Journal of Agriculture and Environment for International Development - JAEID 2016, 110 (1): 87 - 95
DOI: 10.12895/jaeid.20161.402

Assessment of faba bean gall (*Olpidium viciae* (Kusano) in major faba bean (*Vicia faba* L.) growing areas of Northeastern Amhara, Ethiopia

Bogale Nigir Hailemariam *, Setu Baze Tagele, Mulugeta Tilahun Melaku

Sirinka Agricultural Research Center, Bahir Dar, Ethiopia.

**Corresponding author: bogale84@gmail.com*

Submitted on 2015, 10 December; accepted on 2016, 10 May. Section: Research Paper

Abstract: Faba bean (*Vicia faba* L.) is one of the most important crops grown in the highlands of Wollo, Ethiopia. Yield in the country is generally very low, and diseases represent one of the major production constraints. In Ethiopia, a great variety of diseases affects faba bean production. However, gall forming faba bean disease has become a very serious disease that seriously affected faba bean producing areas. To study the status of this disease in the highlands of Wollo, Ethiopia, a survey was conducted in six major faba bean producing districts during the main cropping season of 2012 and 2013. A total of 119 farmers' fields were visited to determine the incidence and severity of faba bean gall forming new disease. The level of incidence was high in all the five districts, namely Gubalafito, Meket, Woreilu, Wadila, Jama, Legehida and Dessie Zuria. The level of disease severity ranged from 9.9 and 59.3%, while the incidence varied from 50 to 100%. The mean differences in incidence and severity within the districts variable classes, altitude, varieties, growth stage, plant population, planting date, previous crop, weed population and soil type were high. The independent variables: districts, altitude, growth stage, plant population, previous crops, weed population, drainage system and soil types were significantly associated with high incidence and severity of faba bean new disease as single predictor in the logistic regression model. A reduced multiple variable model was fitted using districts, altitude, growth stage, plant population, previous crop, weed population, soil type and drainage system as independent variables. High severity (>5%) had a high probability of association to all independent variables, except previous crop. There were about 1.44, 2.42 and 2.44 times higher probabilities that faba bean new disease severity exceeded 5% in dense plant population compared to low plant population, high weed population compared to low weed density and bad drainage system compared to moderate drainage system fields, respectively.

*Keyword: faba bean (*Vicia faba L*), Northeastern Amhara, Ethiopia*

Introduction

Faba bean (*Vicia faba* L.) is the most widely grown food legume in Ethiopia with an estimated annual production of 285,000 metric tonnes obtained from a cultivated area of some 245,000 ha. Worldwide, Ethiopia is the second largest producer in area and production after China (FAO, 1996). However, yield in the country is generally very low, and diseases represent one of the major production constraints (Gorfu and Beshir, 1994). In Ethiopia, a great variety of diseases affects faba bean production. However, gall forming faba bean new disease has become a very serious disease that seriously affected faba bean producing areas of Amhara and Oromiya region (Dereje et *al.*, 2012; Beyene and Wulita, 2012). Such similar disease symptoms on faba bean crop were reported in China (Lang *et al.*, 1993). The Lang and coworkers indicated that the disease showed 20% yield loss in China.

The Faba bean new disease, locally called Koritim, appears on leaves and stems. At the initial infection stage, on the back side of leaves, small chlorotic galls are formed, and then progressively enlarge to become light brown, circular or elliptical rough spots. Thus, the small tumorlike galls are formed, adjacently to form huge galls, resulting in rolling up and abnormal growth of leaves. At the later stage, the galls turn black or brown, the tissues decay and a few galls break to form necrotic areas. Leaves with more galls usually die earlier. Similar galls can form on the middle or lower parts of the stems. Severely infected leaves and stems are often stunted with few pods, or even fail to yield.

Dereje Gorfu, Wendafrash and Gemechu Kenei (2012) reported that this faba bean new disease called faba bean galls. The causative agent of fanba bean gall is Olpidium viciae (Kusano) (Dereje *et al.*, 2012; Xing 1984). *Olpidium viciae* (Kusano) first reported as a new species in 1912 in Japan. Kusano S. (1936) confirmed that the small galls in Japan were caused by the same pathogen which had a wide host range, including faba bean and pea. Additionally, by artificially inoculation, the pathogen also infects rapeseed, cabbage, cucumber, spinach and buckwheat but not soybean, kidney bean and other legume crops (Xing, 1984).

In faba bean producing area of wollo similar symptoms are observed. The disease was occurred on very limited plots around Meket, wadila, Jamma and woreilu before three and four years ago (farmers information) and in 2012 and 2013 cropping season, the distribution and the severity level become increased. However, in this area this new disease are not assessed and identified. Therefore, the objectives of this study were:

- To identify the disease macroscopically
- To determine the incidence and severity of new faba bean disease in faba bean production areas of Wollo
- To assess the association of the disease with environmental and cultural practice.

Material and methods

Survey area

Field survey was conducted in major faba bean growing areas of seven districts of Wollo highlands, Ethiopia representing different agro-ecologies; namely Gubalafito, Mekit, Wadila, Legehida, Woreilu, Jamma and Dessie Zuria districts. The survey was conducted during main cropping season of 2012 and 2013. Selections of districts were initially done purposely on the bases of high practice of faba bean production in the area. From each district, representative farmer's fields were assessed and samples were taken randomly at fixed interval of 5 up to 10 km (which were adjusted depending on the availability of faba bean farms. A total of 119 fields were assessed.

Disease assessment

The disease incidence and severity were recorded by moving in each field diagonally and observing 10 random plants per spot of a 0.5 m x 0.5 m quadrat sample area. Additional information such as altitude, previous crop, weeds, drainage system, soil type and plant density were recorded to study whether they have any effect on the status of the disease.

Disease incidence was calculated by using the number of infected plants and expressed as a percentage of the total number of plants assessed. Disease severity was scored based on the percentage recording system. The mean plant and weed population density was obtained by averaging five quadrats and recorded the weed density [low, <40 weeds; medium, 41- 60 weeds and high, >61 weeds m-2] (Getaneh *et al.*, 2006), and plant population [high (>30 plants m-2), low (<20 plants m-2) and medium (20–30 plants m-2)]. Information on variety type, previous crop and planting date were obtained from growers through interview.

Statistical analysis

Simple descriptive statistics were used to summarize data obtained from field surveys by using proc mean SAS procedure. The values corresponding to each independent variable represented the frequency of fields falling in the different boundaries and were used to analyze the association of the new disease incidence and severity with the independent variables and variables class using stepwise logistic regression of SAS procedure (SAS Institute, 2003). The procedure has been used by many authors to evaluate the association of disease incidence and severity of the different independent variables (Chemeda and Yuen, 2001; Getaneh *et al.*, 2006; Tamire *et al.*, 2007). The logistic regression model was used to evaluation the

importance of multiple independent variables (McCullagh and Nelder, 1989). The binary outcome was the probability that faba bean new disease incidence exceeds 50% or severity exceeds 5% in a given faba bean field. The logit link function was used in this binomially distributed data to determine the association of the independent variable to the response variable. The likelihood ratio statistics was used to examine the importance of variables and was tested against a Chi-square.

Result and discussion

Symptoms of faba bean gall

The faba bean gall (locally called Koritim) (*Olpidium viciae* (Kusano), appears on leaves and stems. At the initial infection stage, on the back side of leaves, small chlorotic galls are formed, and then progressively enlarge to become light brown, circular or elliptical rough spots (fig. 1). Thus, the small tumorlike galls are formed, adjacently to form huge galls, resulting in rolling up and abnormal growth of leaves. At the later stage, the galls turn black or brown (fig. 2), the tissues decay and a few

Figure 1 - Initial symptom of faba bean new disease back and upper side of the leaf.

Figure 2 - Abnormal leaf growth of faba bean. *Figure 3 - Abnormal stem growth of faba bean.*

galls break to form necrotic areas. Leaves with more galls usually die earlier. Similar galls can form on the middle or lower parts of the stems. Severely infected leaves and stems are often stunted with few pods, or even fail to yield (fig. 3).

Faba bean gall occurrence and association with environmental and cultural practices

A total of 119 faba bean fields from major producing districts in the highlands of Wollo, Ethiopa were assessed for faba bean new disease distribution in 2012 and 2013 main cropping season. Occurrence of the disease was highly distributed over all the

Table 1 - Mean incidence and severity of faba bean new disease for different independent variables.

Variable	variable class	N	Severity				Incidence			
			Mean	Sd	Min	max	Mean	Sd	Min	max
Year	2012	46	26	17	2	70	87	23	10	100
	2013	73	16	19	0	90	60	42	0	100
Woreda	Dzuria	14	12	12	0	40	64	46	0	100
	guba	15	28	34	0	90	46	50	0	100
	jamma	7	9	6	5	20	75	25	50	100
	lege	11	13	17	0	45	35	28	0	80
	meket	39	26	18	0	65	83	32	0	100
	wadlla	22	15	13	0	44	72	32	0	100
	wore	11	22	16	5	55	94	17	43	100
Alt	<2500	17	6	13	0	55	24	40	0	100
	2500-3000	84	22.5	19	0	90	81	30	0	100
	>3000	18	21	22	0	70	63	40	0	100
Growth stage	flowering	54	17	15	0	65	71	36	0	100
	Poding	44	24	22	0	90	74	41	0	100
	Grain	21	20	21	0	70	60	39	0	100
plant population	Dense	26	26	27	0	90	66	40	0	100
	Medium	61	18	17	0	61	73	38	0	100
	Low	32	17	15	0	45	68	39	0	100
weed density	High	28	38	23	0	90	86	31	0	100
	Medium	55	18	15	0	52	74	33	0	100
	low	36	9	9.5	0	30	53	45	0	100
Soil type	Blck	33	15	19	0	80	60	40	0	100
	Gray	17	30	26	0	90	78	36	0	100
	Red	69	20	17	0	65	73	38	0	100
Previous crop	Barley	33	21	18	0	65	77	33	0	100
	Fallow	8	17	30	0	90	60	46	0	100
	Tef	21	18	20	0	80	58	47	0	100
	wheat	57	20	19	0	70	73	37	0	100
Drainage	Bad	12	52	23	5	90	99	4	87	100
	Good	52	11	11	0	41	54	42	0	100
	Moderate	55	21	17	0	58	79	33	0	100
cropping system	intercrop	12	18	16	0	45	73	45	0	100
	sole	107	20	20	0	90	70	38	0	100

Table 2 - Independent variables used in logistic regression modeling faba bean new disease incidence and severity and likelihood ratio test (LRT) for 9 variables as single predictors of disease outcome.

Independent variable	DF	Fababe an new disease severity LRT>5%		Fababe an new disease incidence >50%	
		DR	Pr > ChiSq	DR	Pr > ChiSq
Intercept		2873.7377			
year	1	2696.1149	<.0001	8968.2298	<.0001
Woreda	6	2343.4280	<.0001	6827.7981	<.0001
Altitude	2	1962.3376	<.0001	5284.7663	<.0001
Growth stage	2	1906.0208	<.0001	4968.5081	<.0001
Plant population	2	1860.2763	<.0001	4673.3807	<.0001
Previous crop	3	973.1956	<.0001	2759.8898	<.0001
Weed population	2	1311.0948	<.0001	4399.3923	<.0001
Soil type	2	1274.1572	<.0001	3953.2422	<.0001
Drainage	2	1014.0484	<.0001	3104.9679	<.0001
Crop sys	1	971.62	0.2094	2754.0166	<.0.0154

surveyed areas. Mean incidence and severity of new disease on faba bean for different independent variables were presented (Table 1). Incidence and severity among geographic areas and between years varied (Table 1). The highest faba bean new disease incidence was recorded at Woreilu (97%), followed by Mekit (83%), Jamma (75%) and Wadila (72%), and Dessie Zuria (65) while the lowest at Gubalafito (46%) and Legehida (35). Similarly, the maximum mean disease severity (28%) was recorded at Gubalafito, followed by Meket (26%), while Dessie Zuria and Jamama showed the least severity 12% and 9%, respectively (Table 1).

This indicated that all the survey areas had favorable environmental conditions for this gall development.

The independent variables varied in their association with new incidence and severity (Table 2). All the variables except cropping system for disease severity were significantly associated with new disease incidence when entered first into a logistic regression model. The probability of new disease severity being associated with the independent variables is presented (Table 3).

Faba bean new disease severity occurrence was found significantly associated with independent variables such year, district, altitude, growth stage, plant density, weed population soil type, previous crop, drainage system (Table. 3). High severity (>5%) had a high probability of association to all independent variables, except previous crop. There were about 1.44, 2.42 and 2.44 times higher probabilities that faba bean new disease severity exceeded 5% in dense plant population compared to low plant population, high weed population compared to low weed density and bad drainage system compared to moderate drainage system fields, respectively.

Table 3 - Analysis of deviance, natural logarithms of odds ratio and standard error of added variables in a reduced model analyzing new faba bean disease severity.

Parameter	Residual deviance	DF	Deviance reduction	Pr> χ2	Variable class	Estimate	SE	Odd ratio
Intercept	2873.7377					-2.69	0.18	
year	2696.1149		177.6228	<.0001	2012	0.73	0.07	2.08
					2013	0.00	0.00	1.00
woreda	2343.428	6	352.6869	<.0001	D/zuria	-0.46	0.13	0.63
					Gubalafito	0.40	0.15	1.50
					Jamma	-0.81	0.16	0.45
					Legehida	0.15	0.16	1.16
					Meket	0.04	0.11	1.04
					Wadlla	-0.42	0.12	0.66
					Woreilu	0.00	0.00	1.00
Alt	1962.3376	2	381.0904	<.0001	<2500	-1.28	0.15	0.28
Alt					2500- 3000	0.17	0.10	1.19
Alt					>3000	0.00	0.00	1.00
GS	1906.0208	2	56.3168	<.0001	Flowe	0.33	0.12	1.40
					Pod	0.73	0.12	2.07
					Seed	0.00	0.00	1.00
Plp	1860.2763	2	45.7445	<.0001	Dense	0.36	0.09	1.44
					Med	0.29	0.07	1.33
					Low	0.00	0.00	1.00
weed	1311.0948	2	549.1815	<.0001	High	0.88	0.09	2.42
					Med	0.06	0.09	1.06
					Low	0.00	0.00	1.00
soil	1274.1572	2	36.9376	<.0001	black	0.05	0.09	1.05
soil					gray	0.59	0.11	1.81
soil					red	0.00	0.00	1.00
Drain	1014.0484	2	260.1088	<.0001	bad	0.89	0.10	2.44
					good	-0.61	0.08	0.54
					mode	0.00	0.00	1.00
Previ	973	3	41.0484	<.0001	Barley	0.33	0.07	1.40
					fallow	-0.46	0.14	0.63
					tef	0.03	0.09	1.03
					wheat	0.00	0.00	1.00

Conclusion and recommendation

The present work determined the distribution of faba bean new disease (gall) and the associations of disease with other environmental variables, agronomic practices, and crop management techniques. Incidence and severity of the disease varied among district, altitude, growth stage, plant density, weed population, soil type and drainage system. High disease incidence and severity were positively associated with high plant

population, high weed density, and bad drainage system. To manage faba bean new disease (gall) different epidemiologically relevant factors must be considered. Therefore, appropriate plant density, frequent weeding, good drainage system and appropriate planting date can help to break this cycle by reducing pathogen inoculum levels.

For possible use of integrated disease management (IDM), further studies are justified to conclusively determine:

- The distribution and severity level should be done in regional and country level
- The pathogen should be identified in molecular level
- The reaction of genotypes and genetic basis of resistance in faba bean to STB resistance and its genetic association with agronomic traits.

Acknowledgement

The authors wish to thank all Sirinka Agricultural research Center staffs, specially, Abebe Ayalew and Desalegn for assisting during data collection.

Reference

Bos L., Hampton R.O. and Makkouk K.M., 1988. Viruses and virus diseases of pea, lentil, faba bean and chickpea. In: World Crops: Cool Season Food Legumes. (R.J. Summerfield ed.) Kluwer Academic Publishers, Dordrecht, The Netherlands, 591-615.

Dereje Gorfu, Wendafrash and Gemechu Kenei, 2012. Faba Bean Galls: a new disease of faba bean in Ethiopia. Holetta Agricultural Research Center. Google.doc.com

Getaneh Woldeab, Yuenb J., Chemeda Finninsa and Singh H., 2006. Barley leaf rust (Puccinia hordei Otth) in three production systems and practices in Ethiopia. Crop Protection, 26 (2007): 1193-1202.

Gorfu D., and Beshir T., 1994. Faba bean diseases in Ethiopia. In: Cool Season Food Legumes of Ethiopia. (T. Asfaw, B. Geletu, M.C. Saxena, M.B. Solh, eds). Proceedings of the First National Cool Season Food Legumes Review Conference, 16-20 December, 1993. Addis Ababa, Ethiopia. ICARDA/Institute of Agricultural Research, Aleppo, Syria, 328-345.

FAO, 1998. Production Year book. Rome, Italy, Volume 52, 96 pp.

Fernández-Aparicio M., Shtaya M.J.Y., Emeran A.A., Allagui M.B., Kharrat M. and Rubiales D., 2011. Effects of crop mixtures on chocolate spot development on faba bean grown in mediterranean climates. Crop Protection, 30 (2011), 1015-1023

Katul L., Vetten H.J., Maiss E., Makkouk K.M., Lesseman D-E. and Casper R., 1993. Characterization and serology of virus-like particles associated with faba bean necrotic yellows. Annals of Applied Biology, 123, 629-647

Lang Li-juan, Yu Zhao-hai, Zheng Zhao-jie, Xu Ming-shi and Ying Han-ging. 1993. Faba bean in Chine: state of the arts review. ICARDA, Alepo, Syria.

Makkouk K.M., Bos L., Azzam O.I., Kumari S.G. and Rizkallah A., 1988. Survey of viruses affecting faba bean in six Arab countries. Arab Journal of Plant Protection, 6, 61-53

Xing Zhesheng 1984. Faba bean gall disease caused by Oplidium and its control. Acta Phytopathological Sinica 14(3):165-173.

Yan Ji-ming and Ye hua-zhi, 2012. On the occurrence regularity of broad bean blaster. Journal of Sichuan Agricultural University, 30(3)