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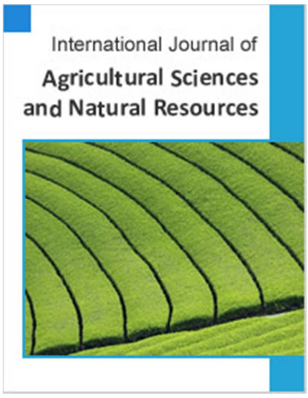

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Efficacy of Seed Treatment of Three Cultivars of Wheat with Two Systemic Insecticides to Control of Viral Diseases with Natural Vectors in Southwest Iran

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Abstract
Viral diseases are the most important diseases of cereal in southwest Iran. During 2008-2011 growing seasons, the efficacy of seed treatment with imidacloprid and thiamethoxam on three cultivars of wheat were evaluated for the control of virus diseases with natural vectors in field condition. The experimental design was a split plots arrangement of a randomized complete block with four replications. Disease incidence was determined based on the percentage of plants exhibiting symptoms and ELISA test. At harvest, data were collected on yield and yield components. The three-year analysis of results indicated that seed treatment insecticides increased grain yield and yield components, with significant reduction in the incidence of *barley yellow dwarf virus* (PAV and MAV serotypes), *cereal yellow dwarf virus)* RPV serotype), *wheat dwarf virus* (*WDV*), *maize Iranian mosaic virus* (*MIMV*) and *barley yellow striate mosaic virus* (*BYSMV*) in wheat plants relative to untreated controls, while incidence of *wheat streak mosaic virus* (*WSMV*) wasn't affected significantly (P=0.01). The effect of seed treatment with imidacloprid was higher than thiamethoxam. "Shahriar" wheat cultivar treated with imidacloprid was the most effective treatment in controlling virus diseases. Incidence of virus diseases on Alvand cultivar was more than other cultivars. The amounts of infection to *WSMV, BYDV*-PAV, *CYDV*-RPV, *WDV, BYSMV, BYDV*-MAV and *MIMV* in seed treatment plots were from highest to lowest (in descending order), respectively.

1. Introduction

Although a large number of viruses of cereal have been reported in the world, only some are causing economic damage. *Barley yellow dwarf viruses* (*BYDV*-MAV, *BYDV*-RMV and *BYDV*-PAV serotypes), *cereal yellow dwarf virus* (*CYDV*-RPV serotype), *wheat streak mosaic virus* (*WSMV*), *maize Iranian mosaic virus* (*MIMV*), *barley yellow striate mosaic virus* (*BYSMV*), *wheat dwarf virus* (*WDV*), *wheat Eqlid mosaic virus* (*WEqMV*) and *wheat soil borne mosaic virus* (*WSBMV*) are the most important of wheat viruses reported in Iran (Izadpanah *et al*., 1991; Izadpanah and Kamran, 1995; Masumi and Izadpanah 1995; Moeini *et al*., 1995; Sahragard *et al*., 2006b; Sahragard *et al*., 2008).

Viral diseases are among the most economically important diseases of wheat in southwest Iran; they cause yield losses of up to 100% in early planting fields (Sahragard *et al.,* 2010). The following viruses were identified in the area using DAS- ELISA or TAS- ELISA: *BYDV- PAV, BYDV-MAV, CYDV- RPV, WDV, WSMV, MIMV* and *BYSMV* (Sahragard *et al.,* 2010). All these viruses transmit by natural vectors: *BYDVs* and *CYDV*-RPV by several aphid species (D, Arcy and Burnett, 1995), *WSMV* by Aceria *tulipae* (Masumi *et al*., 1999), *MIMV* and *BYSMV* by *Unkanodes tanasijevici* and *Laodelphax striatellus* (Izadpanah *et al*., 1983; Massah *et al*., 2008) and *WDV* by *Psammotettix alienus* (Behjatnia *et al*., 2011). BYDVs and CYDV are the most important viruses affecting wheat fields in regions of southwest Iran. Besides *BYDVs* and *CYDV*, the occurrence of other wheat viruses like *WDV, WSMV, MIMV* and *BYSMV* have also been reported earlier (Sahragard *et al.,* 2006 and 2010).

Epidemiology and incidence of viral diseases relates to biology and population of vector; therefore, management of them can be based on vector control (Irwin and Thresh, 1990; Gourmat *et al*., 1994; Manurung *et al*., 2004).

Prevention and control of viral diseases of wheat have a complex pathosystem associated with their vectors, virus-vector relationship and perennial grasses as reservoir viruses, and their vectors. Infected plants in the seedling stage damage more than twice as many in the tillering stage, and infected plants in tillering to stem elongation stage and before heading are about twice as sensitive. Use of favorable sowing dates and seed-treatment insecticides are methods to consider for controlling viruses (Irwin and Thresh, 1990). On the other hand, in some regions, there is no possibility of changing planting dates, and the economy cannot chemical treatments; thus, the use of tolerance and resistance cultivars is the only way to control these diseases or their transmitting vector (Irwin and Thresh, 1990; D, Arcy and Burnett, 1995). Compounds such as imidacloprid and thiamethoxam under the neonicotinoids group, are used as effective insecticides for the control of sucking insects, such as aphids, white flies, leafhoppers and thrips. Their broad-spectrum efficacy, systemic and translaminar action, pronounced residual activity, and a unique mode of action, lead to rapid expansion of production, and as a result, the use of these pesticides has increased in recent years (Elbert *et al*., 2008). The first compound of this group (imidacloprid) (Iwaya and Tsuboi, 1992) was developed in 1991 and marketed by Bayer CropScience; since then, there have been several of these compounds with different formulations (Elbert *et al*., 2008). Neonicotinoids are used for the management of viral diseases of cereal, potato, oilseed, tobacco and sugar beet with natural vectors through seed treatment; these have a significant effect in reducing viral diseases on these crops (Gourmat *et al*., 1996; McKirdy and Jones, 1996; Elbert *et al*., 2008).

Given the importance of viral diseases of wheat in southwest Iran (Sahragard *et al*. 2010), this study has been conducted to measure the efficiency of seed treatment with insecticides using three varieties of wheat in the control of viral diseases with natural vectors.

2. Materials and Methods

2.1. View the Geographic Location of the Project

Field studies were performed in Agriculture and Natural Resources Research Center of Chahar Mahal va Bakhtiari, in southwest Iran, with latitude 1.8", 18 ', 32° north and longitude 52.6", 55', 50° 'E and altitude 2073 meters above sea level, with an average annual rainfall of 320 mm, the average annual temperature of 11.8°C.

2.2. Seed Treatment of Three Cultivars of Wheat With Selected Insecticides

The effect of seed treatment on three wheat cultivars using two systemic insecticides was evaluated for control of viral diseases with natural vectors during three growing seasons 2008 to 2011.

The experiment was a split plot in a randomized complete block design with four replications. Main plots consisted of three cultivars of winter wheat Alvand, Shahriar and Toos (most varieties cultivated in southwest), a sub-plot involving seed treatment with insecticide. Distance 2.5 m sub-plots. Planting date (first irrigation) was 22 September in each three years, this time is peak activity of virus vectors of wheat in the region (Sahragard *et al*. 2006 and 2010).

To seed treatment were used of imidacloprid (1- (6-chloro-pyriclin-3-ylmethyl) - N-nitroimidazolidin - 2- ylideneamine) brand Gachu ratio of 0.7 gr/kg seed of commercial powder form vetabl 70% and thiamethoxam (Cruiser) (flowable concentrate for seed treatment), a ratio of 1 ml/kg seed. Enough water was added to the mixture of seeds and pesticides and stored overnight at room temperature temperature so that the insecticide enteres the seed tissue. Plot size in the field was 4 x 3.5 m. Two hundred grams of seed were used per plot. Seeds of all experimental plots were treated using Carboxin-thiram (1.5 gr/kg seed).

At time planting was used a full macro fertilizer (N-P2O5-K2O) based on soil test. Ammonium nitrate was used as a fertilizer in early spring. Weed control was performed using manual weeding and spraying with 2-4-D (to the extent of 1.5 liter per hectare). To evaluate the effect of seed treatment and cultivar on grain yield, yield components including plant height (based on an average length of 30 tillers per plot), 1000 kernel weight and biomass per plot were measured. The whole plot was harvested to measure biomass and grain yield. After measuring biomass, wheat seeds were separated by harvesting machine and measured.

2.3. Evaluation of Viral Infection of the Plants in the Experimental Plots

The incidence of viral diseases in each plot was evaluated on the basis of symptoms including: leaf discoloration (chlorosis and purple to red leaves), low growth rates (relative reduction in internode distance, stunting and severe dwarfing) and eventually plant death. Early June in each growing season, one cadre (1×1 m) was placed randomly in experimental plots and thepercentage of infected plants were measured based on symptoms and dead plants. In mid-May in each year, four random samples of wheat plants were collected from each plot and tested using DAS- ELISA for *BYDV*-PAV, *BYDV*-MAV, *CYDV*-RPV, *WDV* and *WSMV* and TAS-ELISA to *BYSMV* and *MIMV* to confirm the symptoms associated with these viruses (D, Arcy and Hewings, 1986; Clark and Adams, 1977).

2.4. Statistical Analysis of Data

For statistical analysis of data on grain yield and yield componentsthe software SAS (version? SAS Inst, 1998) was used and the means were compared using LSD test at 1% level.

3. Results and Discussion

3.1. Seed Treatment

The results showed seed that treatment with both insecticides had a significant effect in reducing the incidence of viral diseases of wheat and increased grain yield and yield components (P = 0.01) (Table 2, 6, 7 and 8). insecticide × cultivar Interaction on grain yield and yield components was showed a significant effect (Table 6). The best treatments in grain yield and reduction of viral diseases was on Shahriar cultivar treated with imidacloprid. Imidacloprid was more effective in reducing viral diseases and increase grain yield than thiamethoxam (Table 8).

Infection of *WSMV, BYDV*-PAV, *CYDV*-RPV, *WDV, BYSMV, BYDV*-MAV and *MIMV* in seed treatment plots were shown from the highest to the lowest, respectively, seed treatment with insecticides had no effect on the rate of *WSMV* (Table 1).

3.2. Effect of Cultivar

The effect of cultivar on viral diseases, grain yield and yield components of wheat were statistically significant (P = 0.01) (Tables 2 and 7). Disease incidence on Alvand, Toos and Shahriar cultivars was from the highest to the lowest, respectively (Table 6). The highest grain yield was related to Shahriar cultivar and the following Alvand and Toos were ranked (Table 6).

3.3. Effect of Year

Effect of year and interaction year×insecticide in incidence of viral diseases, grain yield and yield components of wheat was significant (Tables 2, 3, 4, 5 and 6). The rate of infected plants in 2009, more than two years of testing (Table 6), grain yield of this year was less than 2010 and 2011 (Table 6).

The purpose of this study was to compare the efficacy of imidacloprid and thiamethoxam in the control of viral diseases of wheat through vectors control in three wheat cultivars recommended for cold climates during three growing seasons 2008-2011 in southwest Iran. Epidemiology of viral diseases with natural vectors depends on the efficiency of vectors, the vectors population, and the their biology (Irwin and Thresh, 1990, Manurung *et al*., 2004, D' Arcy and Burnett, 1995).

In southwest Iran, the population of viral vectors in wheat, barley and maize on early planting dates in the autumn was higher compared with late planting dates and the incidences of viral diseases was higher on these planting dates (Sahragard *et al*., 2010; Amanifar *et al*., 2012b).

Biological relationships between *BYDV*-PAV, *CYDV*-RPV, *WDV*, *BYSMV*, *BYDV*-MAV and *MIMV* and their vectors remain persistent (D, Arcy and Burnett, 1995; Izadpanah *et al*., 1983; Massah *et al*., 2008; Behjatnia *et al*., 2011). In addition, the inoculation and feeding period of vectors is long, and insecticides, such as imidacloprid and thiamethoxam are systemic in the vascular sap of the plants; therefore, feeding insects are poisoned and die by lead insecticides before the virus is transferred (Elbert *et al*., 2008).

Cereal seed treatment with systemic insecticides, such as imidacloprid, is effective in controlling viral diseases and decreaseing infection in the early stages of growth (Gourmat *et al*., 1994; McKirdy and Jones, 1996; Sahragard *et al*., 2010).

A seed- treatment insecticide posting low risk to nontarget organisms, causing no phytotoxicity, and systematically translocated in the plant would provide control of vectors from the day the seedling emerges from the ground (Gourmat *et al*., 1994 and 1996). There are several cases of success for the management of viral diseases of plants with seed treatment by systemic insecticides, the greatest success in controlling viral diseases of sugar beet, tobacco, potato and barley and cereal yellow dwarf virus (Gourmat *et al*., 1994; Mckirdy and Jones, 1996; Elbert *et al*., 2008; Sahragard *et al*., 2010).

Table 1. *Status naturally infection of experimental plots to BYDV-PAV, BYDV- MAV, CYDV-RPV, WDV, BYSMV, MIMV and WSMV based on ELISA test in three years in southwest of Iran (From 16 samples).*

Treatment	BYDV-PAV	BYDV- MAV	CYDV-RPV	WDV	BYSMV	*MIMV*	WSMV
2008-2009							
Shahriar cultivar							
Control	2/16	0/16	1/16	Nd*	Nd	Nd	1/16
Imidacloprid	0/16	0/16	0/16	Nd	Nd	Nd	0/16
Thiamethoxam	0/16	1/16	0/16	Nd	Nd	Nd	2/16
Alvand cultivar							
Control	7/16	3/16	4/16	Nd	Nd	Nd	4/16
Imidacloprid	1/16	0/16	0/16	Nd	Nd	Nd	6/16
Thiamethoxam	0/16	1/16	1/16	Nd	Nd	Nd	2/16

Treatment	BYDV-PAV	BYDV- MAV	CYDV-RPV	WDV	BYSMV	*MIMV*	WSMV
Toos cultivar							
Control	1/16	3/16	2/16	Nd	Nd	Nd	5/16
Imidacloprid	0/16	0/16	0/16	Nd	Nd	Nd	1/16
Thiamethoxam	1/16	1/16	0/16	Nd	Nd	Nd	5/16
2009-2010							
Shahriar cultivar							
Control	2/16	0/16	0/16	Nd	4/15	1/16	1/16
Imidacloprid	0/16	0/16	0/16	Nd	0/16	0/16	2/16
Thiamethoxam	0/16	0/16	0/16	Nd	1/15	1/16	0/16
Alvand cultivar							
Control	3/16	3/16	1/16	Nd	3/16	0/16	6/16
Imidacloprid	0/16	0/16	0/16	Nd	1/16	0/16	4/16
Thiamethoxam	1/16	0/16	0/16	Nd	0/16	0/16	5/16
Toos cultivar							
Control	5/16	2/16	2/16	Nd	5/16	2/16	1/16
Imidacloprid	1/16	0/16	0/16	Nd	0/16	0/16	0/16
Thiamethoxam	1/16	0/16	1/16	Nd	0/16	0/16	3/16
2010-2011							
Shahriar cultivar							
Control	6/16	2/16	4/16	2/16	3/16	1/16	4/16
Imidacloprid	0/16	0/16	1/16	1/16	0/16	1/16	3/16
Thiamethoxam	01/16	1/16	2/16	0/16	0/16	1/16	5/16
Alvand cultivar							
Continued Table 1.							
Control	9/16	3/16	4/16	4/16	4/16	3/16	4/16
Imidacloprid	3/16	0/16	1/16	2/16	1/16	0/16	5/16
Thiamethoxam	2/16	0/16	1/16	0/16	2/16	2/6	1/16
Toos cultivar							
Control	5/16	0/16	2/16	3/16	5/16	3/16	3/16
Imidacloprid	3/16	1/15	2/16	0/16	0/16	0/16	1/16
Thiamethoxam	1/16	2/16	0/16	0/16	0/16	1/16	2/16

* Nd, not determined test

Table 2. *Combined analysis of variance effect of cultivar and seed treatment on grain yield, grain components and percent infection of virus diseases of winter wheat during three growing seasons (2008 to 2011) in southwest of Iran.*

Variable	df	Grain yield	Biomass	Plant height	1000 kernel weight	Infection
Year (Y)	2	23114.3*	321.9**	1358.4**	4	603.2*
Insecticide (I)	2	64375.2**	104.9**	678.5**	146.4**	2827.1**
Y*I	4	493726.1*	16.8	91.1	22.8**	635.7**
Error a	27	12421.2	7.5	97.1	4.9	139.6
Cultivar (c)	2	344226.3**	64.6**	135.2**	63.8**	1147.4**
Y*C	4	55678.7	2.2	29.4	1.4	334.7**
C*I	4	45671.2*	6.2*	108.8**	10.1**	94.4
C*I*Y	8	5673.3	3.6	38.7	2.9	2135.4
Error b	54	89720.8	2.3	27.8	2.7	94.1
C. V.	-	19.1	11.9	7.1	6.2	20.5

* and **Significant at 0.05 and 0.01 probability levels, respectively

Table 3. *Analysis of variance effect of cultivar and seed treatment on grain yield, grain components and percent infection of virus diseases of winter wheat 2008-2009 growing season in Southwest Iran.*

Variable	df	Grain yield	Biomass	Plant height	1000 kernel weight	Infection
Block (Rep.)	3	2454.3	211.2	123.2	23.7	302.2
Insecticide (I)	2	21343.2*	97.5*	115.5**	78.4**	987.3**
Cultivar (C)	2	71435.4**	45.6**	132.2**	70.3**	879.3**
C*I	4	86547.6*	11.2*	111.3**	15.2**	77.3**
Error	24	75456.2	2.3	33.2	6.7	55
C. V.	-	16.7	12.4	5.6	14.1	15.6

* and ** Significant at 0.05 and 0.01 probability levels, respectively

Table 4. *Analysis of variance effect of cultivar and seed treatment on grain yield, grain components and percent infection of virus diseases of winter wheat 2009-2010 growing season in Southwest Iran.*

Variable	df	Grain yield	Biomass	Plant height	1000 kernel weight	Infection
Block (Rep.)	3	3743.2	268.1	109.1	42.3	520.2
Insecticide (I)	2	36345.3**	109.4*	122.4**	82.4**	754.2**
Cultivar (C)	2	84356.8*	66.2**	142.1*	64.1**	678.6**
C*I	4	96789.9*	21.1*	122.2*	16.2**	56.1**
Error	24	55678.2	17.4	37	7.5	73.3
C. V.	-	14.9	12.4	6.2	9.4	21.2

* and ** Significant at 0.05 and 0.01 probability levels, respectively

Table 5. *Analysis of variance effect of cultivar and seed treatment on grain yield, grain components and percent infection of virus diseases of winter wheat 2010-2011 growing season in Southwest Iran.*

Variable	df	Grain yield	Biomass	Plant height	1000 kernel weight	Infection
Block (Rep.)	3	2934.3	230.1	134.2	32.5	678.3
Insecticide (I)	2	59476.4**	112.7*	152.2**	76.5*	965.1**
Cultivar (C)	2	79642.3**	98.1**	156.1*	54.3**	860.2*
C*I	4	88754.2**	32.5**	89.7*	23.6**	76.3**
Error	24	55678.2	19.5	45.5	9.1	53.7
C. V.	-	15.1	14.7	8.9	11.8	20.5

* and ** Significant at 0.05 and 0.01 probability levels, respectively

Table 6. *A comparative means of grain yield, yield components and percent infection with virus diseases in winter wheat during three growing seasons from 2008-2011 in Southwest Iran.*

Treatment	Grain yield (kg/plot)	Biomass (kg/plot)	Plant height (Cm)	1000 kernel Weight (g)	%Infection
Insecticide					
Control	4.05 b*	10.9 c	69.4b	24 b	30.6a
Imidacloprid	5.94 a	14.2 a	77.8a	27.8 a	9.5 c
Thiamethoxam	5.46 a	13.2 b	75.4 a	27.2 a	20.5 b
Cultivar					
Shahriar	6.32 a	14.3 a	76.4 a	27.9 a	12.5 b
Alvand	4.76 b	12.1 b	73.7 b	25.6 b	25.7 a
Toos	4.38 b	11.9 b	72.6 b	25.5 b	22.4 a
Year (growing season)					
2008-2009	4.8 b	9.8 c	70.4 b	26.6 a	24.3 a
2009-2010	4.96 ab	12.8 b	71 b	26.3 a	18.5 b
2010-2011	5.69 a	15.8 a	81.3 a	26 a	21.1 b

*within columns, means followed by the same letter are not significantly different at the 0.01 probability level.

Table 7. *Mean effect of cultivar and Insecticide on grain yield and percent infection of virus diseases of winter wheat during three growing seasons from 2008-2011 in Southwest Iran.*

Treatment	Grain yield (kg/plot)	% Infection
Shahriar		
Control	5.06 b*	21 a
Imidacloprid	7.01 a	6 a
Thiamethoxam	6.88 a	10.4 b
Alvand		
Control	3.48 c	39 a
Imidacloprid	6.12 a	10 b
Thiamethoxam	4.69 b	28.5 a
Toos		
Control	3.61 b	32 a
Imidacloprid	4.84 a	12.6 c
Thiamethoxam	4.68 a	22.6 b

*within columns, means followed by the same letter are not significantly different at the 0.01 probability level.

Table 8. *Effect of growing season on grain yield and percent infection virus diseases of winter wheat in Southwest Iran.*

Treatment	2008-2009		2009-2010		2010-2011	
	Grain yield (kg/plot)	Infection (%)	Grain yield (kg/plot)	Infection (%)	Grain yield (kg/plot)	Infection (%)
Shahriar cultivar						
Control	4.76 b*	39.9 a	4.28 c	13.6 a	6.16 b	33.5 a
Imidacloprid	6.68 a	15 c	7.24 a	10.5 a	7.48 a	5 b
Thiamethoxam	6.6 a	16.5 b	6.56 b	4.3 b	7.11 a	12.5 b
Alvand Cultivar						
Control	3.32 b	37.4 a	2.99 b	29.9 a	4.12 b	48 a
Imidacloprid	4.64 a	13.5 b	5.77 a	19.8 b	8.00 a	12.3 b
Thiamethoxam	3.38 b	25.8 a	5.8 a	17.5 b	4.48 b	17.5 b
Toos cultivar						
Control	3.72 b	38.2 a	2.60 c	44.7 a	4.52 a	35.5 a
Imidacloprid	4.96 a	12.8 c	4.12 b	19.5 b	3.96 b	11.8 b
Thiamethoxam	4.76 a	19.3 b	5.32 a	6.5 c	3.96 b	13.8 b

*within columns, means followed by the same letter are not significantly different at the 0.01 probability level.

In this study, the effect of seed treatment with insecticide was significantly reduced viral diseases of wheat and increased grain yield, so that 46.7% and 34.8% of grain yield rose to imidacloprid and thiamethoxam, respectively. Seed treatment reduced viral diseases in experimental plots 72.4 and 40.9% for imidacloprid and thiamethoxam, respectively (Table 3). Similar results were obtained in previous researches, so that seed treatments of barley with imidacloprid resulted in an increased grain yield from 12% to 377%, depending on planting date; the effect of seed treatment on the reduction of viral diseases was much higher on early planting dates (22 September to 6 November) (Sahragard *et al*., 2006b). In this study, seeds were planted on 22 September to coincide with the peak time of emergence of the vectors (Sahragard *et al*. 2010) and may provide a natural infection. Oat and wheat seed treatment with imidacloprid on susceptible varieties BYDV-PAV increased grain yield by 35% (Gourmat *et al*., 1996). Grain yield and yield components of maize have shown an increase in response to seed treatment with imidacloprid from 3.9 to 32%, depending on planting date of maize, in southwest of Iran for control of maize Iranian mosaic disease (Amanifar *et al*., 2012a).

Alvand as the dominant cultivar of wheat is planting in southwest Iran. In this study, viral diseases in Alvand was more than the others, so that winter killing plants mainly due to the interaction BYDVs and CYDV with the winter frost (D, Arcy and Burnett, 1995) were higher in the plot of this cultivar. The response wheat cultivars in seed treatment were followed by Alvand, Shahriar and Toos showed an increase in grain yield (Table 7). During 2003-2007, 414 advanced lines, commercial and local cultivars of wheat and barley were evaluated for resistance against viral diseases at Agriculture Research Station of Southwest Iran in southwest of Iran, under natural infection. In all lines and cultivars mosaic and yellowing symptoms were observed, and none showed resistance to all viral diseases of cereal (Sahragard *et al*., 2006a). With regard to the distribution of viral diseases of wheat in southwest (Sahragard *et al*., 2010) and susceptibility to these pathogens, Alvand cultivar is not suitable for these regions. The rate of infected plants in Alvand was more than Toos, but grain yield was higher (Table 6), these results may indicate the role that other factors in the yield of wheat cultivars.

The effects of the year on viral infection rate, grain yield and yield components were statistically significant (Table 2). The rate of viral diseases in 2008 were more than other years (Table 6). This results were confirmed effect viral diseases on yield and yield components in wheat, while the evidence on the impact of weather conditions throughout the year of the rate of infected plants.

4. Conclusion

According to this results, previous researches and the results of other researchers we can say seed treatment of cereal with a systemic insecticide reduces viral diseases and consequently results an increase of grain yield. The use of resistance or tolerance cultivars with appropriate planting date increase the efficiency of seed treatment. With regard to the distribution of viral diseases of cereals in Iran, especially in cold regions the results of this study are advisable for co-climate regions.

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