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Short communication

Dissipation and harvest time residue of 2,4-D in soil and wheat crop

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Wheat, a member of family *Poaceae* is one of the major food crops in the world. Globally, it occupies about 17% of the cropped land and contributes 35% of the staple food (Pingali 1999).Wheat constitutes one of the most abundant sources of energy and protein for the world population and its increased production is essential for food security (Chhokar *et al.* 2006). Severe competition from weeds is one of the most important factors determining productivity and sustainability of any crop. Weeds compete with crop plants for space, solar radiation, nutrients, water and carbon dioxide. Usually, the intensity of weeds in wheat remains higher. In the absence of efficient control measurers, weed plants cause 15-50% or more yield reduction depending upon the weed density and type of weed flora (Chhokar *et al.* 2006, Kumar *et al*. 2007). In weed management practices, chemical weed control contributes gainful increment in crop production. The use of 2,4-D has contributed greatly to increase the production of wheat.

2,4-D (2,4-dichlorophenoxy acetic acid) is a systemic auxin type selective herbicide and is commonly used in cereal crops (Jat *et al*. 2003). However, the usage of pesticides in agriculture is a matter of both food and environmental safety concern because these chemicals are recognized as a source of potential adverse impact (Alexandre and Claudio 2002). So, their environmental behavior is required to be studied to ensure their use safely. Therefore, the present work was undertaken to study the dissipation and residues of 2, 4-D in wheat and soil under field conditions.

Field investigations pertaining to dissipation studies of 2,4-D in wheat grown soil were conducted at the Research Farm of Department of Agronomy, CSK HPKV, Palampur (HP). Wheat variety '*HPW-155*' was used in study and 2,4-D doses were applied at the rate of 0.5, 1.0 and 2.0 kg/ha in wheat crop at 35 days after sowing. Soil samples were collected at 0, 1, 3, 5, 7, 15, 30, 45 60, 75 and 90 days after herbicide application and were processed. Wheat straw and grain samples were collected at harvest of crop. 2,4-D standard used was procured from Accu Standard, USA. 2,4-D residues from different substrates (soil, wheat straw and grain) were extracted as described by Marquadt *et al*. (1955), and Devi *et al*. (2001).

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The validation of spectrophotometeric method for 2,4-D was carried out. The standard curve for reference material was prepared by plotting graph of concentration versus absorbance for 2,4-D . Beer's law plot was linear with good correlation coefficient (R^2=0.998). LOD and LOQ values were 0.01 µg/ml and 0.02 µg/ml, respectively calculated using following equations.

LOD: X*bi* + 3S*bi*

LOQ: X*bi* + 10S*bi*

where X*bi* is the mean concentration of the blank and S*bi* is the standard deviation of the blank.

The validated procedure was used for quantitative measurement of 2,4-D in further study. The recoveries of 2,4-D of soil, wheat plant and grain ranged from 82 to 83.2% for fortification of 1 and 2 µg/g, respectively.

Initial residues of 2,4-D applied at 0.5, 1.0 and 2.0 kg/ha were 0.023, 0.041 and 0.066 µg/g which after 3 days of herbicide application reached to 0.015, 0.025 and 0.041 µg/g, respectively (Table 1). The corresponding per cent losses of applied 2,4-D was 34.8%, 39.0% and 37.9%, respectively at three days after application. Dissipation of 2,4-D revealed that approximately 21.7, 34.1 and 45.5% of applied 2,4-D remained in soil at 7 days after herbicide application at three levels of 2, 4-D *i.e*. 0.5 , 1.0 and 2.0 kg/ha. After 15 days of herbicide application, dissipation of 2, 4-D (35 DAS) was highest (91.3%) in 2, 4-D 0.5 kg/ha (35 DAS) followed by 2,4-D 1.0 kg/ha (35 DAS) (78%) and for least in highest dose *i.e.* 2.0 kg/ha (62.1%). This clearly indicated that 2,4-D (35 DAS) at higher dose persisted in the soil for longer periods than at lower doses. The residues (Table 1) were below detectable levels for 2,4-D 0.5 kg/ha at 30 days after herbicide application. The concentration of 2, 4-D 1.0 kg/ha was 0.004 µg/g and for 2,4-D 2.0 kg/ha was 0.019 µg/g. The corresponding dissipation was 100, 90.2 and 71.2%, respectively indicating

Table 1. Residues of 2,4-D in soil treated at different doses

Application	Residues (µg/g)		
	Rates of 2,4-D application		
	0.5 kg/ha	1.0 kg/ha	2.0 kg/ha
0	0.023 (-)	0.041 (-)	0.066 (-)
1	0.020 (13.04)	0.030 (26.82)	0.046 (30.30)
3	0.015 (34.78)	0.025 (39.02)	0.041 (37.87)
5	0.007 (69.56)	0.020 (51.21)	0.036 (45.45)
7	0.005 (78.26)	0.014 (65.85)	0.030 (54.54)
15	0.002 (91.30)	0.009 (78.04)	0.025 (62.14)
30	ND	0.004 (90.24)	0.019 (71.21)
45	-	0.002 (95.19)	0.008 (87.87)
60	-	ND	0.005 (92.42)
75	-	-	0.002 (96.96)
90	-	-	ND

Values in parenthesis are % dissipation, ND-Not detectable

Table 2. Slope of curve, correlation coefficient, half life and regression equation of 2,4-D residues in soil

Treatment	Slope of curve	Half life (days)	Correlation coefficient	Regression equation
2,4-D 0.5 kg/ha	0.073	4.12	0.95	y=0.073x + 1.325
2,4-D 1.0 kg/ha	0.027	11.1	0.96	y=0.027x + 1.463
2,4-D 2.0 kg/ha	0.017	17.70	0.98	y=0.017x + 1.694

that only 0, 9.8 and 28.8% of applied 2,4-D 0.5 kg/ha, 2,4-D 1.0 kg/ha and 2,4-D 2.0 kg/ha was left in soil.

The residues of 2,4-D exhibited a declining pattern as a function of time. Rate of dissipation was very rapid during initial 30 days when dissipation was of order 100, 90.24 and 71.21% at three levels of 2,4-D that is 0.5, 1.0 and 2.0 kg/ha, respectively. As the period of 30 days experienced rainfall, it is quite likely that 2,4-D (Na) (aqueous solubility = 45g/l) might have leached down or washed off due to rains. Similar conducive environmental conditions prevailing during the tenure of 30 days might have resulted in rapid loss of herbicide from field. Combined effect on dissipation has also been reported previously by Devi *et al.* (2001). Similar observations have been reported by Randhawa and Sandhu (2004), and Fengfu *et al.* (2009).

The plots indicated that the dissipation of 2, 4-D at 0.5 to 2.0 kg/ha fitted first order kinetics decay curve

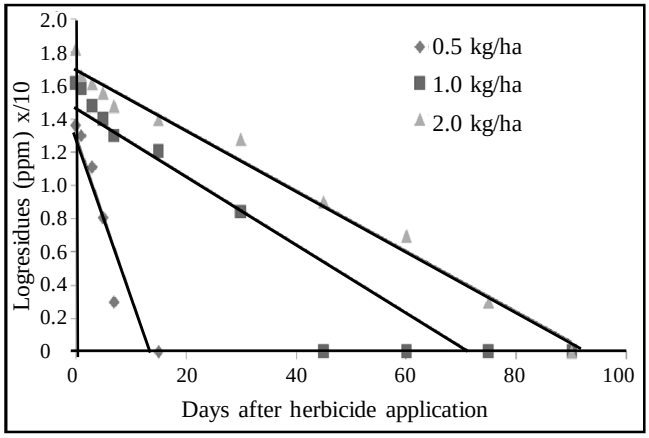

Fig. 1. First order dissipation curve of 2,4-D at 35 DAS in soil

(Fig. 1). The slope of curve, correlation coefficient, half life of herbicide along with regression equation are summarized in Table 2. The correlation coefficient for 2,4 D 0.5 kg/ha, 1.0 kg/ha and 2.0 kg/ha were 0.95, 0.96 and 0.98, respectively indicating perfect fit. As time versus log residue plot is linear, dissipation followed first order kinetic reaction. These findings were in conformity with Cheah *et al.* (1998) and Jiang *et al.* (2010).

Terminal residues of 2,4-D in wheat plant and wheat grain were determined by estimating 2,4-D concentration at the maturity of the crop. It was found that residues of 2,4-D were below detectable level in both plant and grain samples at harvest. The above findings were in conformity with results given by Kumari *et al.* (2004) and Jiang *et al.* (2010).

SUMMARY

Application 2,4-D at three levels in 0.5, 1.0 and 2.0 kg/ha in wheat crop at 35 days after sowing persisted in soil up to 15, 45 and 75 days, respectively. The logarithmic plots of herbicide residues versus time obtained by fitting the regression equation indicated that disappearance of 2,4-D in soil followed a first order kinetics decay curve at all the levels of application with the half life period varying from 4.21-17.70 days. Residues of 2,4-D were found below detectable level (0.02 ppm) in wheat grain and wheat straw.

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