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Response of chickpea varieties and sowing dates for the management of chickpea ascochyta blight (*Ascochyta rabiei* (Pass.) Disease at West Belesa District, Ethiopia

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A two year experiment was conducted at Ascochyta rabiei sick plot infested West Belesa District to evaluate potential chickpea varieties and sowing date for the management of Ascochyta blight. Five varieties namely, Dhera, Habru, Ejeri, Chefe, Teje; and three sowing dates at 10-day intervals (15th July (early), 25th July (optimum) and 5th August (late) were used as treatments. Treatments were arranged in split plot design with three replications. Varieties were assigned on main plot and sowing date to sub-plot. Results indicated that the maximum incidence and severity of 44.65 and 30.06% respectively were recorded from Teje variety in early sowing while the minimum incidence and severity of 28.1 and 15.45%, respectively were recorded from Dhera variety in optimum sowing. The maximum grain yield of 33.49 q/ha and insignificance yield loss were recorded from Dhera variety in optimum sowing while the minimum grain yield and maximum yield loss of 18.41 q/ha and 44.97% respectively were recorded from Teje variety in early sowing. Based on mean value of two years experiment result suggested that Dhera variety applied at optimum sowing caused significant reduction in ascochyta blight incidence leading to a corresponding increase in grain yield of chickpea.

Key words: Chickpea, ascochyta blight, didymellarabiei, disease incidence, percentage severity index, area under disease progress curve, relative yield loss.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the second most important cool season food legume crop after common bean (*Phaseolus vulgaris* L.) followed by field pea (*Pisum sativum*) and third in production among the food legumes grown worldwide (Diapari et al., 2014; Benzohra et al., 2014). The average chickpea yield in Ethiopia on farmers' field is usually below 20 q/ha although its potential yield is more than 50 q/ha (Ejeta and Hussein, 2015; Melese,

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2005; Zewdie, 2018b). A number of biotic and abiotic factors are responsible for high yield gaps. This resulted from susceptibility of chickpea landraces to frost, drought, water-logging, poor cultural practices and low or no protection against weeds, diseases and insect pests (Iqbal et al., 2003).Although more than 70 pathogens have been reported on chickpea from different parts of world so far (Iqbal et al., 2003; Zewdie, 2018b), only a few of them are currently recognized as significantly important pathogens to chickpea production (Pande et al., 2011). One of the greatest biotic stress reducing potential yields in chickpea is Ascochyta blight caused by Ascochyta rabiei (Pass) Labr. (Teleomorph: Didymell arabiei (Kovacheski) von Ayx). It is the most destructive foliar fungal disease of chickpea in the world, where the chickpea growing season is cool and humid (Benzohra et al., 2012; Iqbal et al., 2003).

The occurrence of chickpea Ascochyta blight has been reported from across six continents, including Asia; Africa; Europe; North America; South America and Australia (Nene et al., 2012). Ascochyta blight has been reported to cause up to 100 percentage crop loss under favorable environmental conditions where the relative humidity is greater than 60% and temperature range of 10-20^{o}C (Aslam et al., 2014). Sometimes it may cause total failure of the whole chickpea crop. At present in Ethiopia, production of the Kabuli type of chickpea is being commercialized and seed exchange is widely adapted. Commercial cultivars only possess partial resistance and resistance can breakdown easily by the pathogen, and this is because of the pathogen is highly sexual recombination (Kanouni et al., 2011). However, ascochyta blight is effectively managed with the integration of different strategies. Several cultural practices, such as rotation with non-host crops, use of host resistance, sowing dates and destruction of diseased plant debris, will all help to reduce inoculum level and inhibit severe epidemics (Ejeta and Hussein, 2015). Therefore, the objectives of this study were (i) to evaluate potential chickpea varieties and sowing date against chickpea ascochyta blight disease; and (ii) to determine association of ascochyta blight incidence and severity on yield and yield component of chickpea.

MATERIALS AND METHODS

Description of the study area

The field experiments were conducted during 2017 and 2018 cropping season on ascochyta blight sick plot at West Belesa District, which are demonstration site of College of Agriculture and Environmental Sciences. The study area was located in North Gondar Zone, Amhara Regional State, Ethiopia. The study area has latitude, longitude and altitude of 16°49″44′N, 43°27″47′E and 950 m above sea level, respectively and receives average annual rainfall of about 1050 mm; it has maximum and minimum temperatures of 31.0 and 17.5.0°C, respectively, whereas the soil type is light silty-loam and 85 km away from East south of Gondar (Ebissa, 2017).

Treatments and experimental design

There are a total of 15 treatment combinations, five Kabuli chickpea varieties namely, Dhera, Ejeri, Habru, Chefe, Teje; and three sowing date at 10-day intervals (15th July, (early), 25th July (optimum) and 5th August (late). Treatments were laid out in Split Plot Design with three replications. Chickpea varieties were assigned on main plot and sowing date as subplot. Spacing between subplots and replications were 0.5 and 1 m, respectively. Each experimental plot size was 4.8m^2 (1.2 m × 4 m). The seeds were planted at spacing of 10 cm between plant and 30 cm between rows and were covered with fine layer of soil. Plots were prepared and fertilized with 100 kg/ha DAP at planting and all other management practices were performed as per the general recommendations for chickpea.

Data collection

In field experiment, observation of ascochyta blight incidence was done at 10 days interval based on the percent of wilt incidence in each experimental unit. Initial scoring for ascochyta blight incidence was done when lesions were visible on the three to five basal leaves of the plants. Numbers of plants infected in the middle rows were recorded and their means were converted into percentage as the total plant observation.

Disease incidence on each plot was calculated on the following way:

$$\text{DI (\%)} = \frac{\text{Number of plant that appear symptoms}}{\text{Both number of disease infected and healthy plants}} \times 100 \quad (1)$$

Ascochyta blight disease assessment was started immediately after disease onset was visible as lesion on upper leaf and wilting of leaf tips were observed. Severity was recorded on ten randomly tagged plants per plot and assessed seven times every ten days interval using 1-9 rating scale (Millan et al., 2006). Disease severity was calculated from the estimated size of the lesions. Lesion sizes were scored on a 1- 9 scale as follows: 1No lesions; 2 Lesions on some plants, usually not visible; 3 A few scattered lesions, usually seen only after careful examination; 4 Lesions and defoliation on some plants, not damaging; 5 Lesions common and easily observed on all plants but defoliation/damage not great; 6 Lesions and defoliation common, few plants killed; 7 Lesions very common and damaging; 8 All plants with extensive lesions causing defoliation and the drying of branches, 50% of the plants killed; 9 Lesions extensive on all plants, defoliation and drying of branches; more than 75% of the plants killed. The severity grades were converted into percentage severity index (PSI) for the analysis (Campbell and Madden, 1990; Fininsa, 2003)..

$$\text{PSI} = \frac{\text{Sum of numerical ratings}}{\text{Number of plants scored} \times \text{maximum score on scale}} \times 100 \quad (2)$$

The disease progress rate for each treatment was estimated as the slope of the regression line of the disease progress data. Area under progress curve (AUDPC) was calculated for each treatment from the assessment of disease incidence using the formula:

$$\text{AUDPC} = \sum 0.5(X_{i+1}+xi)\,(t_{i+1}-ti) \quad (3)$$

Where, x**i** is the cumulative disease severity expressed as a proportion at the ith observation, ti is the time (days after sowing) at the observation and n is total number of observations. Since

Table 1. Significances of mean square values for different traits affected by chickpea varieties and sowing date at West Belesa district during 2017 and 2018 cropping season.

SV	DF	DI (%)	PSI	AUDPC	DPR	NPPP	HSW	Yield
Replication	(r-1) = 2	7.99^{ns}	9.39^{ns}	219.5^{ns}	0.79^{ns}	219.5^{ns}	0.18^{ns}	207.23^{ns}
Main plot (A)	(m-1) =4	3.58*	66.13*	36.45*	21.13	45.03*	11.98*	67.45*
Error (a)	(r-1) (m-1)= 8	14.05*	27.18*	337.89*	10.13	337.89*	7.15*	158.34*
Sub plot (B)	(s-1) = 2	91.13*	91.13*	191.65*	40.53	191.65*	29.47*	175,89*
AXB	(m-1)(s-1) = 8	12.79*	0.79*	44.82^{ns}	21.13^{ns}	44.82^{ns}	1.58^{ns}	628.36*
Error(b)	m(r-1)(s-1) = 20	2.14	0.38	23.52	1.08	23.52	3.71	56.36
CV (%)		10.98	12.74	11.23	12.56	14.43	10.23	7.44

ns non-significant at P < 0.05, * Significant at P<0.05, SV source of variation, DF degree of freedom, CV coefficient of variation, DI % disease incidence percentage, PSI percentage severity index, AUDPC area under disease progress curve, DPR disease progress rate, NPPP number of pod per plant, HSW hundred seed weight.

Ascochyta blight severity was expressed in percent and time (t) in days, AUDPC values were expressed in %-days (Campbell and Madden, 1990). AUDPC values were used in analysis of variance to compare amount of disease among plots with different treatments. Relative yield loss (RYL) was calculated using the formula of Madden et al. (2007).

$$RYL = \frac{Y1-Y2}{Y2} \times 100 \quad (4)$$

Where, RYL Relative yield loss (reduction of the yield and yield component), Y1yields which was obtained from plots with maximum protection) and Y2 yields which was obtained from plots with minimum protection).

Statistical data analysis

Data on chickpea Ascochyta blight incidence, percentage severity index, AUDPC%-day, yield and yield component various agronomic data were subjected to analysis of variance (ANOVA) according to the Duncan Multiple Range Test (DMRT) as suggested by Gomez and Gomez (1984) using statistical package SAS, version 9 (SAS institute Inc, 2002); least significance difference (LSD) was used for the mean comparison at 5% probability level.

RESULTS AND DISCUSSION

Incidence of Ascochyta blight

Analysis of variance showed that disease incidence (DI) was significantly affected by chickpea varieties, sowing dates, and their interaction at $p < 0.05$(Table 1). Among the interaction effects, the minimum disease incidence of 27.34 and 28.85% respectively was recorded from Dhera variety in optimum sowing date during 2017 and 2018 cropping season respectively, followed by Habru variety in optimum sowing date with result of 28.45 and 29.03%. On the contrary, the maximum disease incidence of 43.34 and 45.95% respectively was recorded from Teje variety in early sowing date during 2017 and 2018 cropping season respectively, followed by Chefe variety in early sowing date with results of 42.62 and 43.07% respectively (Table 2).This indicates that varieties of Dehra and Habru have potential resistance against blight incidence than other varieties under different sowing dates; this agrees with the observation made by Jirata (2016) on the same crop.

According to the mean value of two years; the minimum disease incidence of 28.10 and 28.74% was recorded from Dhera and Habru variety in optimum sowing date, respectively while the maximum disease incidence of 44.65 and 42.83% was recorded from Teje and Chefe varieties in early sowing dates, respectively (Table 2). Variety resistant had less disease incidence than that of the susceptible variety (Kanouni et al., 2011). Incidence of Ascochyta blight was reduced and greater influence was recorded in optimum sowing date than early and late sowing date, which is in agreement with findings of Ejeta and Hussein (2015).. During 2017 cropping season, all treatments showed better resistance against Ascochyta blight incidence than 2018. As mentioned previously, this could be due to high rainfall, high soil water holding capacity and lower daily maximum temperature conditions during 2018 which are conducive for the growth and development of disease.

Ascochyta blight percentage severity index

The results found that chickpea varieties, sowing date and their interaction revealed that significant differences at P<0.05 on Ascochyta blight percentage severity index (Table 1). Among interaction effects, the minimum percentage severity index was recorded from Dhera variety (13.84% and 17.05%) in optimum sowing date, followed by Habru variety (15.04 and 18.53%) in optimum sowing date during 2017 and 2018 cropping season respectively (Table 2). On the other hand, the maximum percentage severity index was recorded from Teje variety (31.67 and 34.45%) in early sowing date, followed by Teje variety (28.97 and 30.07%) in late sowing date and

Table 2. Two way interaction effects of chickpea varieties and sowing date on incidence and PSI of chickpea Ascochyta blight at West Belesa district during 2017 and 2018 cropping season.

Variety	Sowing date	DI (%)		Mean of two years (%)	PSI (%)		Mean of two years (%)
		2017	2018		2017	2018	
Dhera	Early	33.08^{c}	35.04^{c}	34.06^{c}	18.18^{c}	22.34^{c}	20.26^{de}
	Optimum	27.34^{a}	28.85^{a}	28.10^{a}	13.84^{a}	17.05^{a}	15.45^{a}
	Late	30.56^{b}	32.19^{b}	31.38^{b}	15.36^{ab}	20.47^{b}	17.92^{bc}
Habru	Early	35.05^{d}	37.56^{d}	36.31^{d}	21.55^{de}	25.55^{d}	23.55^{fg}
	Optimum	28.45^{a}	29.03^{a}	28.74^{a}	15.04^{ab}	18.53^{a}	16.79^{ab}
	Late	32.95^{c}	35.08^{c}	34.02^{c}	18.09^{c}	23.48^{c}	20.79^{de}
Ejeri	Early	38.33^{e}	39.55^{e}	38.94^{e}	24.66^{f}	27.55^{e}	26.11^{h}
	Optimum	30.23^{b}	32.76^{b}	31.50^{b}	17.05^{bc}	20.87^{b}	18.96^{cd}
	Late	35.08^{d}	40.07^{ef}	37.56^{de}	21.34^{d}	22.47^{c}	21.91^{ef}
Chefe	Early	42.62^{gh}	43.07^{g}	42.83^{gh}	28.09^{g}	30.03^{f}	29.06^{i}
	Optimum	35.42^{d}	37.53^{d}	36.48^{d}	22.67^{def}	23.53^{c}	23.10^{f}
	Late	38.45^{e}	40.56^{ef}	39.51^{ef}	24.65^{f}	27.56^{e}	26.11^{h}
Teje	Early	43.34^{h}	45.95^{h}	44.65^{h}	31.67^{h}	34.45^{g}	33.06^{j}
	Optimum	40.45^{f}	41.67^{fg}	41.06^{fg}	24.05^{ef}	26.67^{de}	25.36^{gh}
	Late	41.76^{fg}	43.03^{g}	42.42^{g}	28.97^{g}	30.07^{f}	29.52^{i}
LSD (0.05)		1.55	1.74	2.05	2.55	1.35	1.95
CV (%)		7.89	9.56	8.56	12.45	11.08	11.89

LSD least significant difference at 5% level of significant, CV coefficient of variation in percent, DI % disease incidence percentage and PSI percentage severity index; Mean values in the same letter within a column are not showed significantly different at 5% probability.

Chefe variety (28.09 and 30.03%) in early sowing date during 2017 and 2018 cropping season respectively (Table 2).

Based on the mean disease severity value of the two years, the minimum percentage severity index of 15.45% was recorded from variety of Dhera in optimum sowing date, followed by variety of Habru in optimum sowing date and Dhera variety in late sowing date (16.79 and 17.92% respectively) (Table 2). This result is in line with Jirata (2016), who reported that the minimum percentage severity index was recorded in resistance variety applied at mid sowing date followed by late sowing.

Area under disease progress curve (AUDPC%-day)

Area under Disease Progress Curve at P< 0.05 was significantly influenced by both main effects such as varieties and sowing dates but there was no significant difference among interaction effects (Table 1). Among varieties, the minimum AUDPC value of 663.56%-days and 670.85%-days was recorded from Dhera variety, followed by Habru which recorded 684.86%-day and 696.56%-day during 2017 and 2018 cropping season respectively; the maximum AUDPC value of 714.76%-day and 721.67%-day was recorded from Teje variety during 2017 and 2018 cropping season respectively (Table 3).

According to the mean value of two years the minimum AUDPC value of 667.21%-day and 690.71%-day was recorded from Dehra and Habru variety respectively whereas the maximum AUDPC value of 718.22%-day and 710.81%-day was recorded from Teje and Chefe variety respectively (Table 3). This means that Dhera variety has more resistance against the Ascochyta blight incidence compared to other tested varieties. The AUDPC%-day value of the disease was higher for susceptibility than that of resistant variety in respect to location. This is in agreement with previous findings of other researchers (Aslam et al., 2014; Ghazanfar, 2010).

On the contrary among sowing dates; the maximum AUDPC values of 687.85%-day and 703.04%-day were recorded from early sowing while the minimum AUDPC values of 657.87%-day and 687.34%-day were recorded from optimum sowing dates during 2017 and 2018 cropping season respectively (Table 3). Based on the mean AUDPC%-day value of the two years; the maximum AUDPC value of 695.45%-day was recorded

Table 3. Main effects of chickpea varieties and sowing date on AUDPC%-day and disease progress rate of ascochyta blight at West Belesa district during 2017 and 2018 cropping season.

	AUDPC (%-days)		Mean of two years (%)	Disease progress rate		Mean of two years (%)
	2017	2018		2017	2018	
Varieties						
Dhera	663.56[a]	670.85[a]	667.21[a]	0.0416[a]	0.0535[a]	0.0476[a]
Habru	684.86[ab]	696.56[b]	690.71[ab]	0.0574[ab]	0.0724[ab]	0.0649[ab]
Ejeri	696.05[bc]	709.45[bc]	702.75[bc]	0.0773[b]	0.0895[bc]	0.0834[b]
Chefe	704.35[bc]	717.26[bc]	710.81[bc]	0.0846[b]	0.0956[c]	0.0901[b]
Teje	714.76[c]	721.67[c]	718.22[c]	0.0889[c]	0.0999[c]	0.0944[b]
Mean	692.72	703.16	697.94	0.0699	0.0822	0.0761
LSD (5%)	**25.56**	**22.55**	**24.45**	**0.03**	**0.02**	**0.03**
Sowing date						
Early	687.85[a]	703.04[a]	695.45[a]	0.0958	0.0998	0.0978
Optimum	657.87[b]	687.34[b]	672.61[b]	0.0505	0.0706	0.0606
Late	663.05[b]	692.56[b]	677.81[b]	0.0745	0.0874	0.0809
Mean	669.59	694.31	681.95	0.0736	0.0859	0.0798
LSD (0.05)	23.57	10.58	17.08	NS	NS	NS
CV (%)	12.45	8.45	10.45	4.56	8.57	6.56

LSD least significant difference at 5% level of significant, CV coefficient of variation in percent, NS non significance, AUDPC area under disease progress curve; Mean values in the same letter within a column are not showed significantly different at 5% probability.

from early sowing date while the minimum of 672.61%-day was recorded from optimum sowing date, followed by late sowing date (677.81%-day) (Table 3).

Ascochyta blight disease progress rate

The disease progress rate exhibited significant difference at P<0.05 among the main effects of varieties and sowing dates but not their interaction (Table 1). The progress rate of Ascochyta blight disease infection rate was faster (0.0889and 0.0999) per day units on the susceptible Teje variety than Dhera resistant variety (0.0416 and 0.0535) in which slower infection rate was noticed during 2017 and 2018 cropping season respectively (Table 3). Infection progress rate greatly determines varietal differences more on susceptible varieties than resistant ones (Ejeta and Hussein, 2015; Zewdie, 2018a, b). On the other hand, the higher infection rate progressed rapidly on early sowing date (0.0958 and 0.0998) while the lower infection rate of 0.0505and 0.0706 was recorded from optimum sowing date during 2017 and 2018 cropping season respectively.

Number of pod per plant

Significant differences at P < 0.05 were observed among varieties and sowing date on number of pod per plant but not their interaction (Table 1). Among the mean value of two years experiment, the maximum (49.50) number of pod per plant was recorded from Dhera variety, followed by Habru (46.00) while the minimum number of pod per plant (34.64) was recorded from Teje variety, followed by Chefe (38.16) (Table 4). Similarly the results of Shamsi et al. (2010) showed that varietal differences are more associated with pods per plants and used as criteria for selection of best materials. On the other hand, the maximum number of pod per plant (43.58) was recorded from optimum sowing date while the minimum (35.25) was obtained from early sowing date, followed by late sowing date (41.46). The result is conformity with findings of Ramanappa et al. (2013).

Hundred seed weight

The main effects of chickpea varieties and sowing date showed significant difference at P < 0.05 on hundred seed weight (Table 1). Among the mean value of two years the highest hundred seed weight (24.35 and 23.11 g) was recorded from Dhera and Habru variety while the lowest hundred seed weight (16.05 and 18.17 g) was recorded from Teje and Chefe variety, respectively (Table 4). On the mean value of two years the highest hundred seed weight (24.01 g) was obtained from optimum sowing date while the lowest (19.94 g) was recorded from early sowing, followed by late sowing date (21.04 g). However, they did not show significance difference. Similar findings were previously reported by Turhan et al. (2011) and Sattar et al. (2013) that minimum hundred seed weight was obtained from early sowing date.

Table 4. Mean of chickpea varieties as influenced sowing date on number of pod per plant and hundred seed weight at West Belesa district during 2017 and 2018 cropping season.

	NPPP(No)		Mean of NPPP (No)	HSW(g)		Mean of HSW (g)
	2017	2018		2017	2018	
Variety						
Dhera	50.34^{a}	48.65^{a}	49.50^{a}	25.04^{a}	23.65^{a}	24.35^{a}
Habru	46.65^{ab}	45.34^{ab}	46.00^{ab}	23.87^{a}	22.34^{a}	23.11^{a}
Ejeri	42.28^{bc}	40.23^{bc}	41.26^{bc}	21.86^{ab}	19.67^{ab}	20.77^{ab}
Chefe	39.45^{c}	36.87^{cd}	38.16^{cd}	19.38^{bc}	16.96^{b}	18.17^{bc}
Teje	37.04^{c}	32.23^{d}	34.64^{d}	17.05^{c}	15.05^{b}	16.05^{c}
Mean	43.15	40.66	41.91	21.44	19.53	20.49
LSD (0.05)	5.35	6.57	5.96	4.35	4.76	4.56
Sowing date						
Early	37.46a	33.04^{a}	35.25^{a}	20.48^{a}	18.79^{a}	19.64^{a}
Optimum	45.09b	42.07^{a}	43.58^{b}	24.87^{a}	23.15^{b}	24.01^{a}
Late	43.35b	39.56^{a}	41.46^{ab}	22.03^{a}	20.05^{ab}	21.04^{a}
Mean	41.97	38.22	40.10	22.46	20.66	21.56
LSD (0.05)	5.67	9.25	7.46	6.05	3.75	4.9
CV (%)	8.56	12.34	9.56	12.45	14.65	11.34

LSD least significant difference at 5% level of significant, CV coefficient of variation in percent, NPPP number of pod per plant; HSW hundred seed weight; Mean values in the same letter within a column are not showed significantly different at 5% probability.

Grain yield of chickpea

Analysis of variance showed that grain yield of chickpea was significantly affected by chickpea varieties, sowing dates and their interaction at $P < 0.05$ (Table 1). Among interaction effects, the maximum grain yield (35.75 and 31.23 q/ha) was recorded from Dhera variety in optimum sowing date, followed by Habru variety in optimum sowing date (34.34 and 31.05 q/ha) during 2017 and 2018 cropping season, respectively; the minimum grain yield (19.37 and 17.34 q/ha) was recorded from Teje variety in early sowing date, followed by Chefe variety in early sowing (20.59 and 17.45 q/ha) during 2017 and 2018 cropping season, respectively (Table 5). These results are in line with the finding of Tobe et al. (2013) who stated that the grain yield was highest on optimum sowing date followed by late sowing date. Similarly, Yigitoglu (2006) reported the highest grain yield in optimum sowing date with a resistant variety. The highest grain yield production depends on sowing date (Shamsi et al., 2010; Varma et al., 2014).This finding is in accordance with the findings of Sadeghipour and Aghaei (2012), who reported that sowing date and varietal difference could affect grain yield production.

Relative grain yield losses

Among interaction effects of varieties and sowing date, the maximum mean relative grain yield losses of 44.97% (15.14 q/ha) was recorded from Teje variety which was applied in early sowing date, followed by Chefe variety in early sowing date 43.45% (14.47 q/ha).This was because, in early sowing there was abundant inoculum of Ascochyta rabiei on infested chickpea residue that served as a source of initial inoculum; this in turn resulted in higher blighting in all the leaves of the plants before their physiological maturity. On the other hand, the mean minimum relative grain yield loss was obtained from Dhera variety which was applied in optimum sowing date; it resulted in significant loss, followed by Habru variety in optimum sowing date and Dhera variety in late sowing date 2.26%(0.79 q/ha) and 12.2%(4.15 q/ha) respectively (Table 5).

Conclusion

Generating reliable information on ascochyta blight management practices such as use of high performance varieties and appropriate sowing date is quite important to come up with profitable and sustainable chickpea production and productivity. In view of this, an experiment was conducted to evaluate resistant varieties and sowing date against ascochyta blight management; yield and yield components of chickpea. The findings of the present study suggest that the adoption of resistant variety Dhera and Habru with applied optimum sowing date may result in reduced ascochyta blight disease progress with a corresponding increased grain yield of chickpea. Further, undoubtedly the ascochyta blight appears to be an important disease that calls for better attention in the

Table 5. Interaction effect of chickpea varieties and sowing date on grain yield of chickpea and their corresponding losses due to Ascochyta blight at West Belesa district during 2017 and 2018 cropping season.

Chickpea variety	Sowing date	Grain yield (q/ha)		Mean of grain yield (q/ha)	Relative grain yield loss				Mean of relative grain yield loss %	
					2017		2018			
		2017	2018		Loss (q/ha)	Loss (%/ha)	Loss (q/ha)	Loss (%/ha)	Loss (q/ha)	Loss (%/ha)
Dhera	Early	27.65[de]	24.76[d]	26.21[de]	8.10	22.66	6.47	20.72	7.29	21.69
	Optimum	35.75[a]	31.23[a]	33.49[a]	0.00	0.00	0.00	0.00	0.00	0.00
	Late	30.46[b]	28.23[b]	29.35[b]	5.29	14.79	3.00	9.61	4.15	12.2
Habru	Early	25.04[fg]	23.09[e]	24.07[fg]	10.71	29.96	8.14	26.06	9.43	28.01
	Optimum	34.34[a]	31.05[a]	32.70[a]	1.41	3.94	0.18	0.58	0.79	2.26
	Late	28.75[cd]	25.65[cd]	27.20[cd]	7.00	19.58	5.58	17.87	6.29	18.73
Ejeri	Early	23.23[h]	20.53[fg]	21.88[h]	12.52	35.02	10.70	34.26	11.61	34.64
	Optimum	29.67[bc]	26.87[bc]	28.27[bc]	6.08	17.01	4.36	13.96	5.22	15.49
	Late	26.46[ef]	23.34[e]	24.90[ef]	9.29	25.99	7.89	25.26	8.59	25.63
Chefe	Early	20.59[ij]	17.45[h]	18.97[ij]	15.16	42.41	13.78	44.48	14.47	43.45
	Optimum	27.56[de]	25.56[cd]	26.56[d]	8.19	22.91	5.67	18.16	6.93	20.54
	Late	24.34[gh]	21.05[f]	22.70[gh]	11.41	31.92	10.18	32.59	10.79	32.26
Teje	Early	19.37[j]	17.34[h]	18.41[i]	16.38	45.82	13.89	44.12	15.14	44.97
	Optimum	24.45[gh]	21.34[f]	22.90[gh]	11.30	31.61	9.89	31.67	10.00	31.64
	Late	21.08[i]	19.55[g]	20.32[i]	14.67	41.03	11.68	37.39	13.18	39.21
LSD(5%)		1.55	1.37	1.46						
CV (%)		11.04	9.34	10.56						

LSD least significant difference at 5% level of significant, CV coefficient of variation in percent, Mean values in the same letter within a column are not showed significantly different at 5% probability.

study area in terms of economic management with optimum sowing date and use of Dhera and Habru resistant varieties. It was concluded that using resistant variety with optimum sowing date gave reasonable grain yields and reduced Ascochyta blight incidence and severity; therefore, genetic resistance needs to be investigated further by screening several germ plasms for source of resistance at several testing locations and one more cropping season.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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