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Efficacy of Various Herbicides and Determination of their Persistence through Bioassay Technique for Garlic (*Allium sativum*)

B. B. Ramani and V. D. Khanpara
Department of Agronomy
Junagadh Agricultural University, Junagadh-362 001 (Gujarat), India

ABSTRACT

A field experiment was carried out during the **rabi** seasons of the years 2007-08 and 2008-09 at Junagadh (Gujarat) to study the effect of some herbicides for weed management in garlic and their persistence. The results indicated that all the treatments reduced the density and dry weight of weeds and increased yield and yield attributes significantly over unweeded check. A pre-emergence application of oxyfluorfen 240 g/ha showed its effect on indicator plants like sorghum and cucumber. Effect of oxadiargyl 90 g/ha was observed on cucumber at 30 DAS which disappeared at 60 DAS. Post-emergence application of oxadiargyl 90 g/ha, quizalofop-ethyl 40 g/ha and fenoxaprop-p-ethyl 75 g/ha made at 60 DAS did no show persistence effect on sorghum and cucumber at 90 DAS. Similarly, post-harvest study on succeeding crops of groundnut, greengram and pearl millet indicated that there was no residual phytotoxic effect of either pre- or post-emergence herbicides tested in the experiment.

Key words : Garlic, weed, bulb yield, bioassay

INTRODUCTION

Garlic crop is highly vulnerable to weed infestation due to its slow initial growth, non-branching habit, sparse foliage, shallow root system, frequent irrigation and high fertilizer application. Manual weeding is very difficult due to narrow row spacing of this crop besides non-availability of labour and increased cost involved in it. Yield loss in garlic was upto 94.8% due to weed competition (Anonymous, 2009). Therefore, the farmers are resorting for chemical weed control which is found to be cheaper than many situations. Continuous application of herbicide may lead to residue accumulation in soil which causes considerable health hazards and environmental pollution. An ideal herbicide in soil on crop land is the one that brings abou selective control of weeds for sufficiently long period to give competitive advantage to the crop but, at the same time, allows the herbicides to dissipate from the soil before the end of the crop season so that rotation crop could be planted safely. Bioassay is a major tool for quantitative and qualitative determination of herbicide residues. Very little information is available on the efficacy of new herbicides for weed control in garlic as well as on the persistence of different herbicides. With this in view, the present investigation was planned to study the effect of herbicides like oxyfluorfen, oxadiargyl, quizalofop and fenoxaprop and their persistence by bioassay methods.

MATERIALS AND METHODS

A field experiment was carried out during **rabi** seasons of the years 2007-08 and 2008-09 at Junagadh which is situated in South Saurashtra Agro-climatic region of Gujarat state and enjoys a typically sub-tropical climate characterized by fairly cold and dry winters, hot and dry summer and warm and moderately humid monsoon. The soil of the experimental plot was medium black clayey in texture and slightly alkaline in reaction (pH 7.92 to 8.00). The soil was low in available nitrogen (217.5 to 228.8 kg/ha), while medium in available phosphorus (22.74 to 23.34 kg/ha) and potassium (268.9 to 275.1 kg/ha). The experiment comprising 10 weed management treatments (Table 1) was laid out in randomized block design with four replications during both the years. Pre-emergence (PE) and post-emergence (POE) application of herbicides was done using spray volume of 500 l/ha on the next day of sowing and at 60 days after sowing (DAS), respectively. In bioassay, persistence of herbicides was measured in terms of total plant responses (Lavy and Santelmann, 1986). Plastic pots of 20 cm diameter and 10 cm height were used for raising sorghum and cucumber as indicator plants. Pots were filled with 500 g soil sample taken from each net plot at 0-15 cm depth. Counted seeds were sown in each pot for different tests. Water was applied as and when required. Number of

plants was counted at 10 DAS from each pot. The plant height was measured from ground level to the top of main shoot of randomly selected five plants in each pot at 30 DAS. The randomly selected five plants from each pot were dried in the oven at 65±5°C till the constant weight. The average value of dry matter per five plants (g) was recorded. After harvesting of the garlic crop, field bioassay was carried out in the same plots. Three crops viz., groundnut, greengram and pearl millet were grown as indicator plants. Fixed number of seeds of the indicator plants was sown in each plot for different tests. Number of plants was counted from each row and converted into the per cent basis. The other procedures were same as in pot bioassay.

RESULTS AND DISCUSSION

Effect on Weeds

The composition of weed flora in garlic crop grown during 2007-08 and 2008-09 was monocot weeds viz., *Echinochloa colonum* L. Beauv (12-83%), *Eluropus villosus* (8-22%), *Brachieria* spp. (20%), dicot weeds viz., *Chenopodium album* L. (4%), *Indigofera glandulosa* (6%) and *Euphorbia hirta.*

All the treatments significantly reduced the weed density as well as dry weight of weeds as compared to unweeded check (Table 1). However, none of the treatments could reach the level of weed free check in case of dry weight of weeds. As compared to unweeded check, the magnitude of reduction in weed density was from 81% under 1 HW at 25 DAS + oxadiargyl 90 g/ha POE at 60 DAS to 93% under oxyfluorfen 240 g/ha PE +1 HW at 40 DAS, while reduction in dry weight of weeds was from 24% under oxyfluorfen 240 g/ha PE + oxadiargyl 90 g/ha POE at 60 DAS to 47% under oxyfluorfen 240 g/ha PE+1 HW at 40 DAS.

Effect on Crop

All the treatments showed significantly higher values of plant height, bulb diameter, number of cloves per bulb and 100-cloves weight over unweeded check (Table 1); however, they were not at par with weed free, except oxyfluorfen 240 g/ha PE + quizalofop-ethyl 40 g/ha POE at 60 DAS in case of bulb diameter and number of cloves per bulb which remained at par with weed free check. This positive effect of weed management treatments resulted in significantly higher bulb yield over unweeded check; however, they could not produce yield equivalent to weed free check. Under different treatments, magnitude of increase in bulb yield over unweeded check was from 386% under 1 HW at 25 DAS + oxadiargyl 90 g/ha POE at 60 DAS to 869% under oxyfluorfen 240 g/ha PE+quizalofop-ethyl 40 g/ha POE at 60 DAS. This increase in bulb yield was 979% under weed free check over unweeded check.

Bioassay Studies

Pot study : The results revealed that different herbicides when applied in garlic crop showed significant effect on germination, plant height and dry matter production of sorghum and cucumber at 30 DAS (Table 2). There was significant persistence effect of oxyfluorfen 240 g/ha pre-emergence on sorghum as well as cucumber and oxadiargyl 90 g/ha pre-emergence on cucumber at 30 DAS. However, persistence effect of these pre-emergence herbicides on sorghum and cucumber disappeared at 60 DAS. The results also showed that post-emergence herbicides when i. e. oxadiargyl 90 g/ha, quizalofop-ethyl 40 g/ha and fenoxaprop-p-ethyl 75 g/ha when applied at 60 DAS showed no effect on biometric parameters of indicator plants (sorghum and cucumber). The results are akin to those reported by Yadav *et al.* (1993) and Naik *et al.* (2004).

Post-harvest field study : The results reveal that carry-over effect of different herbicides applied in garlic crop was found non-significant on germination (10 DAS), plant height (30 DAS) and dry matter production (30 DAS) of groundnut, greengram and pearl millet crop recorded after harvesting of garlic in the same plots (data not presented). The results clearly indicated that there was no residual phytotoxic effect of either pre-emergence application of oxyfluorfen 240 g/ha and oxadiargyl 90 g/ha or post-emergence application of oxadiargyl 90 g/ha, quizalofop-ethyl 40 g/ha and fenoxaprop-p-ethyl 75 g/ha made at 60 DAS in the soil after harvesting of garlic crop. The results corroborate with those of Walia *et al.* (2000), Naik *et al.* (2004) and Yadav *et al.* (2004).

Table 1. Effect of different treatments on weed parameters and yield attributes and bulb yield of garlic (Pooled over two years)

Treatments	Dose (g/ha)	Time (DAS)	Weed density/ m^2	Dry weight of weeds (g/m^2)	Plant height (cm)	Bulb diameter (cm)	No. of cloves/ bulb	100-clove weight (g)	Bulb yield (q/ha)
Oxyfluorfen PE + 1 HW at 40 DAS	240	1	5.89 (41)	246	36.5	3.11	18.6	64.95	60.60
Oxadiargyl PE + 1 HW at 60 DAS	90	1	9.02 (96)	304	37.7	3.28	19.3	70.38	57.55
1 HW at 25 DAS + Oxadiargyl POE	90	60	10.59 (116)	350	36.2	3.01	17.8	65.51	46.25
1 HW at 25 DAS + Quizalofop-ethyl POE	40	60	9.79 (98)	309	36.7	3.08	18.2	67.27	53.15
1 HW at 25 DAS + Fenoxaprop-p-ethyl POE	75	60	10.07 (115)	329	39.2	3.10	18.0	69.63	51.39
Oxyfluorfen PE + Oxadiargyl POE	240+90	1+60	8.59 (79)	354	37.8	3.07	18.0	65.30	52.78
Oxyfluorfen PE + Quizalofop-ethyl POE	240+40	1+60	6.92 (56)	306	38.8	3.40	19.9	73.08	65.28
Oxyfluorfen PE + Fenoxaprop-p-ethyl POE	240+75	1+60	7.50 (61)	319	39.1	3.25	18.8	69.77	54.77
Weed free	-	-	0.71 (0)	0	42.5	3.60	21.1	80.06	72.73
Unweeded check	-	-	24.12 (606)	465	30.6	2.37	12.8	35.40	6.74
LSD (P=0.05)	-	-	5.55	45	3.3	0.24	1.3	5.77	5.38

Data of weed density have been transformed to $\sqrt{X} + 0.5$ and figures in parentheses are original values.

Table 2. Persistence effect of different herbicides on bioassay parameters of sorghum and cucumber at 30 DAS (Pooled over two years)

Treatments	Dose (g/ha)	Time (DAS)	Sorghum			Cucumber		
			Germination (%)	Plant height (cm)	Dry matter (g/five plants)	Germination (%)	Plant height (cm)	Dry matter (g/five plants)
Oxyfluorfen PE + 1 HW at 40 DAS	240	1	47.50	5.51	0.17	55.00	2.03	0.21
Oxadiargyl PE + 1 HW at 60 DAS	90	1	75.00	10.59	0.36	50.00	1.85	0.16
1 HW at 25 DAS + Oxadiargyl POE	90	60	83.75	11.23	0.39	83.75	4.74	0.53
1 HW at 25 DAS + Quizalofop-ethyl POE	40	60	81.25	10.94	0.40	83.75	4.91	0.55
1 HW at 25 DAS + Fenoxaprop-p-ethyl POE	75	60	83.75	11.20	0.42	82.50	4.90	0.54
Oxyfluorfen PE + Oxadiargyl POE	240+90	1+60	43.75	5.84	0.18	52.50	2.01	0.20
Oxyfluorfen PE + Quizalofop-ethyl POE	240+40	1+60	46.25	5.76	0.19	53.75	2.10	0.19
Oxyfluorfen PE + Fenoxaprop-p-ethyl POE	240+75	1+60	43.75	5.64	0.18	53.75	2.13	0.20
Weed free	-	-	85.00	12.14	0.43	87.50	5.19	0.58
Unweeded check	-	-	82.50	9.75	0.38	82.50	4.08	0.51
LSD (P=0.05)	-	-	8.36	0.58	0.03	7.05	0.45	0.03

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