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Evaluation of Celest Top® 312.5 FS (fludioxonil 25g/L; difenoconazole 25g/L; thiamethoxam 262g/L) to control insect pests and seedling diseases on wheat, Sudan

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Abstract: The experiments were conducted at Hudiaba research station farm (River Nile State) and New halfa Research Station (Kassala State) for two consecutive seasons 2014/015 and 2015/016, to evaluate the effectiveness of Celest Top 312.5 FS (flowable solution) as seed dressing to control insect pests and seedling diseases of wheat. Celest Top 312.5 FS was used at the rates of 1.25ml/kg seed, 1ml/kg seed and 0.75 ml/kg seed with its respective (standard) check 1.5g/kg Raxil2% WS (tebuconazole) + 0.5g/kg Gaucho70% WS (imiddacloprid) and untreated control. In contrast, Celest Top 312.5 FS at the rates of 1ml/kg and 1.25ml/kg seed significantly (P≤ 0.01) reduced green bug and termite infestation and seedling diseases of wheat and increased wheat grain yield compared to the untreated and standard. In vitro evaluation of Celest Top 312.5 FS against *Pythium spp.* revealed that the pesticide containing fungicidal components significantly inhibited the mycelia growth of test pathogen. Results of residue analysis showed that no detectable levels of Celest Top 312.5 FS were found in all samples of wheat collected at harvest.

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INTRODUCTION

Wheat (*Triticumaestivum*L.) has become an important stable food in Sudan and its production has steadily increased in recent years. Control measures of pests and diseases are important aspects to ensure acceptable productivity (Khalid et. al., 2017). The economic important of the termite *Odontotermis spp.*, and green bug *Schizaphisgraminum*(Rond) are major wheat insect pest in Sudan. *S.graminum*, was reported to badly affect plant tissues and reduce wheat yield by 25-30% (SharafEldin, 1992). Termite causes serious damage of wheat in Rahad and New Halfa, it was significantly reduced when the seeds were treated with Gaucho (Kannan et. al., 1998 and Mohamed et. al., 2009). The common world-wide seedling diseases of wheat and barley are, mainly caused by the soil borne pathogens: *Pythium spp*., *Rhizoctonia spp*. and *Fusarium spp*. and crown rot. All are caused by fungi that live in the soil. *Pythium* begins its attack of wheat by infecting the germ (embryo) end of the germinating seed. In Sudan *Pythium* root rot is the most common fungal diseases associated with seed bed and seedling stage of wheat. *Pythium* species infection decrease root mass which leads to poor nutrient uptake resulting in variable crop stand, decrease tillers, varying maturity stage and eventually yield losses (Kurmut et. al., 2009). Most seed treatments going back to early-day chemicals prevent this phase of *Pythium* damage to wheat and barley (Cook et al, 2002). Chemical seed treatment can give a good control of Fusarium since the fungus can be found on diseased seedlings (Koenning, 2004). In the last few years damping off of seedling become a challenge to wheat production in River Nile State. Chemical seed dressing is the best way of control seedling damping off of wheat. The objective of this study was to evaluate the efficacy of Celest Top 312.5 FS (fludioxonil 25g/L; difenoconazole 25g/L: thiamethoxam 262g/L); (Chemical group: Neonicotinoids, phenylpyroles, triazoles) as seed dressing to control insect pests and seedling diseases of wheat.

MATERIAL AND METHODS

The experiments were conducted at Hudeiba Research Station experimental Farm (River Nile Stat) and New Halfa Research Station (Kassala State) in consecutive seasons 2014/015 and 2015/016. Wheat seeds cultivar Bohain (germination 96 %) were moistened with water and the calculated amount of each product dose of Celest Top 312.5 FS) at the following rates:

1.25ml/kg seed, 1ml/kg seed and 0.75 ml/kg seed were made. The treatments were compared to the standard Raxil 2% WS (tebuconazole) + Gaucho 70% WS (imiddacloprid) at the rate of 1.5 g + 0.5 g/kg seeds. The products were thoroughly mixed and added. The treated seeds were allowed to dry and sown in the next day. The plot size at Hudeiba site was 25 m² and 56 m² in New Halfa Station. The treatments were arranged in a randomized complete block design with threereplications. The net harvested area was 9 m^2. The cultural practices were applied as recommended for wheat packages by Agricultural Research Corporation (ARC).

Aphid, termite and seedling damage assessment

To assess the efficacy of the different seed dressing products against aphids on wheat plants, observation and counts were weekly made. Two concepts were used; the percentage of infested tiller and the intensity of aphid per tiller. The percentage of infested tillers was assessed by counting the infested ones in one meter long and the intensity was by counting the number of aphids on 20 randomly selected tillers per plot. Termite infestation was assessed as percentage of damaged plants by counting the damaged and undamaged ones in meter length. The emergence of seedling was counted 10 days after sowing; total plant and % of damping off of wheat seedling were assessed by monitoring the counting in one m² for each treatment, plant height and grain yield was recorded at harvest time. Data was transformed to Arcsine when required. Statistical Analysis of variance (ANOVA) and means were separated according to Duncan's Mutable Range Test using MSTAT-C software program.

In vitro test

In vitro evaluation of the fungicide component was conducted to check the colony growth of the fungus *Fusarium sp.*, on PDA medium. Fungicide was tested at 5 concentrations (50, 100, 200, 500 and 800 ppm) The PDA medium without fungicide was kept as control. Diameter of the fungus colony growth was measured in the different pesticide concentrations and the diameter of fungus treatments in 6 concentrations inhibition zones was calculated.

Residues analysis

Wheat samples, treated with the highest dose of Celest Top 312.5 FS (fludioxonil 25g/L; difenoconazole 25g/L; thiamethoxam 262g/L) were collected at harvest and used for residues analysis. A standard method was used for extraction and clean-up of theses samples. Analysis was carried out by thin-layer chromatography (TLC) using plastic ready-made silica gel GF254 coated plates with thickness of 0.25 mm (Merck).

RESULTS AND DISCUSSION

Effect on aphid and termite damage

The performance of Celest Top 312.5 FS (flowable solution) against aphid at Hudeiba Research Station Farm in seasons 2014/015 and 2015/016 was presented in (Table 1& 2). The effectiveness of Celest Top 312.5 at the two seasons, suppressed green bug population and consequently residual level of aphid infestation with highly significant difference compared to the standard and untreated control (Table 3 &4). The outstanding of Celest Top 312.5 was maintained throughout the two seasons particularly at higher and medium doses. The pesticide resulted in yield significantly higher than that of untreated control and the standard. On the other hand, in new Halfa site and throughout the two seasons, no aphid was observed on all plots including the untreated control. With regard to termite infestation results presented in (Table 3& 4), showed that the three dosage rates of Celest Top 312.5 FS were comparable to the standard check Gaucho and had significantly ($P \leq 0.001$) lower level of infestation compared to the untreated control. The performance had its significant consequence on plant population and grain yield, during the two seasons where the three doses of Celest Top 312.5 FS and the standard check significantly ($P \leq 0.05$) out-yielded the untreated control. These findings suggested that, the lower dosage rate of Celest Top 312.5 was equally effective to the medium and higher rates in reducing termite infestation and subsequently increasing wheat grain yield.

Table1. Effects of Celest Top 312.5 FSon green bug numbers, percentage ofinfestation and grain yield ofwheat at HudeibaR.S.F. season (2014/015)

Treatment Rate ml/kg seed)	Green bug number /10 tillers			% infested tillers				Grain yield (kg/fed)
	1st count	2nd count	3rd count	14/1/2015	21/1/015	1/2/015	15/2/015	
Celest Top 312.5 FS at 0.75 ml/kg	1.9 (3.3) a	4.2 (17.3) b	12.7 (161.3) c	0.9 (0.5) a	(3.6) ab	1.9 (3.2) a	1.7 (2.2) b	14481.1 ab
Celest Top 312.5 FS at 1.0 ml/kg	1.9 (3.3) a	1.4 (1.7) a	8.5 (72.5) b	0.0 (0.7) a	(1.7) a	1.2 (1.0) a	1.2 (0.9) a	1740.9 a
Celest Top 312.5 FS at 1.25 ml/kg	1.9 (3.3) a	1.4 (2.0) a	4.5 (62.0) a	0.0 (0.7) a	(1.6) a	1.2 (1.0) a	0.9 (0.3) a	1393.1 ab
Gaucho(0.5g/kg)+(Raxil1.5ml/kg) Standard	3.6 (13.0) b	18.5 (343) c	26.1 (683) d	1.1 (1.0) a	(3.7) b	3.3 (10.5) b	2.0 (3.3) b	1151.0 b
Untreated- control	7.8 (60.7) c	18.7 (349) c	28.8 (827.7) e	2.6 (6.2) b	(3.9) b	3.3 (10.5) b	2.2 (4.2) b	1207.9 b
SE±	0.43**	0.53**	0.38**	0.59**	0.59**	0.10**	0.587**	109.7*
C.V%	21.9	10.3	4.0	30.5	35.3	35.5	30.5	13.7

Data transformed according to the √x+ 0.5, actual figures in parenthesis. Means followed by the same letter(s) with the same column are not significant different according to DMRT at 0.05 and 0.001 level of probability respectively.

Table 2 Effects of Celest Top® 312.5 FSon green bug numbers, percentage ofinfestation and grain yield ofwheat at HudeibaR.S.F. season (2015/016).

Treatment (Rates/kg seeds)	Green bug number /10 tillers			% infested tillers			Grain yield (kg/fed)
	1st count	2nd count	3rd count	21/1/016	14/2/016	22/2/016	
Celest Top 312.5 FS at 0.75 ml/kg	0.9 (0.3) a	14.5 (210) ab	3.5 (11.7) c	1.7 (2.5) a	(10.7) b	2.3 (5.6) b	1728.0 c
Celest Top 312.5 FS at 1.0 ml/kg	0.9 (0.3) a	14.0 (202) ab	1.1 (0.7) a	1.2 (1.2) a	(10.1) ab	2.2 (4.5) ab	1896.5 b
Celest Top 312.5 FS at 1.25 ml/kg	0.9 (0.3) a	11.0 (124) a	0.8 (0.2) a	1.2 (1.2) a	(7.6) a	2.0 (4.7) a	2035.0
Gaucho(0.5g/kg)+(Raxil1.5ml/kg) Standard	0.9 (0.3) a	16.4 (269) b	2.3 (4.8) b	1.5 (1.9) a	(9.8) ab	2.4 (4.8) b	1674.5 c
Untreated- control	6.9 (47.3) b	33 (1108) c	3.2 (9.5) c	3.0 (8.4) b	(15.2) c	3.3 (13.2) c	1582.4
SE±	0.172**	1.018**	0.164**	0.218**	0.844**	0.073**	19.7**
C.V%	14.2	9.9	13.2	21.6	13.7	5.2	1.9

Data transformed according to the √x+ 0.5, actual figures in parenthesis. Means followed by the same letter(s) with the same column are not significantdifferent according to DMRT at 0.001 level of probability.

Table 3. Effects of Celes Top 312.5 FS on termite damage and wheat grain yield at New Halfa Research Station season 2014/015.

Treatment (Rate ml/kg seed)	%termite damage				No. plants/ meter long	Grain yield (kg/fed)
	1st count	2nd count	3rd count	Mean		
Celest Top 312.5 FS at 0.75 ml/kg	1.1 (0.7) a	1.4 (1.4) a	2.3 (5.5) ab	1.6 (2.4) ab	84.5 a	771.9 b
Celest Top 312.5 FS at 1.0 ml/kg	0.9 (0.4) a	1.4 (1.5) a	2.1 (4.0) ab	1.5 (2.0) ab	92.0 a	871.5 ab
Celest Top 312.5 FS at 1.25 ml/kg	0.9 (0.4) a	1.2 (1.0) a	2.0 (3.7) a	1.4 (1.7) a	89.0 a	945.0 a
Gaucho(0.5g/kg)+(Raxil1.5ml/kg) Standard	1.3 (1.1) a	1.2 (1.0) a	2.7 (7.0) b	1.7 (3.0) b	93.8 a	979.1 a
Untreated- control	1.7 (2.5) b	1.8 (2.8) b	4.5 (19.5) c	2.7 (8.3) c	64.8 b	795.4 b
SE±	0.1**	0.1**	0.2**	0.1**	3.2**	38.1**
C.V%	18.0	12.3	12.2	9.4	7.6	8.7

Data transformed according to the √x+ 0.5, actual figures in parenthesis. Means followed by the same letter(s) with the same column are significant different according to DMRT at 0.001 level of probability.

Table 4. Effects of Celest Top 312.5 FS on termite damage and wheat grain yield at New Halfa Research Station season 2015/016.

Treatment (Rate ml/kg seed)	%termite damage				No. plants/ meter long	Grain yield (kg/fed)
	1st count	2nd count	3rd count	Mean		
Celest Top 312.5 FS at 0.75 ml/kg	1.0 (0.6) a	1.0 (0.6) a	0.8 (0.2) a	1.0 (0.5) ab	(116.7) a	(987.5) a
Celest Top 312.5 FS at 1.0 ml/kg	1.0 (0.6) a	0.7 (0.0) a	0.7 (0.0) a	0.8 (0.2) a	(118.3) a	(1000.0) a
Celest Top 312.5 FS at 1.25 ml/kg	0.9 (0.5) a	0.7 (0.0) a	0.8 (0.2) a	0.8 (0.2) a	(119.7) a	(1001.0) a
Gaucho(0.5g/kg)+(Raxil1.5ml/kg) Standard	1.4 (1.5) b	0.9 (0.5) a	0.7 (0.0) a	1.0 (0.7) b	(117.6) a	(988.8) a
Untreated- control	2.1 (3.9) c	2.1 (3.8) b	1.8 (2.9) b	1.1 (3.5) c	(107.9) b	(887.5) b
SE±	0.1**	0.1**	0.1**	0.1**	0.96**	225.5*
C.V%	13.2	17.4	13.0	9.4	1.6	4.6

Data transformed according to the √x+ 0.5, actual figures in parenthesis. Means followed by the same letter(s) with the same column are not significant different according to DMRT at 0.001 level of probability.

Table 5. Effect of Celest Top 312.5FS on plant height, plant population and damping off of wheat at Hudeiba Research Station seasons 2014/015 and 2015/016.

Treatments (Rates/kg)	Season 2014/015			Season 2015/016		
	Plant height (cm)	Total plant/m^2	% damping off disease	Plant height (cm)	Total plant/m^2	% damping off disease
Celest Top 312.5 FS at 0.75 ml/kg	(67.0)	(269.3) a	2.9 (8.4) b	(72.4)	(237.0)	1.6 (2.1) c
Celest Top 312.5 FS at 1.0 ml/kg	(69.5)	(286.0) a	2.5 (5.6) a	(73.2)	(237.0)	1.2 (0.9 a)
Celest Top 312.5 FS at 1.25 ml/kg	(63.5)	(242.7) b	2.1 (3,9) a	(75.1)	(239.7)	1.3 (1.3) b
Gaucho(0.5g/kg)+(Raxil1.5ml/kg) Standard	(68.3)	209.0) c	3.7 (9.9) c	(72.8)	(225.6)	1.8 (2.6) d
Untreated- control	(73.3)	191.0 c	4.6 (20.7) d	(74.2)	(197.3)	2.4 (4.9) e
SE±	2.8 n.s	6.6**	0.08**	1.5 n.s	16.8**	0.04**
C.V%	5.2	6.6	4.4	3.7	16.5	4.8

Data transformed according to the √x+ 0.5, actual figures in parenthesis. Means followed by the same letter(s) with the same column are not significant different according to DMRT at 0.001 level of probability. n.s= not significant

Table 6. Effect of Celest Top 312.5FS and Raxil 2% WS on in vitro growth of *Pythium spp*. (2014/2015)

Fungicide concentration (ppm)	Means of inhibition zone (cm)	
	Celest Top 312.5 FS (fludioxonil&difenoconazole)	Raxil 2% WS (tebuconazole)
800	1.2	4.3
400	2.0	5.5
200	2.2	5.7
100	3.3	5.8
50	5.0	6.3
Untreated-control	8.5	8.5

Effect on seedling diseases

The performance of Celest Top 312.5 FS against damping off pathogen at Hudeiba Research Station Farm in 2014/15 and 2015/16 seasons was presented in (Table 5). The results showed that the highest plant density (286 seedlings/m²) was observed in the plot treated with Celest Top 1ml/kg seed compared to the lowest one (191 seedlings/m²) in the untreated plot. The lowest infection levels of wheat seedlings (1.2 & 2.1%) was recorded in the plots treated with 1ml/ kg seeds and 1.25 ml /kg seeds Celest Top 312.5 FS, while the higher infection levels (4.6 & 2.4%) were consistently observed in the untreated plots. In both seasons, grain yield was significantly increased by the application of Celest Top 312.5 FS, and all treatments of its increased the yield compared to untreated control, while the plant heights were not significantly affected (Table 1,2 & 5) respectively.

Residues analysis

According to TLC results the retardation factor (R f) values of Fludioxonil; thiamethoxam and difenoconazole: standards were 0.65, 0.50 and 0.80 respectively. The minimum detectable quantity was 0.08 ug and the recovery of the methods was 86%. No detectable levels of residues of Celest Top 312.5 FS (fludioxonil; difenoconazole: thiamethoxam).

In vitro evaluation

The result of in vitro test showed that the fungicide components of Celest Top 312.5 FS had positive effect on inhibition of radial growth of *Pythium sp.*, when tested at 6 concentrations 50, 100, 200,400

and 800 ppm) (Table 6) and gave better results than the standard fungicide Raxil 2% WS.

CONCLUSION

We conclude that, the highest and the medium dosage rates by Celest Top 312.5 FS significantly suppressed aphid population and consequently reduced level of aphid infestation and termite. Likeness, the treatment of Celest Top 312.5 FS reduced damping off seedling disease. The product increased wheat grain yield compared to the untreated control and the standard.

In accordance with the foregoing results, could be recommending the use of the dresser pesticide Celest Top 312.5 FS (fludioxonil 25g/L; difenoconazole 25g/L: thiamethoxam 262g/L) at 1.0 ml/kg of wheat seeds equivalent to (fludioxonil 0.025 g a.i. /kg seeds; difenoconazole 0.025g a.i kg/ seeds: thiamethoxam 0.0262g a.i /kg seeds) as seed dressing to control green bugs, termites and seed bed fungal diseases on wheat. Therefore, and according, to the residues analysis, usage of pesticide Celest Top 312.5 FS in wheat is safe when used at recommended dose.

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