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Mane PN
Oilseeds Research Unit, College of Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Manjusha Gaikwad
Oilseeds Research Unit, College of Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Santosh Gahukar
Oilseeds Research Unit, College of Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Atul Zope
Oilseeds Research Unit, College of Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Prerna Chikte
Oilseeds Research Unit, College of Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Corresponding Author:
Mane PN
Oilseeds Research Unit, College of Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Evaluation of insecticide molecules against necrosis disease of sunflower

Mane PN, Manjusha Gaikwad, Santosh Gahukar, Atul Zope and Prerna Chikte

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Abstract
An investigation was carried out under field conditions during *Kharif* 2018-19 to 2020-21 at Oilseeds Research Unit, Dr. PDKV., Akola (Maharashtra, India) to know the efficacy different chemical insecticides in the management of sunflower necrosis disease by controlling its vector Trips palmi. Statistically non significant difference was observed among the treatments towards germination. Seed treatment (ST) with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Imidacloprid 17.8 SL (T_1) at 0.5 ml/L at 30, 45 and 60 days after sowing (DAS) recorded minimum i.e. 3.71 and 4.74 percent necrosis respectively, at one and two month after germination. ST with Imidacloprid 600 FS at 5 ml/kg seed and foliar spray with different insecticides were found at par with each other and significantly superior over untreated control towards necrosis disease of sunflower. ST with Imidacloprid 600 FS at 5 ml/kg seed and foliar spray with Trizophos 40 EC at 1 ml/L (T_3) at 30, 45 and 60 DAS recorded higher seed yield 1165 kg/ha and found at par with other insecticide treatments. The control plot recorded lowest yield of 991 kg/ha and highest disease incidence 9.15 and 12.40 percent at one and two month after germination, respectively. ST with insecticide and foliar application of insecticides could be protected yield loss of sunflower due to necrosis virus disease.

Keywords: Tobacco streak virus, necrosis, sunflower plant, insecticide, transmission, thrips

Introduction
Sunflower (*Helianthus annus* L.) a member of composite family is the second most important edible oilseed crop in the word after soybean. Sunflower oil is reach in natural vitamins, consisting mainly of poly-unsaturated fatty acids (PUFA) and is low in saturated fats. Sunflower crop is cultivated in an area of 0.28 million hectares with production of 0.25 million tones (DOR Annual Report, 2021-22) and Karnataka, Andhra Pradesh, Maharashtra and Tamil Nadu are the major sunflower growing states. The crop is highly vulnerable to stress factors such as various diseases incited by viruses, bacteria, phytoplasma and fungi (Kolte, 1985) [13] resulting in severe economic losses. Sunflower necrosis disease was reported from Netherlands, Australia and India (Sharman *et al*., 2008) [27]. It was reported for the first time in India at Bagepalli village of Kolar district, Karnataka in 1997 (Singh *et al*., 1997) [34] which later spread to AP, TN and Maharashtra States. Several viruses belonging to Cucumo, Ilar, Poty, Tospo and Aumbra virus groups infects sunflower severly (Brunt *et al*., 1996) [6]. The crop is highly vulnerable to stress factor such as necrosis disease transmitted by thrips and causes economic losses. The disease is caused by tobacco streak virus (Prasada Rao *et al*., 2000) [22] and it was found to be transmitted by thrips (Harvir Singh, 2005) [10]. The virus is reported to be sap transmitted (Battu *et al*., 1965) [4]. The characteristic field symptoms of the disease include mosaic on leaves that leads to extensive necrosis of leaf lamina, petioles, stem, floral calyx and complete death of seedlings eventually. Early infection either kills the plant or causes severe stunting with mall formed head filled with chaffy seeds. Necrosis at bud formation stage makes the capitulum to bend and twist resulting in to complete failure of seed setting and maturation (Ravi K.S. *et al*., 2001, Ramiah M., *et al*., 2001, Jain R.K. *et al*., 2003) [25, 24, 11]. The disease has now spread to sunflower growing areas and up to 80% incidence of the disease was recorded. (Papaiah *et al*., 2013) [21]. Out breaks of this disease in major sunflower growing states of India, especially Andhra, Karnatka and Maharashtra, have virtually threatened the sunflower cultivation and yield losses ranging from 30 to 100 percent have been reported

(Chander Rao *et al*., 2000, Sardaru *et al*., 2014) [7, 26]. Rao and Nagaraju (1999) [9] reported that complete losses occur when the crop get infected at vegetative growth stage. Shivasharanayya (2000) [32] and Shirshikar (2002) [28] reported that minimum and maximum temperature, thrips population and disease are positively correlated and thrips population is negatively correlated with rain fall (Shivasharanayya *et al*., 2003, Upendhar *et al*., 2006) [33, 35]. The survey during 2003-2005 in three districts of Gulbarga, Bidar and Raichur indicated the mean diases incidence of 19.81% with disease ranging from 0.0-100%, and recently in 2011, reported the disease incidence in November 0.67 percent shown then immediately it increased 39.30 percent shown in January (Pankaja *et al*., 2011) [20]. Disease has significant impact on the crop as early infection causes death of the plants or severe stunting with mall formed head or heads filled with chaffy seeds (Ramiah *et al*., 2001) [24]. Lavanya *et al*., 2005 revealed that the weeds such as *Trainthema portulacastrum, Priva leptostachya, Digeria arvensis, Clitoria ternata, Solanum nigrum, Vernonia cineraria, Trichodesma indicum* and some other species were found to serve as hosts for sunflower necrosis virus. Cultural practices such as dates of sowing, border cropping, inter cropping, roughing, optimum plant population and removal of weed hosts etc. have been advocated by several workers to reduce disease incidence and intencity. (Basappa *et al*., 2005, Chander Rao S. *et al*., 2002, Prasad Rao *et al*., 2003, Almeida AMR *et al*., 1991 and 1994, Lava Kumar *et al*., 2008) [3, 8, 23, 1, 2, 14]. Intercropping with redgram or castor was found to reduce disease intensity compaired to monocropping of sunflower and groundnut (Prasad Rao *et al*., 2003, Jain *et al*., 2006) [23, 12]. The most economical and convenient way to manage necrosis disease is to grow resistant varieties. But so far, complete resistant varieties/hybrids were not available in sunflower. The disease is of recent origin and reliable resistant sources have not been found. A three year field trial was conducted during *kharif* season with an objective to manage this disease through seed treatment and spraying of insecticides.

Materials and Methods

A field trial was conducted during *kharif* season of 2018-19 to 2020-21 at research farm of Oilseeds Research unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. Experiment was laid out in randomized block design. The experiment had seven treatments, replicated thrice. Sunflower hybrid KBSH-44 was used for sowing. The net plot size of 3.9 x 3.0m was maintained for each treatment with 60 cm distance between rows and 30 cm between plants. All standard agronomic practices were applied. In each treatment the seed was treated with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spraying of Imidacloprid 17.8 SL @ 0.5 ml/L, Fipronil 5 SC @ 1 ml/L, Triazophos 40 EC @ 1 ml/L were done at 30,45 and 60 days after sowing. Seed germination was recorded. The observation on percent intensity of necrosis was recorded at one and two month after germination of crop. The obtained data were subjected to statistical analysis.

Results and Discussion

Statistically non significant difference was observed among the treatments towards germination (Table 1). Seed treatment (ST) with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Imidacloprid 17.8 SL @ 0.5 ml/L (T_1) at 30,45 and 0 DAS recorded minimum i.e. 3.71 percent necrosis at one month after germination followed by ST with Imidacloprid 600 FS @ 5 ml.kg seed and foliar spray with Diafenthiuron 50 WP 1g/L (T_4) at 30,45 and 60 DAS (3.96%), ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Fipronil 5 SC @ 1 ml/L(T_2) at 30,45 and 60 DAS (4.19%), ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Flonicamide 50 WG @ 0.25 g/L (T_5) at 30,45 and 60 DAS (4.60%), ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Triazophos 40 EC @ 1 ml/L (T_3) at 30,45 and 60 DAS (4.91%) and ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Spiromesifen 24 SC @ 1 ml/L (T_6) at 30,45 and 60 DAS (5.12%) all these treatments were at par (Table 2). At two months after germination lowest necrosis i.e. 4.47 percent was recorded from ST with Imidacloprid 600 FS @ 5 ml/kg seed followed foliar spray with Imidacloprid 17.8 SL @ 0.5 ml/L (T_1) at 30,45 and 60DAS followed by ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Diafenthiuron 50 WP 1g/L (T_4) at 30,45 and 60 DAS (4.96%), ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Fipronil 5 SC @ 1 ml/L (T_2) at 30,45 and 60 DAS (5.08%), ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Flonicamide 50 WG @ 0.25 g/L (T_5) at 30,45 and 60 DAS (5.35%), all these treatments were at par (Table 3). Statistically significant differences were observed among the treatments towards seed yield (Table 4). Seed treatment with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Triazophos 40 EC @ 1 ml/L (T_3) at 30, 45 and 60 DAS recorded higher seed yield 1165 kg/ha followed by ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Diafenthiuron 50 WP 1g/L (T_4) at 30,45 and 60 DAS (1158 kg/ha), ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Fipronil 5 SC @ 1 ml/L (T_2) at 30,45 and 60 DAS (1150 kg/ha), ST with Imidacloprid 600 FS @ 5 ml/kg seed followed by ST with Imidacloprid 17.8 SL (T_1) at 30,45 and 60DAS (1135 kg/ha). ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Spiromesifen 24 SC @ 1 ml/L (T_6) at 30,45 and 60 DAS (1135 kg/ha) and seed treatment with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Flonicamide 50 WG @ 0.25 g/L (T_5) at 30,45 and 60 DAS (1131kg/ha). ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Triazophos 40 EC @ 1 ml/L (T_3) at 30, 45 and 60 DAS found economical having ICBR 1.47 followed by ST with Imidacloprid 600 FS @ 5 ml/kg seed followed ST with Imidacloprid 17.8 SL (T_1) at 30,45 and 60DAS (0.97).

Present investigation is on evaluation of insecticide molecules against necrosis disease of sunflower. Management of necrosis disease through chemicals indicated the crop could be protected from loss of yield due to necrosis virus disease by spraying of insecticide combined with seed treatment. Present findings are in conformity with Lokesh *et al*., 2008, who studied the efficacy of new chemical molecules and sorghum as border row crop against sunflower necrosis virus disease and its vector *Thrips palmi* and reported that, highest yield of 17.68 q/ha and minimum percent incidence of necrosis disease (2.56%) and least mean number of thrips (3.33) per five plants was recorded in plot receiving seed treatment by Gaucho along with Confidor spray at 15, 30 and 45 DAS. Pankaja *et al*., 2010 [19] proved that a single thrip was enough to acquire and transmit the virus from an infected to

healthy sunflower plant. Mesta *et al*., 2004 reported that use of border crop like sorghum reduced incidence of SND from 18 to 37 percent. Shirshikar, 2008 conducted field experiment and reported that if the sunflower seed treated with imidacloprid 70 W.S. @ 5 g/kg along with sunflower spraying with imidacloprid 200SL @ 0.05 percent at 15,30 and 45days after sowing, the incidence of sunflower necrosis disease can be minimized. Lokesh *et al*., 2008 [16] recorded that seed treatment with imidacloprid @ 5 g/kg seed and imidacloprid (0.5 percent) spray reduced disease incidence with higher yield compared with other treatments. Seed treatment either with imidacloprid @ 5 g/k or thiomethoxam @ 4g/kg seed followed by two sprays at 30 and 45 days found effective to reduce necrosis disease and increase seed yield significantly over untreated control (Shirshikar *et al*., 2009) [30]. Shirshikar, 2010 [31] revealed that the sunflower necrosis disease can be managed by treating seeds with thiomethoxam at 4g/kg along with two sprays of the chemical at 0.05% 30 and 45 DAS.

Thus it can be concluded from the above results that for the management of sunflower necrosis disease, the sunflower seed should be treated with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Triazophos 40 EC @ 1 ml/L (T_3) at 30, 45 and 60 DAS recorded higher seed yield and found economical having ICBR 1.47. Among different viruses infecting sunflower crop in India, Tobbaco streak virus causing severe threat to sunflower production. Desired level of resistance to TSV both in cultivated species as well as in the germplasm of sunflower is not available as the screened cultivars/germplasm/CMS lines/R lines were found susceptible against TSV in laboratory screening. Therefore there is an urgent need to search the resistance sources both in native and exotic germplasm.

Table 1: Effect of insecticide on Germination

	Treatments	Germination (%)			
		2018-19	2019-20	2020-21	Mean
1	T_1: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Imidacloprid 17.8 SL @ 0.5 ml/L at 30,45 and 60 DAS	96.2 (9.81)	95.9 (9.8)	98.7 (9.94)	97.59 (9.88)
2	T_2: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Fipronil 5 SC @ 1 ml/L at 30,45 and 60 DAS	95.6 (9.77)	93.0 (9.6)	98.4 (9.92)	97.14 (9.86)
3	T_3: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Triazophos 40 EC @ 1 ml/L at 30,45 and 60 DAS	92.4 (9.61)	96.2 (9.8)	98.4 (9.92)	98.20 (9.91)
4	T_4: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Diafenthiuron 50 WP 1g/L at 30,45 and 60 DAS	95.6 (9.77)	96.2 (9.8)	96.5 (9.82)	93.60 (9.67)
5	T_5: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Flonicamide 50 WG @ 0.25 g/L at 30,45 and 60 DAS	92.4 (9.61)	94.6 (9.7)	96.8 (9.84)	92.54 (9.62)
6	T_6: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Spiromesifen 24 SC @ 1 ml/L at 30,45 and 60 DAS	93.0 (9.64)	96.8 (9.8)	98.4 (9.92)	96.82 (9.84)
7	T_7: Control.	96.5 (9.82)	97.1 (9.9)	99.4 (9.97)	97.09 (9.85)

Figures given in parenthesis are square root transformed values

Table 2: Effect of insecticides on necrosis at one month after germination

	Treatments	Necrosis % Intensity			
		2018-19	2019-20	2020-21	Mean
1	T_1: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Imidacloprid 17.8 SL @ 0.5 ml/L at 30,45 and 60 DAS	1.67 (1.27)	3.0 (1.7)	6.4 (2.5)	3.71 (1.92)
2	T_2: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Fipronil 5 SC @ 1 ml/L at 30,45 and 60 DAS	1.67 (1.28)	4.5 (2.0)	6.4(2.5)	4.19 (2.04)
3	T_3: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Triazophos 40 EC @ 1 ml/L at 30,45 and 60 DAS	2.07 (1.41)	4.0 (2.0)	8.7 (2.9)	4.91 (2.21)
4	T_4: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Diafenthiuron 50 WP 1g/L at 30,45 and 60 DAS	1.66 (1.27)	3.6 (1.9)	6.5 (2.6)	3.96 (1.99)
5	T_5: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Flonicamide 50 WG @ 0.25 g/L at 30,45 and 60 DAS	2.14 (1.46)	4.0 (2.0)	7.6 (2.7)	4.60 (2.13)
6	T_6: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Spiromesifen 24 SC @ 1 ml/L at 30,45 and 60 DAS	2.39 (1.54)	4.9 (2.2)	8.1 (2.8)	5.12 (2.25)
7	T_7: Control.	4.28 (2.06)	8.8 (3.0)	14.4 (3.8)	9.15 (3.02)
	SE (m)+	0.14	0.21	0.25	0.12
	(P=0.05)	0.42	0.64	0.77	0.35
	CV (%)	16.07	17.05	15.39	8.96

Figures given in parenthesis are square root transformed values

Table 3: Effect of insecticides on necrosis at two month after germination

	Treatments	Necrosis % Intensity			
		2018-19	2019-20	2020-21	Mean
1	T_1: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Imidacloprid 17.8 SL @ 0.5 ml/L at 30,45 and 60 DAS	2.30 (1.51)	3.7 (1.9)	7.4 (2.70)	4.47 (2.11)
2	T_2: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Fipronil 5 SC @ 1 ml/L at 30,45 and 60 DAS	2.01 (1.38)	5.8 (2.4)	7.4 (2.71)	5.08 (2.25)
3	T_3: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Triazophos 40 EC @ 1 ml/L at 30,45 and 60 DAS	2.84 (1.68)	5.6 (2.4)	9.0 (2.99)	5.82 (2.41)
4	T_4: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Diafenthiuron 50 WP 1g/L at 30,45 and 60 DAS	2.32 (1.52)	4.6 (2.1)	7.9 (2.81)	4.96 (2.22)
5	T_5: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Flonicamide 50 WG @ 0.25 g/L at 30,45 and 60 DAS	2.11 (1.45)	5.4 (2.3)	8.6 (2.92)	5.35 (2.31)
6	T_6: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Spiromesifen 24 SC @ 1 ml/L at 30,45 and 60 DAS	2.72 (1.64)	6.5 (2.6)	9.0 (2.98)	6.10 (2.47)
7	T_7: Control.	5.27 (2.29)	13.1 (3.6)	18.9 (4.33)	12.40 (3.52)
	SE (m)+	0.13	0.19	0.22	0.09
	(P=0.05)	0.40	0.60	0.66	0.28
	CV (%)	13.33	13.62	12.19	6.27

Figures given in parenthesis are square root transformed values

Table 4: Seed Yield (kg/ha) and Incremental benefit cost ratio

	Treatments	Yield (Kg/ha)				I:B:C:R
		RI	RII	RIII	Mean	
1	T_1: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Imidacloprid 17.8 SL @ 0.5 ml/L at 30,45 and 60 DAS	1134	1068	1202	1135	0.97
2	T_2: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Fipronil 5 SC @ 1 ml/L at 30,45 and 60 DAS	1125	1120	1205	1150	0.89
3	T_3: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Triazophos 40 EC @ 1 ml/L at 30,45 and 60 DAS	1145	1142	1208	1165	1.47
4	T_4: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Diafenthiuron 50 WP 1g/L at 30,45 and 60 DAS	1123	1134	1217	1158	0.61
5	T_5: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Flonicamide 50 WG @ 0.25 g/L at 30,45 and 60 DAS	1117	1123	1154	1131	0.65
6	T_6: ST with Imidacloprid 600 FS @ 5 ml/kg seed and foliar spray with Spiromesifen 24 SC @ 1 ml/L at 30,45 and 60 DAS	1108	1120	1177	1135	0.44
7	T_7: Control.	980	1020	974	991	0.00
	SE (m)+	-	-	53.31	37.9	-
	(P=0.05)	-	-	164.27	116.78	-
	CV (%)	-	-	7.94	5.84	-

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