tembotrione, topramezone (selective herbicides used in maize, having good efficacy) are of 4-Hydroxyphenylpyruvate dioxygenase inhibitor group only. This mode of action herbicides inhibit the formation of carotenoid and carotenoid is an essential component which protects the chlorophyll from excessive sunlight, photo oxidation etc. If this carotenoid will not form then sensitivity of chlorophyll for sunlight will increases and which leads to loss of chlorophyll which results turning plant white. Use of different safeners with HPPD inhibitors in combination shows excellent control of major weed species also its beneficial for overcoming increasing resistance against other mode of herbicides. These are primarily used for controlling weeds in maize, barley, wheat, sugarcane and in rice also. HPPD inhibitors also shown good results when they were applied in combination with Photosystem II (PSII) inhibitors which increases the efficacy and weed control spectrum.

The studies are also going on new HPPD inhibitors from azole carboxamides class and they are expected to be available in future.

1. **Mode of action**- HPPD enzyme is very important for the synthesis of Plastoquinone (PQ) and PQ is a cofactor of phytoene desaturase enzyme (cofactor increases the activity of enzyme). This enzyme is required for the carotenoid biosynthesis, indirectly it increases the formation of carotenoids as HPPD inhibit carotenoid will get expose to sunlight and photodegradation starts to take place and the sensitive plants suffers oxidative damage as well as chlorophyll destruction, which turns them a white without deformation and eventually plant die The HPPD inhibiting herbicides are generally used for overcoming the problem of annual grasses as well as broadleaf weeds. They works well or as an

alternate of atrazine in maize and played an important role is increasing resource use efficiency as well as resource management of agronomic crops.

Examples of HPPD inhibitors or pigment synthesis inhibitors (carotenoid biosynthesis inhibitors) are:

Table:1 Name of different herbicide groups and herbicides

Name of herbicide group	Name of herbicide
a) Pyridazinone	Norflurazon
b) Pyridinone	Fluridone
c) Callistemone	Mesotrione
d) Isoxazole	Isoxaflutole, Pyrasulfotole
e) Triketone	Tembotrione, Topramezone
f) Isoxazolidinone	Clomazone
g) Triazole	Amitrole

The results of tembotrione and topramezone in combination with PSII inhibitors shown good results in weed management in maize-based cropping system as per the research done by AICRP on weed management. The quantity required of tembotrione and topramezone is not very much as compared to many herbicides.

Use of tembotrione and topramezone in AICRP on weed management by ICAR shows that the results of Tembotrione (@120g/ha) + PSII inhibitors group herbicide (Atrazine @500 g/ha) (Table no.2) including one handweeding at 40 DAS shows the better results in chemical weed control and also the B: C ratio is highest in that treatment.

Also topramezone shows the good results with PSII inhibitors group herbicide (atrazine) with one hand weeding at 40 DAS but the quantity of topramezone was very less, only 25.2 g/ha topramezone was required with 500 g/ha atrazine.

Table 2: Effect of different weed management practices on weed growth, crop yield and economics in maize

Treatments	Total weed density (No/m^2) at 60 DAS	Total weed dry weight (g/m^2) at 60 DAS	Grain yield (t/ha)	Straw yield (t/ha)	NMR (Rs /ha)	B:C Ratio
Atrazine 1.0 Kg/ha PE *fb* HW at 40 DAS	3.47 (11.6)	3.59 (12.3)	4.63	7.00	49,970	3.12
Atrazine + pendimethalin (0.50+0.25 Kg/ha) PE	6.24 (38.4)	5.06 (25.2)	2.98	6.15	28,635	2.37
Atrazine 1.0 Kg/ha PE *fb* 2,4-D 1.0 kg /ha LPoE	4.71 (21.7)	4.64 (21.1)	3.53	6.41	35,970	2.69
Atrazine + pendimethalin (0.50+0.25 Kg/ha) PE *fb* 2,4-D 1.0 kg /ha LPoE	5.19 (26.4)	4.93 (23.9)	3.48	6.37	35,218	2.65
Topramezone 25.2 g/ha EPoE	5.42 (29.0)	5.18 (26.3)	3.38	6.26	33,454	2.57
Tembotrione 120g /ha EPoE	5.75 (32.5)	5.57 (30.5)	3.40	6.28	33,616	2.58
Topramezone 25.2 g/ha EPoE *fb* IC +HW at 40DAS	3.22 (9.89)	2.49 (5.71)	4.21	6.50	43,024	2.83

Tembotrione 120g /ha EPoE *fb* IC +HW at 40DAS	2.97 (8.35)	2.49 (5.69)	4.07	6.70	41,243	2.74
Topramezone +atrazine (25.2+500g/ha) EPOE *fb* IC + HW at 40DAS	2.61 (6.34)	2.29 (4.75)	4.38	6.86	44,976	3.11
Tembotrione +atrazine (120+500g/ha) EPOE *fb* IC + HW at 40DAS	2.76 (7.11)	2.35 (5.01)	4.58	6.98	47,655	3.12
IC+HW at 20 and 40DAS	2.34 (5.03)	2.10 (3.94)	4.87	7.30	50,852	2.75
Weedy check	13.28 (176.0)	12.5 (157.1)	1.99	5.64	15,863	1.81
SE (m) ±	0.21	0.18	0.25	0.23	3,160	—
LSD (P= 0.05)	0.58	0.54	0.72	0.69	8,468	—

(Source: https://aicrp.icar.gov.in/wm/herbicidal-control-of-weeds-in-crops-and-cropping-systems/)

Conclusion

If the herbicide resistance occur in weeds then there is a need to develop new mode of herbicides and we can use them in combination with other previously developed herbicides. HPPD inhibitors have shown good results in controlling broad spectrum of weeds. Triketonic group herbicides have shown good results in controlling weeds effectively with low application rate and increases B: C also. Therefore these herbicides can be used effectively for the control of weeds and to enhance crop productivity.

References

1. https://aicrp.icar.gov.in/wm/herbicidal-control-of-weeds-in-crops-and-cropping-systems/