

Review Article

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Estimation of Yield Losses due to Leaf Rust and Late Seeding on Wheat (*Triticum aestivum* L) Variety Seher-06 in District Faisalabad, Punjab, Pakistan



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Abstract

Wheat is the third important crop in the world and the staple food in Pakistan. Its yield is severely susceptible to a number of factors and diseases such as rust. Leaf rust causes 50% yield loss in fatal epidemic conditions. The experiment was conducted at Wheat Research Institute (WRI) Faisalabad (Pakistan), where 36 plots of wheat variety (Sehr-06) were sown on November 23rd, 2013 and January 2nd, 2014, respectively to identify the losses on wheat due to leaf rust and late sowing. Disease data were recorded by COBB's scale. Crop was harvested and threshed by mini thresher. Yield data was recorded in grams. Statistical analysis of data showed that yield losses due to leaf rust were 4.26g/plot and due to late sowing losses were 923.69 g/plot. The predictability of the analysis revealed that losses due to leaf rust alone were very low. There were also other factors like poor germination, weeds, insect attack, weather conditions, agronomic practices and soil fertility that contributed to lowering yield in Faisalabad.

Keywords: COBB's scale; Late sowing; Leaf rust; Regression coefficient; wheat

Introduction

Wheat is a staple food and contributes about 40% of the world feeding requirements [1]. Major purpose of wheat cultivation is to ensure food security in agriculturally deficient countries [2]. Its total area under cultivation in Pakistan is 9 million hectares with 23 million tons production [3]. Jellis GJ [4] mentioned that wheat was threatened by many biotic and abiotic factors which led to low yield. Wheat production is endangered by a number of diseases such as leaf rust, stripe rust, stem rust [5]. Insects, specially wheat aphids are mainly biotic devastating factor [6], while salinity, drought, fog, heat and excessive cloudy weather conditions during growing season are abiotic stresses [7].

Leaf rust is more regular and more dominant compared to the other two rusts in Pakistan. Its pathogen requires an alternate host to complete its life cycle [8]. In North America, *Puccinia triticina* was introduced accompanying with wheat cultivation in the early 17th century, which decreased the wheat production by reducing the number of kernels per head and lower kernel weights [9]. *Puccinia triticina* is considered now as an important pathogen in wheat growing areas of world, causing significant losses over large regional perspectives [10-13]. In 2007, it led

to 14% loss in Kansas, as the leading wheat-producing state in the USA. Rusted plots yielded 4% less crops as compared to fungicide-protected plots for cultivars [14]. Yield losses in wheat by leaf rust in cultivar trials were also reported in Mississippi, USA [15]. Due to heavy infection of leaf rust, growth and yield parameter of wheat plants are adversely affected [16,17].

In Pakistan, rusts constantly threat to wheat cropping zones, and leaf rust occurs in epidemic since 1978 [18]. Nearly half yield losses were recorded due to this pathological agent [19]. At present, Pakistan is facing with critical shortage of appropriate wheat varieties, which are capable of ensuring food security, and possessing both features of high yield and rust resistance [6]. Quantification of the damaging effects of the pathogen on diseased plants and inclusion of these damaging functions in crop simulation models is of great importance for a more complete understanding of yield response to disease [20].

The late-sown crop takes less number of growing degree days (GDD) due to whose yield components decreasing and hence the economic yield of the crop suffering negatively [21]. Ahmad et al. [22] & Khan et al. (2001) found that planting time

was on November and delayed planting significantly reduced 1% yield per day after November. During late temperature of soil it will decrease yield because of less seed germination, tillering capacity, and less productive tillers [23]. Razzaq et al. (2011) suggested that mid November was superior time to planting wheat. Late sowing and unsuitable temperature affect the uniform establishment of wheat crop [24]. Wheat sown during November gave more yield as compare to it after November [25].

Materials and Methods

The experiment was carried out at Wheat Research Institute (WRI) and Ayub Agricultural Research Institute (AARI), Faisalabad, Punjab, Pakistan during the year 2013-2014. Experiment was laid out in randomize complete block design

(RCBD). Here, randomly, 36 different plots were allocated. The dimensions of each plot was 6 × 1.62m. 100 g/plot healthy seeds of Sehr-2006 variety were sown by drill in 18 plots at proper soil moisture condition on November 23rd, 2013 (normal regional sowing) and 18 plots were seeded on January 2nd, 2014 (late sowing). After 25 days of sowing, first irrigation was applied, 2nd irrigation was given at tiller stage, 3rd at booting, 4th and 5th irrigation were applied at grain formation stage and milking stage respectively. Fertilizers were applied at recommended dozes. When crop was at milking stage, disease data were recorded by COBB's Peterson scale. Crop was harvested manually on 18th of May and threshing was done with mini thresher in each plot. Yield of each plot was weighed and data was tabulated (Table 1).

Table 1: Disease rating scale used to record rust severity and level of resistance/susceptibility of wheat.

	Field Response	Symptoms
0	Immune	No visible infection
R	Resistant	Visible chlorosis or necrosis, no uredia are present
MR	Moderately Resistant	Small uredia are present and surrounded by either chlorotic or necrotic areas
M	Intermediate (Mixed)	Variable sized uredia are present some with chlorosis, necrosis or both
MS	Moderately susceptible	Medium sized uredia are present and possibly surrounded by some chlorotic areas
S	Susceptible	Large uredia are present, generally with little or no chlorosis or necrosis Peterson et al. (1948)

Results and Discussion

The present study showed that leaf rust and late sowing contributed to reducing wheat yield. There was a significant difference of yield between control experiment of plot of leaf rust and late sowing plot experiment. Researchers have conducted trials on leaf rust and have established association between the disease epidemic and yield loss of wheat crop. These results are in consistency with the findings of Afzal et al. [26] and Qamar et al. [27], who reported that stripe rust might cause heavy

losses in the wheat crop. Leaf rust caused heavy losses all over the world [28]. Environmental factors played an important role in epidemic of leaf rust [29,30]. Salman et al. [31] reported that yield losses increased proportionately with the increase in severity of the disease. Late sowing caused yield losses, and similar result was found by earlier research workers Chaudhry et al. [32], Iqbal et al. [33], Ahmad et al. [22] and Nazir et al. [34]. Ahmed et al. (1997) reported decrease in plant height due to late sowing in wheat (Table 2 & 3).

Table 2: Statistic analysis of obtained Results.

D1	TRIAL	REP.	L.R(S)	LODg%	YIELD (gm.)/plot	YIELD(kg/ha)
0	1	1	100	90	3164	3905.958
0	1	2	100	90	1424	1757.928
0	2	1	100	30	3542	4372.599
0	2	2	100	20	1558	1923.351
0	3	1	100	90	4062	5014.539
0	3	2	100	90	1663	2052.9735
0	4	1	60	50	2625	3240.5625
0	4	2	80	80	1575	1944.3375
0	5	1	60	40	4605	5684.8725
0	5	2	70	80	1595	1969.0275
0	6	1	70	90	2954	3646.713
0	6	2	60	30	2450	3024.525
0	7	1	60	50	3406	4204.707

0	7	2	80	5	2587	3193.6515
0	8	1	70	90	2630	3246.735
0	8	2	60	80	2250	2777.625
0	9	1	60	80	2250	2777.625
0	9	2	80	90	2610	3222.045
1	1	1	80	0	2246	2772.687
1	1	2	60	0	2258	2787.501
1	2	1	60	5	2238	2762.811
1	2	2	80	0	2020	2493.69
1	3	1	80	0	2215	2734.4175
1	3	2	60	0	2220	2740.59
1	4	1	70	0	2205	2722.0725
1	4	2	60	0	2150	2654.175
1	5	1	60	0	2400	2962.8
1	5	2	60	0	1705	2104.8225
1	6	1	60	0	1790	2209.755
1	6	2	60	0	1700	2098.65
1	7	1	60	5	1728	2133.216
1	7	2	60	0	2398	2960.331
1	8	1	60	10	2030	2506.035
1	8	2	60	5	1900	2345.55
1	9	1	60	0	1944	2399.868
1	9	2	60	10	2082	2570.229

Table 3: (Predictor) Unweighted Least Squares Linear Regression of Yield (g/Plot).

Variables	Coefficient	Std Error	T	P
Constant	3274.42	750.563	4.36	0.0001
LODG	-5.08447	5.52493	-0.92	0.3643NS
LR	-4.26618	8.57205	-0.50	0.6221NS
D	-923.695	423.626	-2.18	0.0367*

NS indicates non significance.

Wheat plant stopped its vegetative growth just after meeting the photoperiodic requirements which led to shorter height of plant participating the less yield of wheat [35]. Late sowing decreased the wheat production by reducing the spike length (Haider 2000). Maximum grain yield was recorded when planting was done during November. The Present study suggest that November was the optimum time to planting of wheat crop, because crop planted during November produced more tiller, maximum grain yield and more no. of spikes.

$$\text{Yield} = 3274.42 - 5.085 \text{Lodg} - 4.267 \text{LR} - 923.695 \text{D}$$

Where D denotes the sowing status (0=Normal, 1=Late). -923.695 coefficient of D showing that if sowing of the variety (Sehar-06) will be done late leads to 924 gram loss per plot.

$$\text{R-Squared} = 0.1817 (18.17\%)$$

R-Squared is the predictability of the regression which is low because there are some other factors to explain the yield

those are not actually considered for this study. As from the experiment, it was clear that losses due to leaf rust were not so much. Management of other factors causing low yield enable to obtain good yield from high yield potential variety SEHR-06. Late sowing also contributed to loss yield, because crop got less duration to complete its life cycle. Thus, crop should be sown earlier.

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