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BCS-CAST: AN EARLY WARNING COMPUTERIZED MODEL FOR FABA BEAN CHOCOLATE SPOT IN EGYPT

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ABSTRACT
Chocolate spot caused by *Botrytis fabae*, is one of the most devastating diseases resulting in large losses of the crop and poses a major threat to the local faba bean production. The first Egyptian early warning computerized model BCS-CAST presented herein, is an integral linking system based on short-term observations over several faba bean growing seasons. It analyzes real time, 24 hour microclimate data collected automatically by an advanced Agro-weather station (Adcon Telemetry A733). BCS-CAST was designed and validated under both computers Laboratory and field conditions to forecast the faba bean chocolate spot disease daily infection potential. Subsequently, it was evaluated as an advisory system to reduce fungicidal applications compared with the regular spray program during 2010/2011 and 2011/2012. The basic roles of system analysis for model validation and evaluation are discussed.

Keywords: Faba bean chocolate spot, BCS-CAST, system analysis, early warning computerized model and daily disease infection potential (DDIP).

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the most important legume crops in Egypt. It is grown mostly to fulfill food and feed requirements.

Diseases are the major constraints to faba bean production in Egypt, as they cause enormous losses in the yield and quality. The most important diseases are chocolate spot, rust, stemphylium leaf spot, wilt, root rot and viral diseases (Morsy, 1993). Chocolate spot disease of faba bean is widely distributed throughout the world (Yu, 1945; Gaunt, 1983; Omar, 1984; Morsy, 2000 and Mazen, 2004).

In Egypt, chocolate spot disease is very destructive and is the most limiting factor for faba bean production, especially in the Northern Delta region (Ibrahim *et al.,* 1979; Mohamed, Nagwa, 1996 and Morsy 2000). Analysis of yield component of faba bean infected by *Botrytis fabae* indicated that the loss was solely due to a decreasing number of pods per plant, from which it was concluded that the most damaging effect of chocolate spot disease infection was on the foliage growth (Williams, 1975). Losses in faba bean yield caused by chocolate spot disease could reach up to 5% in the North of Delta (Rizk 1974; Ibrahim *et al.,* 1979 and Solh *et al.,* 1994*)*.

The negligent use of chemicals can cause health problems for humans, as well as environmental pollution. The international concern about environmental and human health risks, due to pesticide overuse, raises the necessity of producing food free from chemical substances. If effective, the early warning systems would identify periods when conditions are favorable for disease development, and schedule fungicide applications when needed for better control of faba bean chocolate spot. The computerized early warning model simulates the development of faba bean chocolate spot on the basis of short-term observation of microclimatic factors. The input variables to the model are: temperature, RH, precipitation, wind speed, global radiation and leaf wetness for the primary disease infection potential (PDI) and the secondary daily disease infection potential (DDIP). The goal of this investigation was to evaluate and to facilitate validation of BCS-Cast, the first Egyptian computerized early warning model and to allow direct use of the model in an experimental faba bean over two successive faba bean-growing years in Egypt. To define the optimal time for the first spray and lead the fungicides application for perfect disease control compared with standard fungicide application schedule. Finally, to establish an advisory system for faba bean chocolate spot disease early warning model in Egypt.

MATERIALS AND METHODS

Weather monitoring:

Automated, portable and solar powered in-crop weather stations (Adcon Telemetry A733) (Fig.1) were used to monitor the microclimatological conditions. High technology, sensitive sensors transmitted the digital data for up to 20 km, on average every 15 minutes, via a personal computer using radio waves. In this way, data on temperature, relative humidity, wind speed, leaf wetness, precipitation and global radiation were collected from faba bean canopy. The station is equipped with central base station (Fig.2) which served as a: data collection center (receiver) to receive and save the collected data for up to 50 days and to run advantage software which allowed simple interpretation of the readings using a graph and detailed list of chosen items (Afifi, M.A. and Sahar, A.M. Zayan, 2009).

Faba bean chocolate spot disease early warning model:

A computerized simulation model designated BCS-CAST,(Fig.3) was designed and tested several times under laboratory conditions before switching to the validation experimental phase conducted at Etay El-Baroud Agricultural Research Station (Behera governorate) throughout 2010/2011 and 2011/2012 growing seasons. This allowed us to figure out how well such a model predicted disease incidence and facilitated revision and refinement of the model based on these findings. Frequently, disease control (timing of sprays) of faba bean treated according to the model recommendations were compared to disease managed by traditional routine spray schedules.

The model system analysis

BCS-CAST model, presented as a flowchart (Fig.4) is a creation and designation of a computerized model, based on short-term observations (hourly weather data) analyzing the correlation between the input variables of microclimatological factors such as: temperature, relative humidity, leaf wetness, global radiation and wind speed. The model uses these factors to calculate the actual time of primary disease infection potential (PDIP) and secondary daily disease infection potential (SDIP) of faba bean chocolate spot causal agent *Botrytis faba.* Then, the model outputs a daily announcement as a warning message (spray or don't spray) to guide the fungicides application for perfect disease control in the appropriate time. The model evaluation follows the basic rules of system analysis to identify events A and B. Event A is triggered when the model detects at least X accumulated dynamic summation hours of RH between 90 – 100 % and temperature between Y and Z according to the data tabulated in (Table 1). Event B is triggered when Global radiations exists. Moreover, using the model system analysis brings an extension to the model, that applies the same rules not only to identify the first critical phase of the season (correct time for primary infection), but also to issue warnings for Secondary disease infection potential (SDIP) throughout the whole growing season.

Model validation

Field experiments were conducted in large plots at Etay El-Baroud Agricultural Research Station (Behera governorate) throughout December of the 2010, January and February 2011 and December of the 2011, January and February 2012 growing seasons. A commercial faba bean cultivar (Giza 40), susceptible to chocolate spot disease was used. The field was divided into plots of 3.0 x 3.0m and each plot consisted of three rows. Seeds were sown as two seeds/hole in rows, at the two edges of each row with 20cm between holes.

In both seasons, two treatments were tested: (i) a full-schedule fungicide program, in which plants were sprayed every 15 days; and (ii) spraying when the advisory system of early warning model BCS-CAST indicated that a spray application was needed and at least 15 days after the previous fungicide application. Generally, Tridex 80% (250 gm / 100L water) is considered effective for controlling chocolate spot disease, and this was used with both the advisory - system treatment and the full-schedule program. Plots were carefully inspected at least once a week for the appearance of disease symptoms. The effect of each treatment was evaluated by calculating the severity of chocolate spot disease, according to Hanounik (1986). Data were measured by automatic weather stations (Adcon Telemetry A733), installed within the faba bean plots.

RESULTS

An early warning computerized model BCS-CAST for faba bean chocolate spot disease adopted the rule of system analysis has been evaluated successfully for the first time in Egypt.

Results presented in (Fig.5) showed that the BCS_CAST model has accurately determined the correct time for the first application (PDIP) on the 10th of January and the second application on 14th of February 2012 with disease severity 2.35 after the second spray which was tabulated in table(2). On the other hand, results shown in (Fig.6) proved that the BCS_CAST model accurately estimated the correct time for the first application (PDIP) in 15th of January and the second application on 22th of February 2012 with disease severity 2.11 after the second spray which was tabulated in table (2).

Disease severity in the control was 18.81 in the first season and 16.33 for the second. Therefore, two sprays were applied in each season of evaluation according to the recommendation of BCS_CAST warning system, instead of four sprays in 2010/2011 and 2011/2012 following a full-schedule fungicide program (routine application) with disease severity 3.13 in the first season and 2.22 in the second, with a reduction percentage of chemical application by 50%.Moreover both of the experimental treatments successfully controlled chocolate spot disease in 2010/2011 and 2011/2012 growing season.

Figure 1: Automated in crop weather station (Adcon A733).

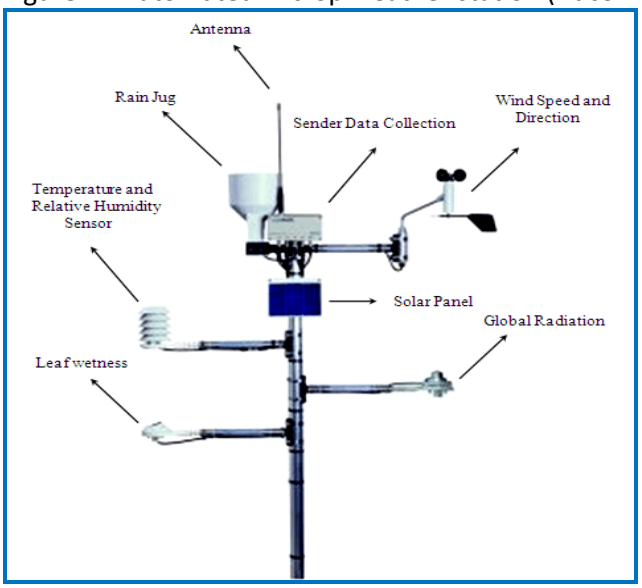

Figure 2: The base station (Receiver, PC, and Advantage Software) Data is instantly plotted for easy examination of weather data. Time line indicates values where it intersects data lines.

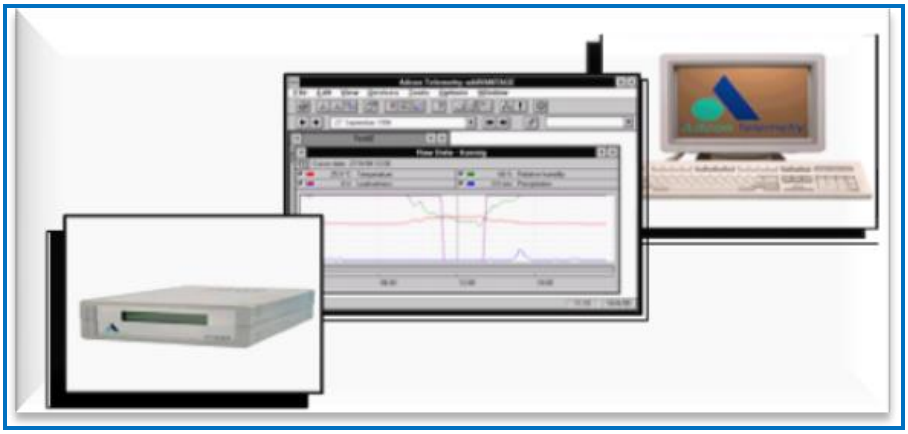

Figure 3: BCS-Cast model`s interface for Faba beans chocolate spot disease in Egypt.

Figure 4: Flowchart of BCS-Cast model`s system analysis for Faba bean chocolate spot disease in Egypt.

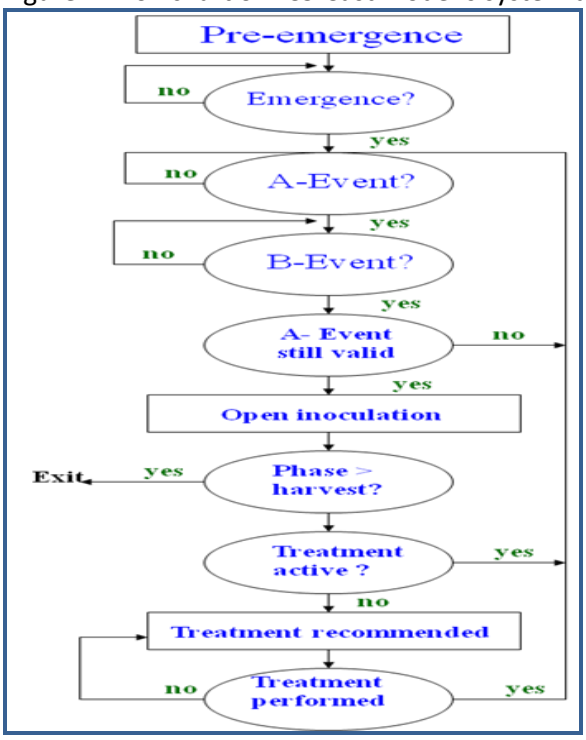

Figure 5: The daily microclimatological factors (BCS-CAST model input variables) during December, January, February 2010/2011 faba bean-growing seasons indicate the early warning system spray recommendations.

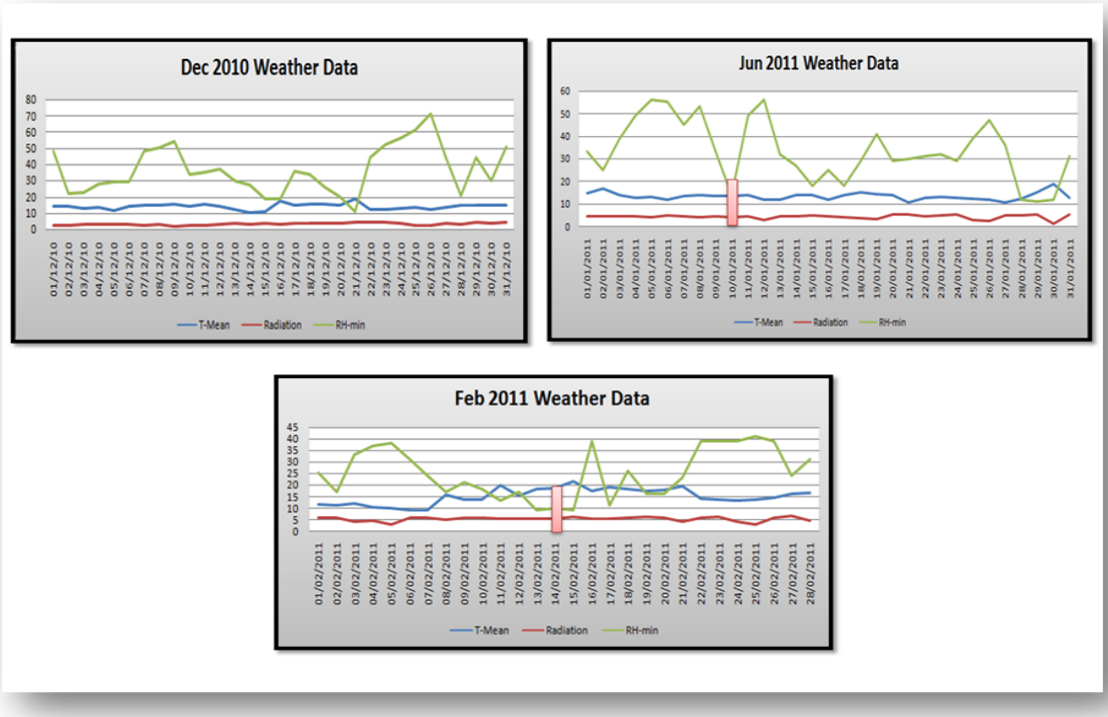

Figure 6: The daily microclimatological factors (BCS-CAST model input variables) during December, January, February 2011/2012 growing seasons indicate the early warning system spray recommendations.

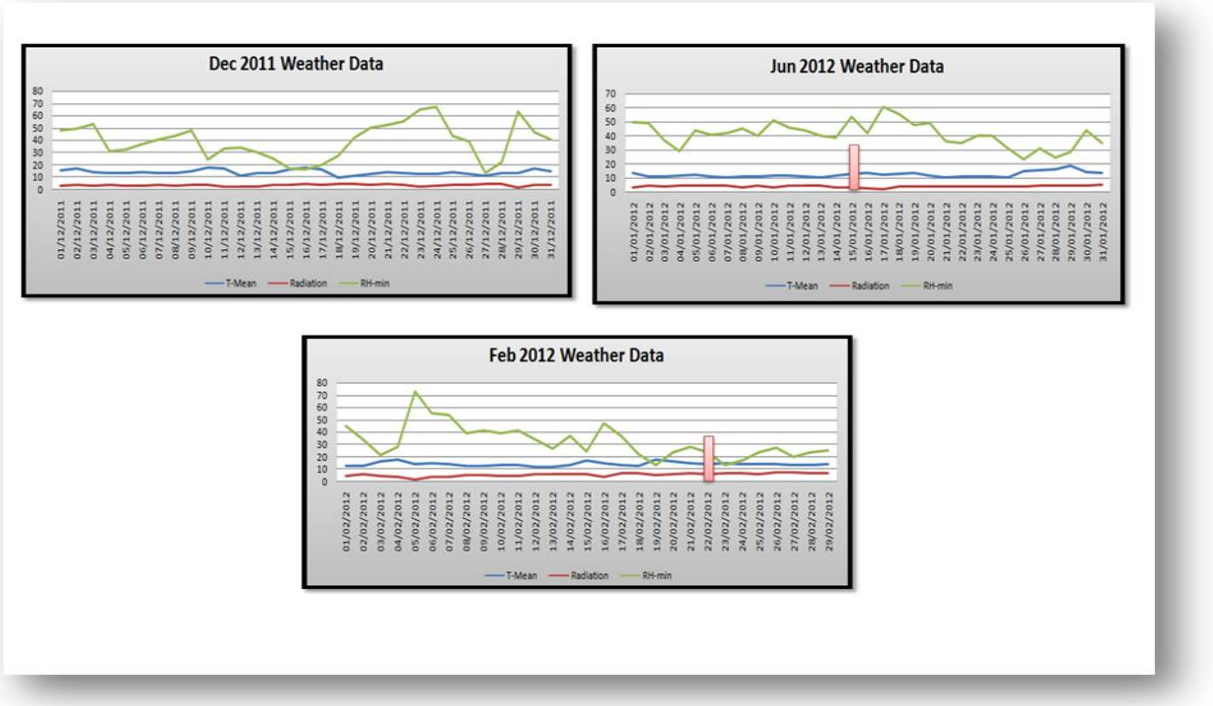

Table 1: The basic rules of system analysis to identify event A.

Y = Temp from:	Z = Temp from:	X = 3 hours of RH	X = 6 hours of RH
17 °C	20°C	**Event A detected**	
20°C	25°C		**Event A detected**

Table 2: Effect of early warning system and time table of fungicides on the severity of chocolate spot disease on faba bean Cv. Giza 40, in Behera Governorate during two successive seasons of 2010/2011 and 2011/2012.

No of fungicide sprays	Disease severity %			
	Spraying using time table of fungicides application.		Spraying using the early warning system.	
	2010/2011	2011/2012	2010/2011	2011/2012
1st Spray	4.67	3.65	3.11	2.85
2nd Spray	4.11	3.33	2.35	2.11
3rd Spray	3.85	2.67	-	-
4th Spray	3.13	2.22	-	-
Control	18.81	16.33	18.81	16.33
L.S.D. at 5 %				

CONCLUSION

Chocolate spot disease caused by *Botrytis fabae* is the most important disease affecting Faba bean Cv. (Giza 40) in Egypt. Most of the knowledge used to manage chocolate spot disease in Egypt is derived from studies that depended mainly on the fungicide management scheme of routine time-table spraying. Increasing the fungicide applications is very expensive and causes environmental pollution has harmful effects on consumers. Accordingly, there is a clear need to re-evaluate the previous research knowledge to know when to start control of chocolate spot disease with the effective fungicides during the growing season, in order to reduce the number of fungicides applications. An advisory system presented as an early warning computerized simulation model BCS-CAST was validated and evaluated successfully for the first time during two successive Faba bean growing seasons in Egypt to help the Faba bean growers manage such a disease with more precise use of fungicides. The obtained results were in agreement with former researches applied on other leguminosae crops (Pan, Z., et al. 2006); which suggest that chocolate spot disease of faba beans could be controlled effectively in Egypt with fewer fungicide applications using disease warning system compared with the standard calendar-based schedule. System analysis played an important role in designing and creating the study subjected model and was detailed in a flowchart. It is noteworthy to record that a significant reduction percentage in fungicide applications was achieved as the number of sprays was reduced by 50%.

And the disease ? the result for the producer ? OK or NOT ?

REFERENCES

1. **Afifi, M.A. and Zayan, S.A.M. (2010).GPM-CAST: An early warning computerized model for grapes powdery mildew in Egypt.** In proceeding of the 9th international conference of plant diseases, tours, Francs, 8-9 December, 2010.pp:516-525. Organized by the association Françoise of plant protection.

2. **Gaunt, R.E. (1983).** Shoot diseases caused by fungal pathogens. The faba bean (*Vicia faba* L.) A Basis for Improvement. Ed. by P.D. Hebblethwaite. (463-492) Butterworths Pub.
3. **Hanounik,S.**B (1986) Screening techniques for disease resistance in faba beans. International Center for Agriculture Research in the Dry Areas (ICARDA), A Lepp, Syria.
4. **Ibrahim, A.A.; Nassib, A.M. and El-Sherbeeny, M.H. (1979).** Production of grain legumes in Egypt. Food Legume Improvement and Development. Ed. G.C. Hawti and G.J. Chancellor, IDRC Pub. 126, Ottawa.
5. **Mazen, M.M. (2004).** Resistance induction against diseases of faba bean crop. Ph.D. Thesis, Fac. Agric., Suez Canal Univ., Egypt.
6. **Mohamed, Nagwa, A.M. (1996).** Studies on chocolate spot disease of broad bean and loss occurrence. Ph.D. Thesis Fac. Agric., Minufiya Univ., Egypt.
7. **Morsy, K.M. (1993).** Pathological and genetical studies for improving resistance of faba bean to chocolate spot disease. M. Sc. Thesis Fac. Agric., Cairo Univ., Egypt.
8. **Morsy, K.M. (2000).** Improving resistance of faba bean to chocolate spot disease. Ph.D. Thesis Fac. Agric., Cairo Univ., Egypt.
9. **Omar, S.A. (1984).** Disease interaction and host response in *Vicia faba* L. Ph.D Thesis, London Univ., U.K.
10. **Rizk, Z. (1974).** Cultural practices of grain legumes in the Arab Republic of Egypt. Proceedings of the first FAO/ SIDA Seminar on Improvement and Production of Field Food Crops for Plant Scientists from Africa and the Near East. FAO. 557-559.
11. **Solh, M.B.; Halila, H.M.; Hernandez- Bravo,G. ; Malik, B.A. ; Mihov, M.I. and Sardi. B. (1994).** Biotic and a biotic constraining the productivity of cool season food legumes in different farming systems: specific examples. Proc.of the Sec.Int.Food Legum Res.Conf., Cairo, Egypt, 12-16. April, 1992, pp. 991.
12. **Williams, P. F. (1975).** Growth of broad beans infected by *Botrytis fabae* . J. Hort. Sci., 50: 415-424.
13. **Yu, T. F. (1945).** The red-spot disease of broad beans (*Vicia faba* L.) caused by *Botrytis fabae* Sardina in China. Phytopathology, **35**: 945-954.
14. **Pan, Z., Yang, X. B., Pivonia, S., Xue, L., Pasken, R., and Roads, J**. 2006. Long-term prediction of soybean rust entry into the continental United States. Plant Disease **90**(7): 840-846.