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Effectiveness of Different Fungicides Formulations and Certain Ground Spraying Equipment in Controlling Wheat Stripe Rust in Egypt

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Abstract:

Wheat (*Triticum aestivum* L.) is of the most important cereal crop for many world's populations. It is the most important staple food of about two billion people. However, the production and productivity of wheat is affected by various biotic and abiotic stresses. Among the biotic stresses, stripe rust caused by *Puccinia striiformis* f. sp. *tritici* (Pst), is one of the most widespread and damaging diseases of wheat. Field experiments were carried out in an area of about three kirats planted with the susceptible variety (Giza160), during seasons 2017/2018 and 2018/2019 in 15th and 30th March in wheat field located at Sakha, Kafrelshiekh Governorate. The selected area was split into 30 plots including 3 control plot. Propiconazole, azoxystrobin + cyproconazole and cyproconazole + propiconazole were sprayed with the rate of recommended dose rate and three treatments sprayed with water as control by using Hydrulic Matabi evolution sprayer (56 L./fed.), Knapsack motor sprayer (Arimitsu) (43 L./Fed.) and Rotary Matabi sprayer (18 L./fed.). Data indicated that, all tested compounds revealed significant influenced on wheat stripe rust pathogen (Pst). Data of two successive sprays gave the same results since propiconazole occupied the first rank in reducing rust severity. The best fungicide in this respect were propiconazole followed by cyproconazole + propiconazole, however azoxystrobint + cyproconazole was the least in this regard. It could be recommended to use these compounds with LV spraying equipment with not less than (18L/Fed.). Also, the best equipment in this respect were Rotary (Matabi) followed by Hydraulic (Matabi) and Knapsack motor sprayer (Arimitsu) the tested equipment under study. Hence, the yield production was high in the best fungicide and equipment. The rate of performance of Arimitsu sprayer was 15.25 Fed./day, but the lowest rate of performance was Rotary Matabi sprayer since it could spray only 2.3 Fed./day.

Introduction

Wheat (*Triticum aestivum* L.) is the most important cereal crop for the majority of world's populations. It is the most important staple food of about two billion people (36% of the world population). Worldwide, wheat provides nearly 55% of the carbohydrates and 20% of the food calories consumed globally (Breiman and Graur, 1995). However, the production and productivity of wheat is affected by various biotic and abiotic stresses. Among the biotic stresses, stripe (yellow) rust of wheat, caused by *Puccinia striiformis* f. sp. *tritici*, is one of the most widespread and damaging diseases of wheat, causing great losses in yield and grain quality (Line, 2002 and Chen, 2005). Grain losses caused by this devastating pathogen have been reported to be 10-70 % besides affecting the quality of grain and forage (Chen, 2005). The frequency of epidemics and damage caused by stripe rust is different in each country. In Egypt, stripe rust is the most common and important wheat disease. It caused severe losses in grain yield (Abu El-Naga *et al*., 2001). A lot of methods were available to control wheat rusts. Growing resistant cultivars and applying synthetic fungicides were commonly used as the two main strategies to successfully control yellow rust in many countries, worldwide. Yield and quality losses were related to reductions in green leaf area resulting from pustule formation on infected leaves. Different management options, such as use of resistant varieties, However, the disease became one of the worst diseases, affecting almost every released and registered variety in the country. Under such condition, when the inoculum level was very high, the use of fungicide is mandatory to obtain optimum yield.

Variety resistance has been ultimately the best option for managing stripe rust in the long term. However, in the short to medium term growers planting moderately susceptible varieties were reliant on the use of fungicides either at sowing (in-furrow on fertilizer or seed treatments) or in-crop (application of foliar fungicides), or a combination of both options. The development of new pathotypes of the stripe rust fungus, which reduced the resistance of selected commercial varieties, could made make fungicide intervention necessary in other situations. Chemical control of cereal rusts was extensively studied by many investigators using different applications in many locations foliar spray fungicides against wheat rusts have been known for many years and most of them were used as protects. Majority of interest was directed to the type, dosage of fungicides used in Egypt, while a lesser attention was given to the application methods. Hindy (1992) recorded significant variation in the spray deposit due to spray technique, arrangement of the nozzles and rate of application. The world attention was directed to minimization of spraying volumes and costs of control pests which might been achieved by using a cheap and effective fungicide or using recent ground spraying technique with low cost of application per feddan and more homogenous spray coverage (Magdoline *et al*., 1992 and Matthews, 1992). Concluded that the optimum droplet size for spraying insecticide and fungicide application should be ranged between 50-150 μm, which gave best control results of the target disease with minimum fungicide and minimum ecosystem contamination. According to Bouse *et al*., (1986), Gohich (1983), Reichard *et al*. (1977) and Yates and Cowden (1985), the droplet size was a combined function of spraying technique chemical formulation and ambient conditions. Thus, this study was carried out to investigate the effect of fungicides and equipment controlling wheat stripe rust pathogen *Puccinia striiformis* f. sp. *tritici* on wheat plants under field conditions in Egypt.

Materials and methods

1. Fungicides:

Trade and common name of fungicides and dosage applied :

- Propiconazole (Telet®), 25% E.C., with concentration 25 cm^3/ 100L water.
- Azoxystrobin + Cyproconazole (Amestar extra®), 28% S.C., rate dose 300 cm^3/ fed.
- Cyproconazole + Propiconazole (Minara®), 41% E.C., rate dose 200 cm^3/fed.

2. Spraying equipment tested on wheat plants:

Three ground application machines were selected to perform the scope of this work as follows:

- Hydrulic Matabi sprayer (56L/fed.).
- Knapsack motor sprayer (Arimitsu) (43 L/Fed.).
- Rotary Matabi sprayer (18 L/fed.).

The tested equipment could be represented according to the technical categorization mentioned in Table (1). Calculations of productivity caliberation and rate of performance were recorded as described by Hindy (1992).

3.Execution of field experiments:

3.1.Description of the Study Area:

The experiment was carried out at Sakha Agriculture Research Center during 2018 and 2019 growing seasons. Wheat planted at 15 th November and two successive sprays takes place on 15th and 30th Mars. The studied area was located in North Delta region, in wheat field located at Sakha Research Station, Kafrelshiekh Governorate. (31° 08 North and 30° 56 East). Climatic condition of the studied area was typically arid Mediterranean climate. the experiment was done under local meteorological conditions of 23°C average temperature, 55% average RH and 2 m/sec. average of wind velocity. The area of 3 kirats was divided into 30 equal plots each plot was, 300 cm^2 between treatments were not cultivated as barrier zones to avoid drift spray between treatments, spraying operations have not been done with any fungicides before execution the field experiment. The experimental field was sprayed with recommended dose of Propiconazole, Azoxystrobin + Cyproconazole and Cyproconazole + Propiconazole by using Hydraulic Matabi evolution sprayer (56 L./fed.) Knapsack motor sprayer (Arimitsu) (43 L./Fed.) and Rotary Matabi sprayer (18 L./fed.) , respectively and three treatments sprayed with water as a control treatment.

3.2.Treatments and experimental design:

Two common wheat cultivars, namely Giza 160 , which had been susceptible to stripe rust, was used for the experiment. A factorial randomized complete block design (RCBD) used with three replications. The selected area of three kirats was split into 30 equal plots including 3 control plots. Fertilizer rate and crop husbandry practices, such as cultivation and weeding were carried out according to the recommended practices. In order to evaluate the tested compounds and equipment on them, before spraying, and post-treatment recorded after days from treatment to determine the effect of the tested chemicals. the 2nd spray takes place after 15days from the 1st spray.

Evaluation of three certain systemic fungicides; propiconazole, azoxystrobint

+ cyproconazole, and cyproconazole + propiconazole and three equipment; Hydraulic Matabi sprayer (56 L./fed.) Knapsack motor sprayer (Arimitsu) (43 L./Fed.) and Rotary Matabi sprayer (18 L./fed.). as well as control un-treatment (water). The experimental unit was a plot included 18 rows with 9 m long and 30 cm. apart, each row received 30g. of seeds using broadcasting method of sowing. The experiment was surrounded with a spreader of highly susceptible varieties; irrigation, fertilization, weed control *etc*. were applied according to the technical recommendation of the crop as normal. Artificial inoculation was performed using the methods of Tervet and Cassel (1951) as mentioned before. The inoculation was concentrated on the spreader plants, on the other hand each fungicides was applied soon after inoculation and repeated 7 days later. The application was carried out at the proper time and correct doses were applied.

4. Calibration and performance adjustment of the tested equipment:

4.1.Collection of spray deposit:

Before spraying each wheat treatment, a sampling line constructed of five wire holder fixed in diagonal line inside each treatment to collect the lost spray between plants; each wire holder top had a fixed water sensitive paper (Novartis Cards®) on it, also, the water sensitive paper cards put on five plants ; to collect the droplets deposit on wheat leaves at both upper and lower levels of plant, were designed according to Hindy (1989). Cards were collected and transferred carefully inside paper. Involved data to the laboratory for measuring and calculating the number of droplets/cm² and its volume mean diameter (VMD) µm in all treatments was done.

4.2. Determination of spray deposit:

Number and size of blue spots (deposited droplets) on the water sensitive papers (Novartis cards®) measured with scaled monocular lens (Strüben) ® (15X) Japanes lens. Volume mean diameter (VMD) µm and number of droplets in one square centimeter (N/cm²) were estimated according to Hindy (1992).

Table (1): Techno-Operational data, calibration and rate of performance of certain ground sprayers applied on Wheat field during season (2017/2018).

Items	Hydraulic (Matabi) evolution sprayer	Rotary (Matabi) sprayer	Knapsack motor sprayer (Arimitsu)
Type of atomization	Hydraulic	Spinning disc	Pneumatic Mechanical
Nozzle type	Hollow cone 800	One restirector	Air shear nozzle
Pump type	Hydraulicair pump	-	Centrifugal fan
Number of nozzles	1	1	1
Pressure (bar)	5	-	-
Spray tank (L.)	20	2	20
Rate of application (L/fed.)	56	18	34
Working speed (Km/h.)	2.4	2.4	2.4
Swath width (m.)	1.5	1.0	5.0
Flow rate (L/min.)	0.8	0.172	1.630
Spray height (m.)	0.5	0.5	0.5
Type of Spraying	Target in all treatments		
Productivity * (fed./h.)	0.86	0.570	2.860
Rate of performance*(fed./day)	3.4	2.3	15.25

* Number of spraying hours = 8 hours daily. *Number of workers =2.
* Calculations of productivity and rate of performance after Hindy (1992).

4.3. Calculation and data analysis:

4.3.1. Rust severity was recorded soon after disease onset and 3 times thereafter with 10 days intervals following the methods adopted by **Petroson *et al*. (1948)**. Evaluation of efficacy of each fungicide were computed according to the following formula adopted by **Rewal and Jhooty (1985).**

$$\% \text{ Efficacy} = \frac{\% \text{ infection in the control} - \% \text{ inf. in treatment}}{\% \text{ Infection in the control}}$$

Yield components expressed as 1000 kernels weight and test weight were estimated at harvest stage.

4.3.2. Statistical analysis of each experiment was performed each season individually using Dunkan's New Multiple Range Test according to **SAS (1996)** .

4.4.Phytotoxic effect:

It was determined by recording any color change, leaf curling or flaming up to 15 days after each spraying, according to **Badr *et al*. (1995).**

Results and discussion

1.Chemical control of stripe rust of wheat:

Data presented in Tables (2) and(3) and Figures (1) and (2) revealed that the evaluation of three certain systemic fungicides and three certain equipment as affected with wheat stripe rust infection in terms of disease severity, on cv. Giza 160 during 2017/18 and 2018/2019 growing seasons. These data indicated that a significant difference was observed between one and two spray application of Propiconazole, however, the rest of fungicides showed significance in this regard, in particular using Rotary Matabi . Under the stress of one spray application a significance was observed between each of three certain systemic fungicides and control treatment. The efficacy of the tested fungicides under the stress of one spray application ranged between (28.57% and 71.43%) and between (75.00% and 93.75%) in case of two spray application.

Data of two successive sprays gave the same result since Propiconazole occupied the first rank in reducing rust severity. The best fungicide in this respect were propiconazole followed by cyproconazole + propiconazole, however azoxystrobint + cyproconazole was the least in this regard. In the second season 2018/2019, data in Table (5) run in a parallel line with those previously mentioned in the first season, since the fungicide Propiconazole was in the first rank (one and two successive sprays). Also, the best equipment in this respect were Rotary (Matabi) followed by Hydraulic (Matabi) the tested equipment under study.

Severe stripe rust epidemic was recorded in the tested wheat cultivar during the second growing season; 2018/2019, than that in the first season; 2017/2018 (Table, 4). The obtained data of disease severity, and infection type (IT), were combined to calculate average coefficient of infection (ACI) was assessed in the cultivar during an epidemic in the two growing seasons. Where, the final stripe rust severity for the tested wheat cultivar varied from one year to another, as affected by the slightly changes in environmental conditions between the two years under study. In addition to, changes occurring in these Pst races population (Figures, 1 and 2).

Table (2): Evaluation of three equipment with three fungicides against stripe rust infection on wheat cultivar; Giza160 in terms of ACI, during 2017/2018.

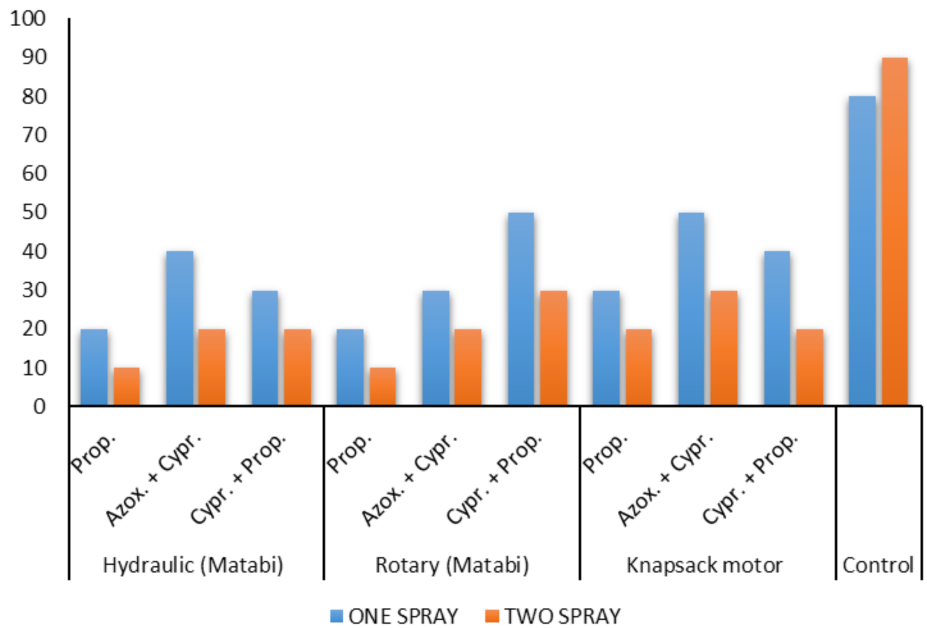
Equipment	Fungicides	A	B	Diff.	Efficacy % A	Efficacy % B
Hydraulic (Matabi)	Propiconazole	20^{d}	5d	15	71.43	93.75
	Azoxystrobint + Cyproconazole	30^{c}	10c	20	57.14	87.50
	Cyproconazole + Propiconazole	20^{d}	10c	10	71.43	87.50
Rotary (Matabi)	Propiconazole	10^{e}	5d	5	85.71	93.75
	Azoxystrobint + Cyproconazole	20^{d}	5d	15	71.43	93.75
	Cyproconazole + Propiconazole	20^{d}	5d	15	71.43	93.75
Arimitsu	Propiconazole	20^{d}	5d	15	71.43	93.75
	Azoxystrobint + Cyproconazole	50^{b}	20b	30	28.57	75.00
	Cyproconazole + Propiconazole	30^{c}	10c	20	57.14	87.5
Control	Water	70^{a}	80a	10	0	0
L.S.D. (1%)	-	0.112	0.884	-	-	-
(5%)	-	0.086	0.649	-	-	-

A = first spray ,B = second spray. Numbers followed by the same letter at the same column are not significantly different.

Table (3): Evaluation of three equipment with three fungicides against stripe rust disease severity on wheat cultivar; Giza160 in terms of ACI conducted at Sakha during 2018/2019.

Equipment	Fungicides	A	B	Diff.	Efficacy % A	Efficacy % B
Hydraulic (Matabi)	Propiconazole	20^{e}	10^{d}	10	75	88.89
	Azoxystrobint + cyproconazole	40^{c}	20^{c}	20	50	77.78
	Cyproconazole + Propiconazole	30^{d}	20^{c}	10	62.5	77.78
Rotary (Matabi)	Propiconazole	20^{e}	10^{d}	10	75	88.89
	Azoxystrobint + cyproconazole	30^{d}	20^{c}	10	62.5	77.78
	Cyproconazole + Propiconazole	50^{b}	30^{b}	20	37.5	66.67
Arimitsu	Propiconazole	30^{d}	20^{c}	10	62.5	77.78
	Azoxystrobint + cyproconazole	50^{b}	30^{b}	20	37.5	66.67
	Cyproconazole + Propiconazole	40^{c}	20^{c}	20	50	77.78
Control	Water	80^{a}	90^{a}	10	0	0
L.S.D. (1%)	-	0.128	0.132	-	-	-
(5%)	-	0.091	0.094	-	-	-

A = first spray , B = second spray. Numbers followed by the same letter at the same column are not significantly different.



Figure(1): Effect of wheat stripe rust severity on wheat cultivar; Giza160 after treatments with different fungicides using three equipment, during 2017/18.

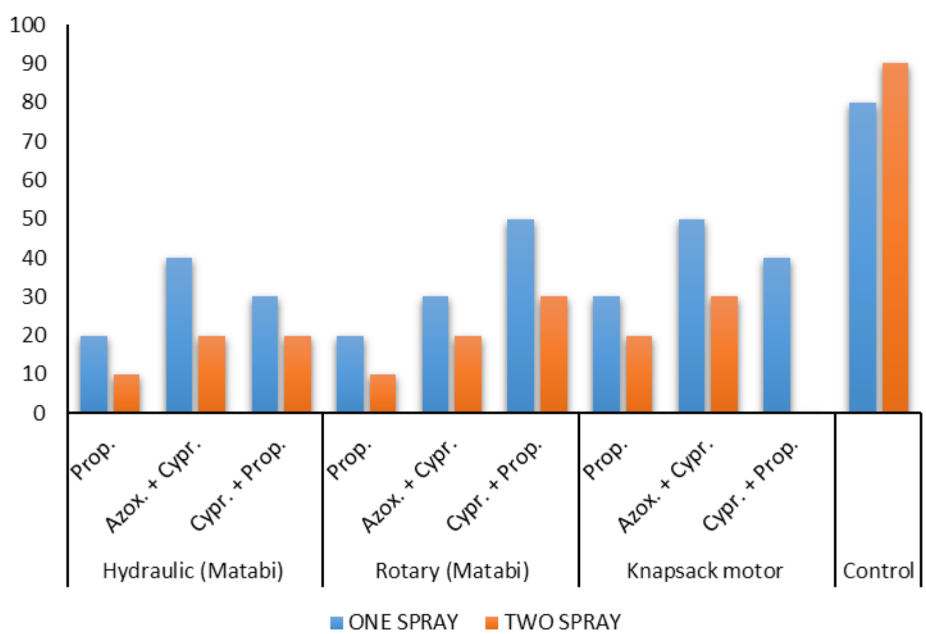


Figure (2): Effect of wheat stripe rust severity on wheat cultivar; Giza160 after treatments with different fungicides using three equipment, during 2018/2019.

As regard to the effect of the application on 1000 k.w. and test weight the presented data indicated the presence of significance between one or two sprays. In Tables (4) and (5) and Figures, (3) and (4) revealed that one spray resulted in the presence of significance between each of the tested three certain systemic fungicides under study. Data analysis of the study revealed that, the best fungicide in this respect were propiconazole followed by cyproconazole + propiconazole, however azoxystrobint + cyproconazole was the least in this regard. The increase over the control treatment was achieved with the application of propiconazole (one spray and two sprays). The increase over control in case of one spray ranged between (18.12%, 23.85% and 32.43%), and between (29.24%, 35.10% and 36.44%) with Knapsack motor sprayer, Hydraulic (Matabi) and Rotary (Matabi), respectively, in case of two sprays application.

Table (4): Evaluation of three fungicides and three equipment against stripe rust infection on wheat cultivar; Giza160 in terms of 1000 k.w. and test weight conducted at Sakha during 2017/2018.

Equipment	Fung.	1000 kernel weight (g)					Test weight -1000 ml (g.)				
		A	B	Diff.	Increase over control A	Increase over control B	A	B	Diff.	Increase over control A	Increase over control B
Hydraulic (Matabi)	F1	45.7 d	61.6 b	8.10	23.85	35.10	668 d	789 b	121	16.17	30.93
	F2	44.4 g	55.2 i	10.8	21.62	27.57	645 f	735 f	90	13.18	25.85
	F3	47.7 b	55.8 g	15.9	27.04	28.35	650 e	738 f	88	13.85	26.15
Rotary (Matabi)	F1	51.5 a	62.9 a	12.8	32.43	36.44	710 b	779 c	69	21.13	30.04
	F2	45.1 e	58.2 d	11.4	22.84	31.31	678 c	758 e	80	17.40	28.10
	F3	47.1 c	59.9 c	13.1	26.11	33.26	675 c	772 d	97	17.04	29.40
Arimitsu	F1	42.5 i	56.5 e	14	18.12	29.24	785 a	799 a	14	28.66	31.79
	F2	44.8 f	55.9 f	11.1	22.32	28.48	602 g	780 c	178	6.977	30.13
	F3	44.0 h	55.4 h	11.4	20.91	27.83	785 a	798 a	13	28.66	31.70
Control		34.8 j	39.9 j	5.18	0.00	0.00	560 h	545 g	15	0	0
L.S.D. (1%)		0.096	0.079				4.262	6.761			
(5%)		0.077	0.054				3.116	4.937			

A = First spray , B = Second spray. Numbers followed by the same letter at the same column are not significantly different.

As for, the effect of fungicides on the test weight, data in the same Tables (4) and (5) and Figures (3) and (4) run in a parallel line with those previously mentioned, since the fungicide propiconazole was in the first rank (one and two sprays). On the other hand, increase over control in case of one spray ranged between (6.98% and 28.66%) and between (25.85% and 31.79%) with the application of Cyproconazole + Propiconazole, Propiconazole, respectively in the first season 2018/2019.

Table (5): Evaluation of three fungicides and three equipment against stripe rust infection on wheat cultivar; Giza 160 in terms of 1000 k.w. and test weight conducted at Sakha during 2018/2019.

Equipment	Fung.	1000 kernel weight (g)					Test weight -1000 ml (g.)				
		A	B	Diff.	Increase over control		A	B	Diff.	Increase over control	
					A	B				A	B
Hydraulic (Matabi)	F1	49.99^{e}	51.41^{e}	1.42	16.96	22.19	599.00^{e}	600.66^{i}	16.0	8.12	12.49
	F2	50.37^{d}	52.93^{b}	2.56	17.59	24.43	625.00^{b}	602.60^{g}	22.4	11.90	12.77
	F3	50.52^{c}	52.36^{d}	1.84	17.83	23.61	595.00^{g}	605.00^{e}	7.51	10.60	13.11
Rotary (Matabi)	F1	47.83^{h}	50.48^{f}	2.65	13.21	20.76	592.33^{i}	611.66^{d}	19.3	7.09	14.06
	F2	48.92^{g}	50.05^{g}	1.13	15.15	20.08	594.66^{h}	601.00^{h}	6.34	7.45	12.54
	F3	50.65^{b}	52.64^{c}	1.99	18.05	24.01	609.00^{e}	619.66^{b}	10.7	9.63	15.17
Arimitsu	F1	47.44^{i}	49.79^{h}	2.35	12.50	19.66	597.33^{f}	614.66^{c}	17.3	7.86	14.48
	F2	49.23^{f}	50.49^{f}	1.26	15.68	20.78	602.33^{d}	603.66^{f}	25.7	8.63	12.92
	F3	51.84^{a}	53.52^{a}	1.68	19.93	25.26	628.00^{a}	623.66^{a}	20.0	12.30	15.71
Control		41.51^{j}	40.00^{i}	1.51	0.00	0.00	550.33^{j}	525.66^{j}	24.7	0.00	0.00
L.S.D. (1%)		0.022	0.072				0.090	0.134			
(5%)		0.012	0.058				0.063	0.098			

A = First spray, B = Second spray. Numbers followed by the same letter at the same column are not significantly different.

As regard to the fungicides evaluation during 2018/2019, data presented in Table (5) revealed that, the application of either one or two successive sprays reduced rust severity comparing with the untreatment control. Concerning the effect of the tested fungicides on 1000 k.w. and test weight run in a parallel line with those previously mentioned in the first season 2017/2018.

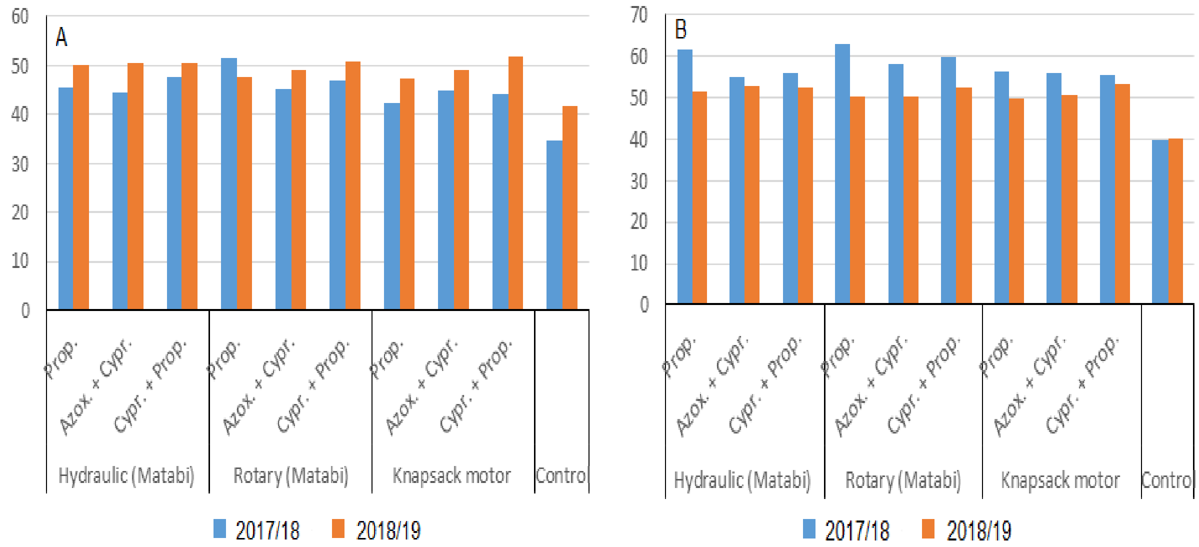


Figure (3): Evaluation of three fungicides using three equipment against stripe rust infection on the Giza160 in terms of 1000 k.w. conducted at Sakha during seasons 2017/2018 and 2018/2019, A = First spray and B = Second spray..

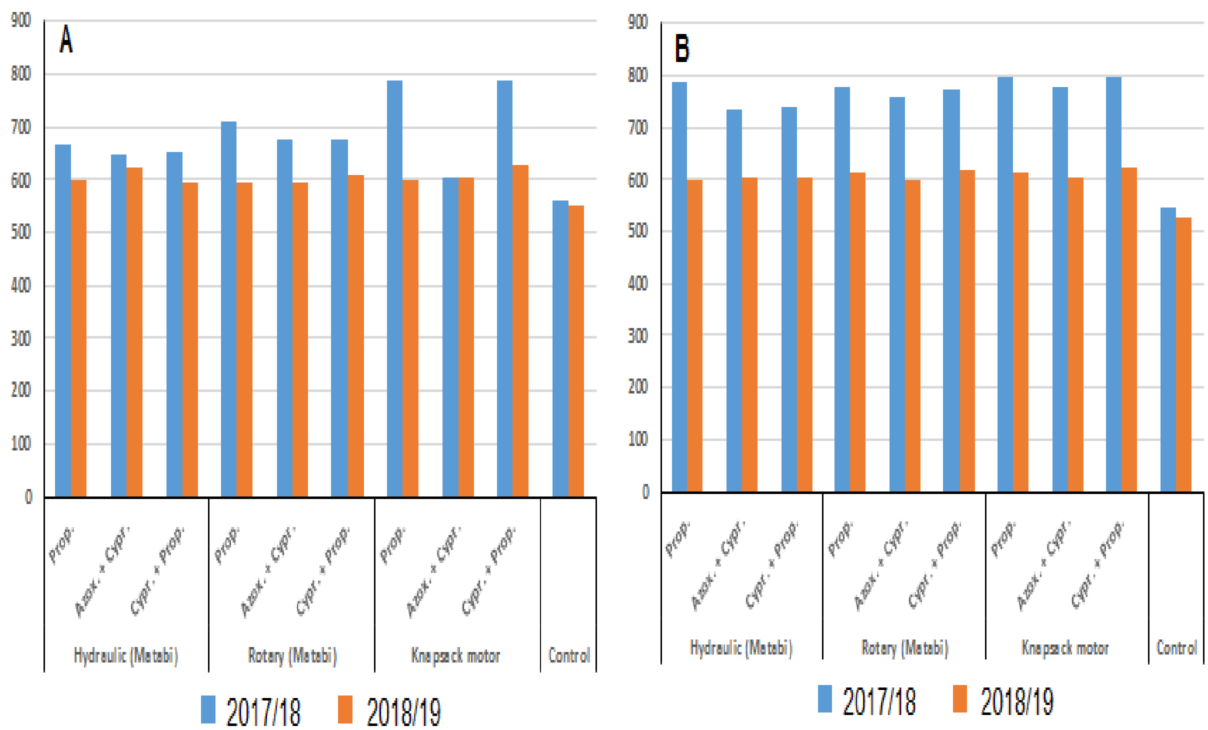


Figure (4): Evaluation of three fungicides using three equipment against stripe rust infection on the Giza160 in terms of test weight conducted at Sakha during seasons 2017/18 and 2018/19, A = first spray and B = second spray.

2. Spray coverage on wheat leaves of fungicide used:

Data in Table (6) showed that ,in the case of propiconazole using Hydrulic Matabi evolution sprayer (56L/Fed.), Knapsack motor sprayer (Arimitsu) (43 L/Fed.) and Rotary Matabi sprayer (18 L/Fed.), respectively the droplet sizes were 152, 143 and 130 µm and N/cm^2 were 157, 183 and 121 for the same equipment. In the case of azoxystrobint + cyproconazole using Hydraulic Matabi sprayer (56L/Fed.), Knapsack motor sprayer (Arimitsu) (43 L/Fed.) and Rotary Matabi sprayer (18 L/Fed.), respectively the droplet sizes were 153, 132 and 147 µm and N/cm^2 were 158, 184 and 119 for the same equipment. In the case of cyproconazole + propiconazole using Hydraulic Matabi sprayer (56L/Fed.), Knapsack motor sprayer (Arimitsu) (43 L/Fed.) and Rotary Matabi sprayer (18 L/Fed.), respectively the droplet sizes were 164, 153 and 134 µm and N/cm^2 were 136, 180 and 117 for the same equipment.

Table (6): Spraying coverage on wheat plants and ground holders produced by certain ground spraying equipment, at season 2017-2018 using total recommended dose rate tested fungicides against wheat stripe rust pathogen *Puccinia striiformis* f. sp. *tritici* at Kafrelshiekh Governorate.

Equipment	**Hydraulic (Matabi) sprayer**						**Knapsack motor sprayer (Arimitsu)**						**Rotary (Matabi) sprayer**					
Application rate L./fed.	**56**						**34**						**18**					
Insecticide	**Propiconazole**		**Azoxystrobin+ Cyproconazole**		**Cyproconazole +Propiconazole**		**Propiconazole**		**Azoxystrobin+ Cyproconazole**		**Cyproconazole +Propiconazole**		**Propiconazole**		**Azoxystrobin+ Cyproconazole**		**Cyproconazole +Propiconazole**	
	N/cm^2	VMD	**N/cm^2**	VMD	**N/cm^2**	VMD	**N/cm^2**	VMD	**N/cm^2**	VMD	**N/cm^2**	VMD	**N/cm^2**	VMD	**N/cm^2**	VMD	**N/cm^2**	VMD
Upper level	188	139	189	159	184	139	199	139	200	138	193	158	133	134	136	145	129	122
Lower level	126	164	164	127	132	146	167	146	168	125	166	148	109	126	102	148	105	146
Mean	157	152	158	153	136	164	183	143	184	132	180	153	121	130	119	147	117	134
Ground	50	143	52	142	52	134	50	131	48	148	48	146	20	101	22	145	18	136
Sapry lost % on ground	13.7	_	14	_	14.1	_	12	_	11.5	_	11.8	_	7.8	_	8.5	_	7.1	_

3.Lost spray on ground of fungicides produced by equipment :

3.1.Hydraulic Matabi sprayer (56L/Fed.):

Data in Table (6) showed that the lost spray percentages which were 13.7,14 and 14.1% from the total spray volume in the case of recommended dose of propiconazole, azoxystrobin + cyproconazole and cyproconazole + propiconazole, respectively.

3.2.Knapsack motor sprayer (Arimitsu) (43 L/Fed.):

Data in Table (6) showed that the lost spray percentages which were 12,11.5 and 11.8 % from the total spray volume in the case of recommended dose of propiconazole, azoxystrobin + cyproconazole and cyproconazole + propiconazole, respectively.

3.3.Rotary Matabi sprayer (18 L/Fed.):

Data in Table (6) showed that the lost spray percentages which were 7.8,8.5 & 7.1% from the total spray volume in the case of recommended dose of propiconazole, azoxystrobin + cyproconazole and cyproconazole + propiconazole , respectively.

The rate of performance of Arimitsu sprayer was 15.25 Fed./day. It was the best equipment, but the lowest rate of performance was Rotary Matabi sprayer since it could spray only 2.3 Fed./day.

Table (7): Relationship between field spray quality of Fungicides by Knapsack motor sprayer (Arimitsu) (34L.\Fed.) , Rotary (Matabi) sprayer (18L.\Fed.) and Hydraulic Matabi sprayer (56L.\Fed.) at 2017\2018 and 2018\2019 seasons against stripe rust of wheat at Kafrelshiekh Governorate.

Equipment	**Hydraulic (Matabi) sprayer**			**Knapsack motor sprayer (Arimitsu)**			**Rotary (Matabi) sprayer**		
Application rate L./fed.	**56**			**34**			**18**		
Insecticide	**Propiconazole**	**Azoxystrobin+ Cyproconazole**	**Cyproconazole +Propiconazole**	**Propiconazole**	**Azoxystrobin+ Cyproconazole**	**Cyproconazole +Propiconazole**	**Propiconazole**	**Azoxystrobin+ Cyproconazole**	**Cyproconazole +Propiconazole**
	Spray Quality	**Spray Quality**	**Spray Quality**	**Spray Quality**	**Spray Quality**	**Spray Quality**	**Spray Quality**	**Spray Quality**	**Spray Quality**
Upper level	0.74	0.84	0.76	0.7	0.69	0.82	1	1.07	0.95
Lower level	1.3	0.77	1.1	0.87	0.74	0.89	1.16	1.45	0.95

S.Q = Spray quality. = VMD/N/cm^2= Spray quality (degree of homogeneity).
The spray height is constant ~ 0.5 meter in all treatments.
VMD= Volume mean diameter ,N/cm^2= Number of droplets/cm^2.

Data in Table (7) showed that homogeneity of spray coverage was high and in case of Rotary Matabi followed by Arimitsu and Hydraulic Matabi. Also The following remarks and results were obtained: There was no Phytotoxic effect on wheat leaves after application treatments with pesticides in all treatments there was no change in the leaves color, and no leaf curling or flaming up phenomena was happened in case of all treatments and there was a highly significant differences between both the distribution percentages of droplet sizes(LSD= 5.85 for equipment,5.9 for levels and 5.8 for compounds) and for the droplets number/cm^2 (LSD= 5.3 for equipment,5.31 for levels and 5.3 for compounds) at 5% .

Wheat stripe (yellow) rust, caused by *P. striiformis* is highly destructive disease of wheat. Under favorable conditions, stripe rust can cause yield losses of up to 100% in susceptible varieties (Roelfs, 1985). The main strategy for the controlling of wheat stripe rust in Egypt would remain focused on the development of resistant cultivars and chemical options are the two principal methods of wheat rust management strategies implemented in most wheat producing areas of the world. To come up with this, several new fungicides have been evaluated against wheat rusts and are being used in wheat as rusts management options and to sustain wheat production and productivity. Concerning the evaluation of three systemic fungicides in controlling stripe rust of wheat through the application of two successive sprays , using three equipment the obtained results indicated that the fungicide Tilt (Propiconazole) exhibited the lowest rust reaction ca 5 in terms of disease severity. Either of the tested fungicides showed high significant difference between one and two sprays applications. It must be noticed here is that Amistar extra (Azoxystrobint + cyproconazole) exhibited the highest disease severity ca 50. Severe stripe rust epidemic was recorded in the tested wheat cultivar during the second growing season; 2018/19, than that in the first season; 2017/2018 (Table, 5). The obtained data of disease severity, and infection type (IT), were combined to calculate average coefficient of infection (ACI) was assessed in the cultivar during an epidemic in the two growing seasons. Where, the final stripe rust severity for the tested wheat cultivar varied from one year to another, as affected by the slightly changes in environmental conditions between the two years under study. In addition to, changes occurring in these Pst races population (Figures, 1 and 2). Thus the obtained results confirmed the elapsed ones with few exceptions. The distinction of Tilt (Propiconazole) as effective in the increase over control with second treatment i.e. two sprays. Similar results were recorded by Boshoff *et al.*, (2003); Jorgensen *et al.*, (2003) and Covarelli and Orfei (2005) and Shahin (2008), who indicated that the dynamic nature of stripe rust required the induction of new wheat cultivars with new genetic constitutions and/or the quick intervention with new fungicides having recent active ingredient, other than those available in the market, especially at the critical times of epiphytotics .

The fungicide treatments were effectiveness in reducing wheat stripe rust disease severity and improving crop yield. Field experiment was carried out on infected area with wheat stripe rust pathogen *P. striiformis* f. sp. *tritici* at early season on wheat plants. For evaluation the field performance of Low-Volume spraying machines; Hydrulic Matabi evolution sprayer (56L/Fed.), Knapsack motor sprayer (Arimitsu) (43 L/Fed.) and Rotary Matabi sprayer (18 L/Fed.), respectively ; to spray propiconazole, azoxystrobin + cyproconazole and cyproconazole + propiconazole with total recommended dose. A satisfactory coverage was obtained on bean plants, the droplet spectrum was obtained in field experiment was agreed with the optimum droplet sizes which mentioned by (Matthews, 1992), in case of low volume equipment. Data indicated that, all tested compounds revealed significant negative influenced on Wheat stripe rust pathogen Puccinia *striiformis* f. sp. *tritici*. Data of two sprays gave the same result since Propiconazole occupied the first rank in reducing rust severity. The best fungicide in this respect were Propiconazole followed by cyproconazole + propiconazole, however Azoxystrobint + Cyproconazole was the least in this regard. It could be recommended to use this compound with LV spraying equipment with not less than (18L/Fed.). Also, the best equipment in this respect were Rotary (Matabi) followed by Hydraulic (Matabi) and Knapsack motor sprayer (Arimitsu) the tested equipment under study. The rate of performance of Arimitsu sprayer was 15.25 Fed./day, but the lowest rate of performance was Rotary Matabi sprayer since it could spray only 2.3 Fed./day. The best obtained result was Rotary Matabi sprayer (18 L/Fed.) spray volume, 140 μm and 115 droplets/cm^2 and the lost spray on ground was 7.1 %., and these results agreed with Hindy *et al.* (2004), Genidy *et al.* (2005) which recommended KZ oil and Pyriproxyfen followed by Agerin using low volume spraying because of reducing the time lost in process filling the machines, improve the homogeneity of the spray solution on the plant leaves and saving the lost spray on the ground, these results also in agreement with Bakr *et al*. (2014) they recommended by using Profenofos followed by Pyriproxyfen and Spinosad with Agromondo sprayer (20L/fed.). Dar *et al.* (2019) showed that Motorized Knapsack sprayer (Agromondo) (20 L.Fed.) was the best equipment to control seadling pests at early seson of Cotton. The rate of performance of Knapsack motor sprayer (Arimitsu) was 15.25 Fed./day. It was the best equipment, but the lowest rate of performance was Hydraulic sprayer (Matabi) since it could spraying only 3.4

Fed./day. Also, the lowest spray volume , the lowest percentage 7.1% of lost spraying between plants occurred by Rotary Matabi sprayer (18 L/fed.), this results was agreed with Hindy *et al.* (1997), who mentioned that, there was a positive relationship between rate of application and lost spray on ground.

Also, the best equipment in this respect were Rotary (Matabi) because the horizontal long ,stripe and narrow leaves which pick the small size droplets with high surface tension more than gravity and still on wheat leaves more than large size droplets followed by Hydraulic (Matabi)and Knapsack motor sprayer (Arimitsu) the tested equipment under study. The rate of performance of Arimitsu sprayer was 15.25 Fed./day, but the lowest rate of performance was Rotary Matabi sprayer since it could spray only 2.3 Fed./day. Spray Quality were near to 1 in case of Rotary Matabi sprayer which indicated high spray coverage homogeneity and best stripe rust of wheat controlling , this results was agreed with (Matthews,1992) .

It could be recommended to use propiconazole with total recommended dose followed by cyproconazole + propiconazole, azoxystrobint + cyproconazole rate with low volume (LV) spraying equipment with not less than (18L./Fed.) which revealed successful results. There was a negative complete correlation between (VMD) and the disease severity of Wheat while there was a positive complete correlate between N/cm² and the disease severity of wheat in all treatments.

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