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PERSISTENCE OF PRETILACHLOR, PENOXSULAM AND PYRAZOSULFURON HERBICIDES IN SOIL

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Abstract- An experiment was conducted during *Kharif* season of 2012-2013 at experimental farm of Directorate of Weed Science Research, Jabalpur. The treatments included application of various herbicides applied to paddy crop @ pretilachlor 750 g a.i. ha $^{-1}$, penoxsulam 25 g a.i. ha^{-1}, and pyrazosulfuron 25 g a.i. ha^{-1} and weedy and hand weeding. The study was aimed to evaluate the pattern of dissipation, persistence and residue in soil at harvest. As regarded to the observation on persistence residue and dissipation study reveals that higher content of residue was found in sample taken at initially as well as during growth period with an interval of 5 days exhibited successive depletion of herbicidal residue with progressive growth of the crop till harvest. HPLC method for detection for persistence residue and dissipation indicated that a first order kinetics was followed and the average half life values ranged for pretilachlor (750 g a.i. ha^{-1}), penoxsulam (25 g a.i. ha^{-1}), and pyrazosulfuron (25 g a.i. ha^{-1}) were 15.06, 26.65 and 24.75 days respectively.

Keywords- Persistence, Pretilachlor, Penoxsulam, Pyrazosulfuron

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Introduction

As herbicides play an important role in agriculture, their use in agricultural crops is increasing throughout the globe. In India herbicide use is likely to increase 10 % annually. The contaminated ground water used for drinking water and irrigation may be hazardous to humans and livestock communities. Moreover, determination of herbicide residue in soil and edible plant part is very essential to evaluate the consequent possible harmful effects on human health or community. In this, regards [1] revealed that use of persistent herbicide may increase risk of accumulation of residue in soil, ground water, crop produce food chain etc. Hence, monitoring of herbicidal behavior in the soil and plant parts is necessary to evaluate the persistence and /or residue in soil that may directly or indirectly affect the soil environment, including soil physical chemical and microbial properties, thereby, directly regulating the productivity [2]. It has been established that agricultural productivity is mainly affected by various factors relating to soil fertility & climatic influences. However, among soil related constraints, monitoring, evaluation of soil fertility ranks on the priority [3]. However, maintaining soil fertility and use of herbicide for controlling weeds has increased considerably the yield potentials of crops to a considerable extent [4]. Hence, judicious use of agriculture inputs is necessary to maintain the balance between soil fertility and crop productivity. It has been observed that use of herbicide may greatly affect the soil properties and consequently the crop productivity [5].

Herbicide are greatly influenced by the soil factors like moisture, temperature, pH and organic matter content, in addition to microbial population and herbicide solubility [6, 7]. Optimum temperature, moisture and organic matter in soil provide congenial environment for the breakdown or retention of any pesticide added in the soil. The length of time a herbicide remains active in soil is called “soil persistence” or “soil residual life”. Herbicides vary in their potential to persist in soil. Persistence studies of sulfonylurea herbicide was also carried out under field condition and such as persistence of metsulfuron-methyl in wheat crop and soil environment, imazosulfuron residue in rice crop and soil persistence and leaching of sulfosulfuron under wheat cropping system [8]. Persistence of a herbicide in soil may be defined as the period of extension of time in which it remains active. Hence, persistence may also be used to determine the extent of contamination. In this connection, higher the persistence greater will be the level of contamination. Keeping above facts in mind the present investigation were carried out.

MaterialsandMethods

The experiment was conducted at Directorate of Weed Science Research Jabalpur (DWSR) and Department of Soil Science and Agricultural Chemistry, JNKVV, Jabalpur (M.P.) was carried out during Kharif season 2012. The experiment was consisted of 5 treatment with 4 replications laid out in randomized block design. The soils of experimental area (DWSR farm) include soil of medium texture (Sandy clay loam). They are deep soil and occur on level or gently sloping land. The soil have been developed on the parent material genesis, shale, sand stone, mostly they are the mixture are transported and residual soils.

Estimation of herbicide residue

Collection of soil samples

Soil sample were collected after application of pretilachlor, penoxsulam & pyrazosulfuron in soil at 1, 5, 10, 20, 30, 40, 60, 90 days and at harvest 0-20 cm depth. Approximately 500 g soil samples were collected. Samples were brought to laboratory for the determination of residue in the samples.

Analytical methodology for determination of pretilachlor residues in soil

10 g soil sample was weight and put in 250 ml conical flask. Added 30 ml solution (methanol: distilled water, 4:1) in each flask and shaken on rotary shaker for 2 hour at 130 rpm. After shaking filtered the samples and collected extract (repeated twice). Then added 5 ml sodium chloride solution and maintained pH-7 of hydrolysed samples. Samples were transferred to a 250 ml separating funnel and partitioned with n-hexane and collected organic layer. The organic layer was passed through activated charcoal. The solvent was evaporated to dryness on a rotary evaporator below 20 ^{0}C. Finally residues were dissolved in 2 ml acetonitrile for HPLC determination.

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Analytical methodology for determination of penoxsulam residues in soil

10 g soil sample was weight and put in 250 ml conical flask. Added 30 ml solution (Acetonitrile: distilled water, 4:1) in each flask and shaken on rotary shaker for 1 hour at 130 rpm. After shaking filtered the samples and collected extract. Then added 5 ml sodium chloride solution. Then maintained pH-7 of hydrolysed samples. Samples were transferred to a 250 ml separating funnel and partitioned with dichloromethane and collected organic layer. The organic layer was passed through activated charcoal. The solvent was evaporated to dryness on a rotary evaporator below 20 ^{0}C. Finally, residues were dissolved in 2 ml Acetonitrile for HPLC determination.

Analytical methodology for determination of pyrazosulfuron in soil

10 g soil sample was weight and put in 250 ml conical flask. Added 30 ml solution (methanol: distilled water, 8:2) in each flask and shaken on rotary shaker for 2 hour at 130 rpm. After shaking, filtered the samples and collected extract. Then added 5 ml sodium chloride solution. Then maintained pH-7 of hydrolysed samples. Samples were transferred to a 250 ml separating funnel and partitioned with dichloromethane and collected organic layer. The organic layer was passed through activated charcoal. The solvent was evaporated to dryness on a rotary evaporator below 20 ^{0}C. Finally residues were dissolved in 2 ml acetonitrile for HPLC determination.

Reference analytical standard

Penoxsulam, pretilachlor & pyrazosulfuron reference analytical standard was obtained from ACCU standard, USA. All the other chemicals and solvents used in the study were analytical grade obtained from E. Merck Germany and all the solvent glass distilled prior to use.

HPLC Determination

Penoxsulam, pretilachlor and pyrazosulfuron residues were analyzed by high-performance liquid chromatography method. HPLC analysis is performed on a Shimadzu HPLC, coupled to diode array detector. Pyrazosulfuron standard solution was injected and measured the peak area.

Half-life period

The long Half-lives of the herbicides were calculated from the logarithmic plot concentration of herbicides versus time (days) with the help of following equation

$$t_{½} = 0.693 / K$$

Where $t_{½}$ is the Half-life of the herbicide and K is dissipation constant.

Dissipation Constant

The integrated from of the first order rate equation is $\ln C = \ln C_o - Kt$ where C and C_0 are concentrations at time t and time zero, respectively and K is the rate constant or in this equation, the herbicide dissipation constant.

Results and Discussion

Persistence of herbicide residue is great concern as persistence of herbicide residue in the soil may damage the sensitive succeeding crop and adversely affect human and animal health due to bioaccumulation of residue in crop produce. The applied herbicide may find its way in to stream by runoff and may result in unfortunate consequences to non-target organism. Thus, persistence and bioaccumulation of various herbicides on soil and, crop plant in was evaluated. It has been established that long-term application of fertilizer, pesticide and other input under continuous cropping effect the dynamic of soil health over the year and their concentration was found to be higher immediately after application and progressive with advancement of growth period and level of input applied

Residues of pretilachlor, penoxsulam and pyrazosulfuron in soil sample

Pretilachlor residue in soil

Pretilachlor residues were recorded after spraying (DAS) of herbicide in soil. Residue of pretilachlor was found 0.714 µg g $^{-1}$ at 0 days after spraying of herbicide *viz.* collected 2 hours after application. Residue was continuously decline with passage of time and reached to 0.422 to 0.072, 0.065, 0.017 µg g^{-1} after 5, 10, 20, 30, and 60 days of spraying. At 90 day after spraying and at harvest residue were not detected in the soil [Table-1]. Similarly [9] reported in rice resulted the herbicide residues found in the soil after rice was harvested were below toxic levels

Penoxsulam residue in soil

Penoxsulam residue was found 0.0451 µg g^{-1} at days which dissipate to 0.0384, 0.0367, 0.0128, 0.0111 and 0.0013 µg g^{-1} after 5,10,20,30, and 60 days after spraying (DAS). At 90 days residue was found below detected level 0.001 µg g^{-1}. At harvest residue were not detected in paddy field [Table-1]. Similarly [10] reported residual effect after harvest that there were no residues of penoxsulam 24SC in soil in transplanted rice.

Pyrazosulfuron residue in soil

After 2 hours of pyrazosulfuron-ethyl application residue was found 0.0595 µg g^{-1}. The dissipation of pyrazosulfuron was found rapid and the residues reduced continuously declined with time and content was found about 0.0250, 0.072, 0.0172, 0.0029 and 0.0010 µg g^{-1} in soil after 5,10,20,30 and 60 days of spraying of pyrazosulfuron-ethyl on transplanting rice. At 90 days residue was found below 0.001 µg g^{-1} in the soil of paddy field. At harvest was also not found in the paddy field [Table-1]. Similar results were also reported by [11].

Table-1 *Residue of pretilachlor, penoxsulam, and pyrazosulfuron on soil at different interval in paddy field (at 0-20 cm depth)*

HERBICIDES RESIDUES	Days After Spraying							
	0	5	10	20	30	60	90	Harvest
Pretilachlor (µg g^{-1})	0.714	0.422	0.072	0.065	0.0017	0.0015	<0.001	ND
Penoxsulam (µg g^{-1})	0.0451	0.0384	0.0367	0.0128	0.0111	0.0013	0.001	BDL
Pyrazosulfuron (µg g^{-1})	0.0595	0.0250	0.0177	0.0172	0.0010	0.0029	<0.001	BDL

Note: BDL indicates below detected limit

Dissipation constant and half-life of pretilachlor, penoxsulam and pyrazosulfuron

Dissipation constant and half life period values of pretilachlor, penoxsulam and pyrazosulfuron are presented in [Table-2]. In this context half life of pretilachlor was found 15.06 days with a dissipation constant of 0.046. Penoxsulam dissipation varied between days and K values was obtained 0.026 that resulted t ½ values of 26.65 respectively. Pyrazosulfuron dissipation varied between various days and K values was obtained 0.028 and resulted t ½ values of 24.75 days respectively [Table-2]. [12] reported half-life values of pyrazosulfuron 5.4, 5.4, and 5.7 days at 20-30 g ha^{-1} rates of applications, respectively. Similar observations were found by [13] they reported half life of pyrazosulfuron-ethyl as being 11 and 19 days in paddy field soil and water respectively. [14] reported a half-life 23.1 days of flumetsulam, a sulfonamide herbicide. This indicates that flumetsulam degrades a little more slowly in soil.

Table-2 *Dissipation constant and Half-life of pretilachlor, penoxsulam and pyrazosulfuron in soil.*

Treatment	Equation	R^2	Dissipation (K)	Half life period (days)$t_{½}$
Pretilachlor	y = -0.046x - 0.429	0.803	0.046	15.06
Penoxsulam	y = -0.026x - 1.276	0.978	0.026	26.65
Pyrazosulfuron	y = -0.028x - 1.382	0.920	0.028	24.75

Conclusion

It was concluded that higher content of residue was found in sample taken at initially as well as during growth period with an interval of 5 days exhibited successive depletion of herbicidal residue with progressive growth of the crop till harvest. HPLC method for detection for persistence residue and dissipation indicated that the average half life values ranged for pretilachlor (750 g a.i. ha^{-1}), penoxsulam (25 g a.i. ha^{-1}), and pyrazosulfuron (25 g a.i. ha^{-1}) were 15.06, 26.65 and 24.75 days respectively.

Conflict of Interest: None declared

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