International J. Seed Spices 10(1), January 2020:16-19

Performance and residue status of some selected pesticides in cumin cultivation

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Abstract

The present study was undertaken to evaluate the efficacies and residue status at harvest for the pesticides Dimethoate, Thiamethoxam, Acetamiprid, Mancozeb and Difenoconazole in cumin crop during 2017-19. Supervised field trial was conducted and keeping in view the PHI, spraying with the requisite field dose of each pesticide was carried out @ 60, 90 & 105 DAS. The collected samples were analyzed using GC-MS-MS and LC-MS-MS for the pesticide residues status. The trend obtained for cumin yield (q ha^{-1}) in the pooled data for different treatments during the years 2017-2019 was $T_2 > T_6 > T_5 > T_1 > T_3 > T_4$ and $> T_7$ control thereby representing the efficacy of the various pesticide treatments. The residues status for the pesticides were below the prescribed MRL values with the spray at 60 and 90 DAS but spray @ 105 DAS resulted in higher MRL values for the pesticides dimethoate, thiamethoxam, acetamiprid and difenoconazole which ranged between 3.90 to 4.73; ~2.06 and ~2.19 and 1.84-2.04 ppm respectively. This indicates that pesticide use after 90 DAS should be strictly avoided to maintain the crop, residue free, its quality intact and thus promoting safe use and sale.

Key words : Chromatography, DAS, pesticide residues, pre harvest interval

Introduction

Pesticides are considered to be indispensable for the production of a crop. Crop production is seriously affected by insect pests and diseases. Due to plant pests and diseases 20 to 40 percent of the crop yields are reduced globally (Agarwal *et al.,* 2015 and Agarwal, S., 2000). To overcome these situations farmers are using pesticides as it is the most convenient and economical way to control the insect pests and diseases. The remaining residues of pesticides on harvested crops have a deleterious effect on humans and the environment. On the other hand, pesticides play a key role to control the insect pests and diseases. Cumin (*Cuminum cyminum* L.) commonly named as *jeera* is one of the prominent seed spice crops with good export potential and extensive domestic use (Spice Board of India, 2015). It is widely used as an organoleptic nutritional ingredient in food cuisines and savouries along with its inbuilt medicinal importance (Mathe, Akos, 2015). Cumin in particular is a high value seed spice which covers quite an area under cultivation in arid and semi-arid parts of Rajasthan and Gujarat. As evident, a variety of diseases and insect-pest are rampant on this crop during its cultivation such as wilt, blight, powdery mildew and insect infestation by aphids and thrips in moderate to severe form. An array of fungicides and insecticides are used to control these diseases. The majority of people are indirect consumers of pesticides through food intake. Due to lack of education, the farmers of our country do not follow the prescribed dosages and use pesticides at any stage of the crop without any awareness of the residues and their ill effects on human health. Pesticide residues in these commodities if present beyond a prescribed limit (MRL) results in decline of produce quality hindering consumption at domestic and international level (Handa, *et al.*,1999; William *et al.,* 2005 and Anonymous, 1993). To prevent serious pesticide residue issues following pre harvest interval (PHI) is the utmost requirement, so that the residue hazard can be controlled as well as the stakeholder can be suitably educated for opting scientifically developed and justified pesticide spray schedules preventing from higher residue in the harvested produce for better value to their produce and protecting health issues in the consumption chain. Pre harvest interval (PHI)/with hold period (WHP) are harvesting restrictions that state when a crop can be harvested after a pesticide application. Research determines how long it takes for a pesticide to break down to below the maximum residue limit (Prodhan, 2018). This period is called the pre-harvest interval/with hold period (WHP) or days-before-harvest for crops. To evaluate the efficacy and residue status for good quality cumin cultivation in the country, experimental trials for two years (2017- 2019) were conducted at ICAR-NRCSS, Ajmer farm

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with the pesticide molecules Dimethoate, Thiamethoxam, Acetamiprid, Mancozeb and Difenoconazole.

Materials and methods

Cumin variety GC-4 was sown for the experiment. A trial comprising of seven treatments *viz.* Dimethoate + Mancozeb (T1), Dimethoate + Difenoconazole with soil sterilizer (T2), Dimethoate + Difenoconazole (T3), Thiamethoxam + Mancozeb (T4), Thiamethoxam +Difenoconazole (T5), Acetamiprid + Mancozeb (T6) and control (T7) under randomised block design with three replicates was laid at the ICAR-NRCSS, Farm, Ajmer, Rajasthan and continued throughout 2017-2019. The package of practices developed for cumin production by the institute was followed and the pesticide spray was scheduled @ 60, 90 and 105 DAS and the crop was harvested at maturity after 128 days keeping in view the PHI for dissipation of the above mentioned pesticides to safety levels. Treatment wise samples were collected finally at harvest and stored in well labelled polythene packets at -15^{0}C till further analysis. The samples were analysed by suitable chromatographic means to estimate the pesticide residue status. The yield data was calculated to establish the efficacy of the treatments.

Results and discussion

The cumin samples containing Dimethoate, Thiamethoxam, Acetamiprid, Mancozeb and Difenoconazole molecules as pesticides were analyzed for pesticide residues status using GC-Ms-MS and LC-MS-MS (Mathe, 2003; Seiber, *et al.,* 2011 and Wilkowska, *et al.,* 2011). The results obtained from this analysis have been summarized in tables 1 as mentioned below.

Table 1. Residue status of pesticides applied @ 90 & 105 DAS in cumin seeds at harvest.

S. No.	Treatment	Residue status @ 90 DAS application (ppm)	Residue @ 105 DAS application (ppm)	Residue status @ 90 DAS application (ppm)	Residue @ 105 DAS application (ppm)
1	T_1	0.12	3.90	1.04	1.84
2	T_2	0.83	4.73	traces	
3	T_3	0.18	4.51	1.06	2.04
4	T_4	0.30	2.06	traces	
5	T_5	BLQ	0.10	0.31	0.21
6	T_6	0.08	0.02	Traces	
7	Control	traces		traces	

(Note: The Maximum residue limits (MRL) in ppm are Dimethoate - 2.0, Difenoconazole- 1.0, Mancozeb- 2-3 ppm, Thiamethoxam-1.0 and Acetamiprid-1.5; BLQ - Below level of quantification).

The pesticide residue status in the samples harvested for pesticide application till 90 DAS were found to contain no residues or well below the MRL values for respective pesticides but in the cumin samples that were sprayed with the pesticides till 105 DAS contained residues above the MRL values *viz.* 3.90-4.73 ppm for dimethoate, 2.06 ppm for thiamethoxam and 1.84-2.04 ppmfor difenooconazole. At 90 DAS the pre harvest interval counts to be 38 days before harvest whereas at 105 DAS the pre harvest interval counts to be 23 days before harvest which seems to be insufficient to dissipate the pesticide residue below safe MRL values. Hence 90 DAS seems to be the proper cut off time to stop the spray of pesticides on cumin crop, which may otherwise result in higher residue content at harvest. The residue data reveals that the treatments at 105 DAS had higher values of residues well above the MRL values. Prodhan MDH, et al. 2018 also determined the pre-harvest intervals for Quinalphos, Malathion, Diazinon and Cypermethrin in major vegetables so as to derive the safer PHI regime.

The cumin yields hectare^{-1} were also deduced for the various treatments as mentioned in table 2.

The trend obtained for cumin yield (q ha^{-1}) in the pooled data for 2017-2019 shows that the treatment consisting of Metham sodium (soil sterilizer), Dimethoate & Difenoconazole (T_2) was found to be much efficient (8.45 q ha^{-1}) followed by the treatments comprising of Acetamiprid & Mancozeb (T_6) (7.45 q ha^{-1}), Thiamethoxam & Difenoconazole (T5) (7.35 q ha^{-1}), Dimethoate & Mancozeb (T_1) (6.5 q ha^{-1}), Dimethoate & Difenoconazole (T_3) (4.5 q ha^{-1}), Thiamethoxam & Mancozeb (T_4) (3.95 q ha^{-1}) as compared to control (T_7) (3.5 q ha^{-1}). It was also

Table 2. Cumin seed yield at harvest (Pooled Data 2017-2019).

S. No.	Treatment	Seed yield (2017-18) (q ha.$^{-1}$)	Seed yield (2018-19) (q ha.$^{-1}$)	Seed yield (average) (q ha.$^{-1}$)
1.	Dimethoate & Mancozeb (T_1)	6.9	6.1	6.5
2	Dimethoate & Difenoconazole with soil sterilizer (T_2)	9.6	7.3	8.45
3.	Dimethoate & Difenoconazole (T_3)	4.9	4.1	4.5
4.	Thiamethoxam & Mancozeb (T_4)	4.1	3.9	3.95
5.	Thiamethoxam & Difenoconazole (T5)	7.9	6.8	7.35
6.	Acetamiprid & Mancozeb (T_6)	8.3	6.6	7.45
7.	Control	3.9	3.1	3.5
	CD (0.05) 2.43; S.Em± 0.67			

noticed that the difference in cumin yield was also not compromised by restricting the spray of pesticides at 90 DAS itself.

Conclusions

To promote healthy cultivation practices, safe edible produce, residue free product, boost export without issues of pesticide residues and rejection of consignment, above mentioned details will certainly help the farmers. The concept of Pre Harvest Interval (PHI) which is very essential from the point of pesticide residues must certainly be followed. In general a PHI of 25-38 days is effective to resolve the pesticide residues problem in the harvested produce based on the dissipation rate of the applied pesticide molecules. Extrapolation of pesticides used from vegetable cultivation to seed spices should be thoroughly evaluated for their dissipation rates and preference should be given to that having shorter durations. Equally important is to maintain healthy and clean drying as well as storage facilities so as to prevent the produce from extraneous contaminants which may be incorporated due to unhygienic situations resulting in unsafe goods. Grading of the produce before selling in the market certainly fetches higher values. Another emerging concept is Good Agricultural Practices (GAP) in the field of seed spices crops that may lead to reduction of excessive application of pesticides during crop growth. Furthermore, research & development of new and safer molecules with least residual toxicity may put light in this path of consumer preferences and health awareness.

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Received : November 2019; Revised : December 2019; Accepted : December 2019.