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PERSISTENCE OF PENDIMETHALIN AND IMAZETHAPYR IN SOIL AND THEIR EFFECT ON YIELD, SOIL PROPERTIES IN GROUNDNUT (*Arachis hypogaea* L.)

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ABSTRACT

A field experiment was conducted during the Kharif 2011, at College Farm, College of Agriculture, Rajendranagar, Hyderabad to study the persistence of pendimethalin and imazethapyr in soil and groundnut. Effect of herbicides on soil properties and yield of groundnut was assessed. The experiment consisted of two main plots and five sub-plots replicated thrice in split-plot design with Rhizobium inoculation and un-inoculation as main treatments and five sub-treatments viz., weedy check, pendimethalin (pre-emergence) at two doses (750 and 1500 ga.i/ha), imazethapyr (post-emergence) at two doses (75 and 150 g a.i/ha). Pendimethalin and imazethapyr residues in soil and plant were estimated on GC-ECD and GC-NPD, respectively. Recovery of pendimethalin and imazethapyr were 86.5 – 92.3 % and 87.4 - 90.8 % in soil and recovery of imazethapyr 86.6 – 91.7 % in plant. LOQ for pendimethalin and imazethapyrwas0.05 mg/kg and 0.005 mg/kg, respectively. Imazethapyr and pendimethalin residues in soil persisted up to 60 DAA at both the recommended and double doses. Dissipation of both herbicides in soil followed a first-order decay process. Pendimethalin and imazethapyr residues below the detectable limit in the plant, kernel or post-harvest soil samples indicated that these herbicides are safe for usage in groundnut crop. Despite better weed control achieved in imazethapyr double dose treatment, highest pod yield was recorded in imazethapyr at recommended dose where seed inoculation was done (2285 kg/ha) compared to Imazethapyr double dose (2160 kg/ha). Rhizobium seed inoculation did not significantly influence the pod yield. Usage of Pendimethalin and imazethapyr at recommended and double the recommended doses did not adversely affect the soil physical (BD, PD, % PS and MWHC), physic-chemical (pH, EC and CEC) and fertility properties (Available N, P and K).

Key Words : *Pendimethalin, imazethapyr, groundnut, persistence, soil properties.*

Groundnut (*Arachis hypogaea* L.) is one of the most important oilseed crops in India. Groundnut contributes nearly 65 per cent to the vegetable oil produced in India and holds the key to the fluctuating fortunes of vegetable oil industry. The most commonly used herbicides for weed management in groundnut crop cultivated in Andhra Pradesh are Pendimethalin as pre-emergence and Imazethapyr as early post-emergence spray. Application of Pendimethalin as pre-emergence herbicide @ 2.5 liters/ha or Imazethapyr as early post-emergence herbicide (15-20 DAS) is recommended for effective weed management in groundnut (1). Use of herbicides for weed control in legumes and especially in groundnut has certainly contributed to the increased yield and improved quality. However, detrimental effects caused by these herbicides on soil microorganism's growth and metabolism have also been reported in several studies. Persistence is an important characteristic of an herbicide affecting efficacy, exposure to environmentally important transport, and carryover to subsequent crops. The period during which the herbicide remains intact and biologically active has a great practical importance in determining how well it performs its intended task in soil. Persistence of herbicides in the soil and plant matrices is often a crucial factor determining its impact on the activity and metabolism of the symbiotic micro-organisms associated with the crop. Further, studies on persistence patterns of the herbicides viz., Pendimethalin and Imazethapyr are essential in view of their long residual life in the soil (2).

MATERIALS AND METHODS

This experiment was conducted during kharif, 2011 on sandy clay loam soil at College of Agriculture,

Rajendranagar, Hyderabad which is in Southern Telangana agro-climatic zone of Andhra Pradesh. The experiment was laid out in split plot design with 2 main treatments as Rhizobium un inoculated and inoculated at recommended dose (1 kg/ha). Sub treatments as herbicide dosages viz., weedy check, Pendimethalin at two doses 750 g a.i/ha and 1500 g a.i/ha, Imazethapyr at two doses 75 g a.i/ha and 150 g a.i/ha. Soil samples collected at before sowing of the experiment and at the time of harvest were processed and analysed for soil available nitrogen, phosphorous, potassium, pH, EC, organic carbon, CEC, soil texture, bulk density, particle density, pore space, water holding capacity. At maturity, grain and haulm yield from different treatments were recorded.

Standards were prepared using technical grade herbicides of various concentrations. Similarly samples were also extracted kept for clean up and fed to gas chromatograph. GC-ECD was used for estimation of Pendimethalin residue by adopting different GC conditions such as column, temperatures and carrier gas flow rate etc. in the same way GC-NPD was used estimation of Imazethapyr residue. Extraction and analysis of Pendimethalin were carried out as per the method of (3) solvent used for extracting is hexane. Cleanup is done using florosil column of 1.5 cm diameter and 10 cm height was prepared in a chromatography sintered glass column with 10 g florosil activated with 0.6 ml of double distilled water. Over this column, AR grade anhydrous sodium sulphate (2 cm height) was added to make the total column height of 10 cm. To this 25 ml of hexane was added consecutively drop by drop to drain in to the florosil column. Then the residue was obtained is eluted with the solvent and evaporated to dryness using rotary evaporator and made to 5ml and 1 µL was injected into gas chromatograph. Similarly for Imazethapyr was analysed using methanol as a solvent mixture and extracted.

RESULTS AND DISCUSSION

Persistence of residues in soil and plant

Results of the spiking experiment with soil indicated that the recovery of Pendimethalin was 86-92 %. Retention time of Pendimethalin was 10.75 minutes. Residues of Pendimethalin in soil as estimated by gas chromatography in recommended and double the recommended dose indicated that, the residues persisted up to 60 DAA in both the doses. More than 50 % of the Pendimethalin residue dissipated before 30 DAA. At 90 DAA and harvest the residues have reached below detectable limit (0.05 ppm). Regression analysis of the Pendimethalin degradation indicated that the dissipation of the Pendimethalin in soil was biphasic, with the initial 50 % of the residues dissipating at a faster rate compared to the later half. Recovery of Pendimethalin from grain was 82-88 %. Pendimethalin residues could not be detected in both the grain and plant samples at harvest (4) also reported that Pendimethalin persisted in the soils up to 60 DAS with typical half life of 31-32 days (Table-1). Studies conducted by (5) also reported similar persistence pattern of Pendimethalin up to 60 DAA at 0.75 and 1.5 kg a.i/ha in Alfisols. Retention time of Imazethapyr was 5.74 minutes with recovery in soil and plant varied between 81-84 % and 86-91 %, respectively. The Imazethapyr residues in soil persisted up to 60 DAA at both the recommended and double doses beyond which they reached BDL (0.005ppm). At 60 DAA, the soil residues dissipated by 90 % of the initial detected level in recommended dose and 85 % of the initial detected level double the recommended dose (Table-2). The plant Imazethapyr residues could be detected only up to 5 DAA in recommended dose and up to 15 DAA in double the recommended dose (Table-2). The herbicides reached BDL at harvest in both the doses (6) reported that dissipation of Imazethapyr in soils with 2.9 and 3.3 % organic matter was 19-47 days and 34-63 days respectively. However, in fine textured soils (clay loams and clay) the DT50 values of Imazethapyr varied from 143-309 days. Imazethapyr residue analysis data of the current study is in close correspondence with the above studies. In the present study also the half life of Imazethapyr in soils was 30-32 DAA and 4-5 DAA in groundnut plants. The phyto-toxicity symptoms exhibited by groundnut plants in double dose treatments also corroborate with the residue analysis data in the plants. Imazethapyr residue could not be detected in groundnut kernals.

Effect of inoculation and herbicides treatments on pod yield and haulm yield

Highest pod yield was recorded in Imazethapyr

Table-1 : Residues of Pendimethalin (ppm) in soil.

Days after application (DAA)	Recommended dose (0.75 kg/ha)	% Dissipation	Double the recommended dose (1.5 kg/ha)	% Dissipation
0	0.448	-	0.912	-
15	0.321	28.3	0.682	25.2
30	0.176	60.7	0.372	59.2
45	0.097	78.3	0.192	78.9
60	0.056	87.5	0.086	90.6
90	BDL	-	BDL	-
Harvest	BDL	-	BDL	-

Table-2 : Residues of Imazethapyr (ppm) in soil and plant.

Days after application (DAA)	Soil				Plant			
	Recommended dose (0.75 g/ha)	% Dissipation	Double the recommended dose (1.5 g/ha)	% Dissipation	Recommended dose (0.75 g/ha)	% Dissipation	Double the recommended dose (1.5 g/ha)	% Dissipation
0	0.066	-	0.121	-	0.023	-	0.042	-
15	0.049	25.8	0.082	32.2	0.012	47.82	0.019	54.8
30	0.031	53.0	0.062	48.8	BDL	-	0.008	81.0
60	0.006	90.9	0.019	84.3	BDL	-	BDL	-
Harvest	BDL	-	BDL	-	BDL	-	BDL	-

recommended dosage (2285 kg/ha) of inoculated main treatment. Rhizobium seed inoculation did not significantly influence the pod yield even though numerically superior yield was recorded in all the herbicide sub treatments over the corresponding sub-treatments in the un-inoculated main treatment. Mean pod yield was recorded in Imazethapyr at recommended dose (2202.5 kg/ha) was significantly higher than the Pendimethalin treatments (1550 kg/ ha in recommended dose and 1590 kg/ha in double the recommended dose) (7) and no herbicide sprayed plot. In spite of better weed control in Imazethapyr double dose treatment the phytotoxicity observed during 1st 1-2 weeks after spray might have resulted in lower nodulation, nitrogen fixation and consequently lower yields. Similar trend was also noticed when compared

Table-3 : Pod yield and Haulm yield in kg/ha of Groundnut as influenced by inoculation and herbicide treatments

Inoculation treatments (M)	Pod yields in kg/ha					
	Herbicide treatments (S)					Mean
	S_1	S_2	S_3	S_4	S_5	
Un inoculated (M_1)	640.0 (560)	1490.0 (2025)	1540.0 (2160)	2120.0 (2440)	2080.0 (2590)	1574.0 (1955)
Inoculated (M_2)	820.0 (590)	1610.0 (2080)	1640.0 (2265)	2285.0 (2460)	2160.0 (2630)	1703.0 (2005)
Mean	730.0 (575)	1550.0 (2052)	1590.0 (2212)	2202.5 (2450)	2120.0 2610)	
	S.Em±		C.D (0.05)			
Main(M)	21.80		N.S.			
Sub(S)	37.63		112.83			
S at same level of M	48.74		N.S.			
M at same level of S	52.35		N.S			

Table-4 : Effect of Rhizobium seed inoculation and herbicides treatments on soil properties Viz., Soil Texture, Bulk Density (BD), Particle Density (PD), Pore Space and Maximum Water Holding Capacity (MWHC), pH, EC, Organic carbon (%), Available N (kg/ha), P_2O_5 (kg/ha), K_2O (kg/ha), CEC of harvested soil sample of harvested soil sample at harvest.

Treatments	Days after sowing (DAS)				BD ($Mg\ m^3$)	PD ($Mg\ m^3$)	PS (%)	MWHC (%)	pH	EC	OC %	Soil available N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)	CEC cmol(p+)/kg
	Soil Texture			Textural class											
	%sand	%silt	% clay												
Initial soil sample	74	4.8	21.2	scl	1.30	2.64	42.6	37.0	7.8	0.49	0.56	190	43.0	349	15.3
Rhizobium Inoculation treatments															
Un Inoculated (M_1)	74.28	4.64	21.08	scl	1.27	2.64	43.03	37.73	7.90	0.53	0.64	204.6	43.3	356.50	16.14
Inoculated (M_2)	74.26	4.50	21.2	scl	1.29	2.64	44.6	37.47	7.89	0.53	0.69	199.6	43.2	363.2	15.93
S.Em ±	0.27	0.16	0.21	scl	0.02	0.003	0.35	0.41	0.01	0.02	0.02	1.13	0.07	15.93	0.15
C.D (0.05)	NS	NS	NS		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Herbicide Treatments															
S_1	72.23	5.31	22.45	scl	1.27	2.64	43.27	37.50	7.89	0.50	0.63	201.3	42.43	335.0	15.76
S_2	74.77	4.43	20.80	scl	1.26	2.64	43.63	37.50	7.89	0.49	0.65	203.8	43.10	351.9	15.53
S_3	74.55	4.53	20.9	scl	1.30	2.64	43.98	36.83	7.89	0.55	0.66	203.7	43.83	379.88	16.32
S_4	74.05	4.78	21.17	scl	1.29	2.64	44.47	37.33	7.91	0.52	0.68	206.4	44.22	371.83	16.55
S_5	75.75	3.78	20.47	scl	1.28	2.64	43.83	38.83	7.90	0.59	0.67	195.2	43.06	360.72	16.02
S.Em ±	1.03	0.42	0.66	scl	0.01	0.003	0.43	0.60	0.03	0.03	0.01	3.85	0.42	14.93	0.75
C.D (0.05)	NS	NS	NS		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Inoculation at Same Level of Herbicide															
S.Em ±	1.32	0.55	0.85	scl	0.03	0.005	0.65	0.87	0.04	0.05	0.02	5.00	0.53	24.71	0.32
C.D (0.05)	NS	NS	NS	scl	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Herbicides at Same Level of Inoculation															
S.Em ±	0.60	0.36	0.47	scl	0.04	0.006	0.78	0.91	0.02	0.05	0.04	2.53	0.15	35.63	0.96
C.D (0.05)	NS	NS	NS	scl	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

scl: sandy clay loam

with haulm yield. Rhizobium seed inoculation did not significantly influence the haulm yield even though numerically superior yield was recorded in all the herbicide sub treatments over the corresponding treatments in the un inoculated treatments. Mean highest haulm yield was noticed in Imazethapyr double the recommended dose (2610 kg/ha) which might be due to the effective weed control which is followed by Imazethapyr at recommended dose (2450 kg/ha). Least haulm yield was found in no herbicide treatment (575 kg/ha) might be due to insufficient nutrient supply for plant growth because of weed competition (Table-3). Both the Pendimethalin doses were at par with each other. However, the interaction of both herbicide treatments and Rhizobium treatments were found to be non significant.

Effect of inoculation and herbicides treatments on soil properties

Initial soil analysis indicated that the soil was slightly alkaline in reaction (7.80), non-saline (0.49 dS/m), medium in organic carbon (0.56 %) and low in CEC 15.3 c mol (p+) per kg. Application of Pendimethalin or Imazethapyr at recommended or double the recommended doses did not show any significant influence on soil reaction, EC, OC and CEC. Similarly, seed treatment with Rhizobium also did not exhibit any significant influence on these soil properties. Initial soil BD, PD, % PS and MWHC were 1.30 Mg/m^3, 2.64 Mg/m^3, 42.6% and 37.0 % respectively. In the post harvest soil samples the bulk density varied from 1.26 to 1.30 Mg/m, the particle density of all the samples was 2.64 Mg m-3, the pore space in different treatments was in the range of 43.03 to 44.64 % and the maximum water holding capacity values were in a range of 36.83 to 38.83 %. Perusal of the results of physical analysis indicated non-significant influence of herbicide application or seed inoculation with Rhizobium on the soil physical properties. The textural composition of the soil was also not significantly affected by herbicides and seed inoculation treatments (Table-4).

CONCLUSION

Despite better weed control achieved in Imazethapyr double dose treatment, highest pod yield was recorded in Imazethapyr at recommended dose where seed inoculation was done (2285 kg/ha) compared to Imazethapyr double dose (2160 kg/ha). Absence of the Pendimethalin and Imazethapyr residues in the plant, kernel or post-harvest soil samples indicated that these herbicide are safe for usage in groundnut crop. Usage of Pendimethalin and imazethapyr at recommended and double the recommended doses did not adversely affect the soil physical (BD, PD, % PS and MWHC), physic-chemical (pH, EC and CEC) and fertility properties (Available N, P and K).

REFERENCES

1. DWSR (2009). *Annual Report of Directorate of Weed Science Research,* Jabalpur, Madhya Pradesh.
2. DWSRC (2011). *Annual Report of Directorate of Weed Science Research Centre*, Jabalpur, Madhya Pradesh.
3. Zimdhal, R.H and Gwynn, S.M. (1977). Soil degradation of three Dintroaniline herbicide. *Weed Science. 27:* 247-251.
4. Gowda, R.C., Devi, L.S and Prasad, T.V.R. (2002). Bio efficiency of herbicides in groundnut and residues of Pendimethalin in soil under fingermillet- groundnut cropping system. *Pesticide Research Journal. 14(2):* 263-267.
5. DWSRC (2010). *Annual Report of Directorate of Weed Science Research Centre,* Jabalpur, Madhya Pradesh.
6. HCPMRA (2010). Health Canada Pest Management Regulatory Agency. *Ottawa, Ontario,* Canada.
7. Vilas, M.B., Jayashri, V., Karmore and Yuvraj, R.P. (2011). Integrated weed management in groundnut. 23rd *Asian-Pacific Weed Science Society Conference. Conference Proceedings 2:* 18.