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JEB
Journal of Environmental Biology

ISSN: 0254-8704
CODEN: JEBIDP

Occurrence of phytoplasma phyllody and witches' broom disease of faba bean in Bihar

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Publication Info

Paper received:
26 August 2011

Revised received:
26 December 2011

Accepted:
26 March 2012

Abstract

Faba bean (*Vicia faba*) plants showed symptoms of shoe stringed leaves, phyllody and flower abortion in experimental field. The first symptoms consisted of phyllody mild yellowing, vein clearing and slightly inward folding of newly formed leaves in the apical region of the plant. The disease was characterized by a series of floral abnormalities including virescence, phyllody and proliferation of sprouts together with other abnormalities, such as loss of apical dominance, vivipary and enhanced vegetative growth. Ambient temperature found to be contributing positively on disease development. Under climate change condition there may be every possible chance for speedy spread of this very economic important disease to the earlier not known regions.

Key words

Climate change, Faba bean, Phyllody, Phytoplasma, Witches' broom

Introduction

Vicia faba, commonly known as faba bean, is an annual leguminous plant grown as vegetable during winter season. According to F.A.O. (2004), faba bean occupies fourth rank amongst the pulse crops in the world covering an area of 25 million ha producing 18.4 million tons of dry seeds. It can be grown under diverse climatic conditions in varying soil types (Singh and Bhatt, 2012 and Singh *et al*., 2013). Faba bean is seen as an agronomically viable alternative to cereal grains. Faba bean, being a legume is a nitrogen-fixing plant are capable of fixing atmospheric nitrogen, which results in increased residual soil nitrogen for use by subsequent crops. It is one of the best annual crop can be used as green manure. The crop is widely adapted to diverse soil types, and is more tolerant to acidic as well as saline alkaline soils than most legumes (Singh *et al*., 2012b). Being so incredible crop, unfortunately in India it is categorized as minor, underutilized and fully unexploited crops (Singh *et al.,* 2010 and Singh *et al.,* 2012c). The production of faba bean is greatly influenced by several biotic constraints, disease being the major one. The crop is attacked by more than 100 pathogens (Singh *et al*., 2012a) and is being continuously attacked by newer pathogens owing to global climate changes. The Witches' Broom disease was first reported in Sudan by Nour (1962) who succeeded in transmitting the pathogen through grafting. The disease is characterized by a series of floral abnormalities including virescence, phyllody and proliferation of sprouts together with other growth abnormalities, such as loss of apical dominance, vivipary and enhanced vegetative growth (Lee *et al*., 2000). The association of phytoplasma with the disease in faba bean was first reported by Cousin and Abadie (1983) from Morocco; but there was no evidence concerning the relationship of this disease with faba bean phyllody in Bihar. Since the disease appears to be a potential threat to the cultivation of faba bean due to attack of this disease heavy yield loss was recorded everywhere. It is more pertinent to Bihar condition where it is gown under considerable area especially poor farming communities hence the study was undertaken to record the occurrence of the disease in this

crop under climatic condition of Bihar. Further IPCC projected minimum 1.8°C increase in temperature by 2100 above 1990 level and confirms that the global average temperature increased by 0.74°C over the last century, is about poses a potential threat to agricultural production and productivity and affects the crop yields due to increase incidence of plant diseases (Singh *et al.*, 2012d). Apart from field screening for infection/disease development, evaluation under control condition with inoculation were also carried out to know the rising temperature on the disease development to assess the impact of terminal heat which in general concede with reproductive phase of this crop. Due to positive role of temperature in the development of this disease, there is every possible chance to spread of this disease to unconventional region under changing climate scenario. The present study is very much relevant to all the faba bean growing regions where this problem is not occurred yet or is noticed in very few patches. Accordingly this study was undertaken to record the occurrence of the disease in this crop under climatic condition of Bihar.

Materials and Methods

To study the occurrence of phytoplasma phyllody and witches' broom disease of faba bean (*Vicia faba*) under Bihar condition this experiment was conducted in field and control condition (polyhouse). With an objective to screen all the germplasm for this infection /disease under field and control condition.

Field evaluation : A total 75 different germplasm lines were grown and evaluated at experimental farm (ICAR Research Complex for Eastern region) at Patna in Bihar as *rabi* (winter) crop for two years during 2009-2010 and 2010-2011. Each accession was planted in 2.0 m X 1.0 m with spacing of 30 cm apart, to obtain square planting to provide equal opportunity to individual plant. Hence altogether 18 plants per line and total 75 lines were observed for incidence of diseases. When the plants were about 60 days old, diseased symptoms on the affected plants were observed in three germplasm lines (*viz*. line no. 2010312, 2010411 and 2010517), provided momentum for further study under controlled condition.

Study under controlled condition : Under field conditions diseased plants were only recognizable at later stages of disease development, when phylloidy and witches' broom developed. Hence diseased plants were collected from germplasm lines 2010312, 2010411 and 2010517 and sealed in polythene bags for further studies i.e. to observe the chronology of symptoms leading to disease development. Disease isolates were maintained and propagated through graft inoculation technique in which, phylloid flowers with elongated pedicle were used which were grafted to the axil of the first expanded leaf on 2–3 weeks old plants. The inoculated plants were covered with polythene bags to reduce transpiration. To know the effects of ambient temperature on disease development all there susceptible germplasm lines were kept in two groups., each of 15 test plants and 15 controls, in two different polyhouses at temperatures of 18-20ºC and 22-26ºC respectively. Successful grafts were kept under frequent observation for four months. Symptom development in graft-inoculated plants was recorded at 2 days intervals during the first 6 weeks after grafting and then at 2-4 days intervals for as long as 4 months. During the trials, differences in symptom expression were observed in plants grown at different temperatures.

Results and Discussion

Development of phyllody and witches' broom : Based on observation recorded under controlled conditions as well as field evaluation, it was established that early symptoms of faba bean phyllody consisted of light yellowing of the leaves and gradual greening of petals, mild yellowing, vein clearing and slightly inward folding of newly formed leaves in the apical region of the plant. Afterwards successive yellowing and shedding of older leaves and development of Phyllody was noticed. At advanced stages Witches' broom of vegetative origin, production of small yellowing leaves, axillary bud proliferation, dieback of bunches, no further proliferation. Floral symptoms started to appear one week later after anthesis of flower. Young plants that developed systemic infection during flower bud initiation invariably produced phylloid flowers (Fig.1) whereas virescent, phylloid and healthy flowers were observed in older plants. In some cases it was noticed that some flower buds in late infected plants were found to produce pods with fertile as well as aborted seeds. In these pods vivipary was frequently observed. The hypocotyls of developing seedlings ruptured through the walls of pods while their roots developed inside the pod. Similarly, there are reports of phyllody in faba bean (Singh *et al.*, 2012a; Schneider *et al.*, 1995) and witches

Fig. 1 : Phyllody and Witches' broom disease in *Vicia faba*

broom in alfalfa (Salehi *et al.*, 1995) where they showed proliferation of shoots and yellowing of leaves and tillering of stems, rendering the crop either infertile or unmarketable.

Excessive sprouting of buds in basal vegetative parts of the plant started about 6 weeks after grafting and coincided with complete cessation of apical growth. In advance diseased condition bud proliferation became excessive while the main stem became yellow and finally desiccated. Primary proliferation was followed by secondary and tertiary proliferations which contributed to witches' broom symptoms. New virescent flowers continued to arise for as long as three months. These visible above-ground symptoms were also accompanied by characteristic modifications of the root system. They consisted of root proliferation and excessive necrosis. Nodulation was highly affected and diseased plants produced small necrotic and deformed nodules. Likewise, variety of symptoms resembling those caused by phytoplasmal infections, namely shoot proliferation (witches' broom), green petal flowers (virescence), leafy floral structures (phyllody), flower abortion, virescence and yellowing were observed by Romero and Castro (2004) in faba bean in Spain and Rojas-Martinez *et al*. (2003) in marigold.

In varietal reaction at 20-22ºC, symptoms development was observed in the three germplasm lines no. 2010312, 2010411 and 2010517. However it is worth to mention that in the two germplasm lines no. 2010312 and 2010411 three stages of disease development could be distinguished i.e. initial foliar symptoms, first floral symptoms and witches' broom growth. Disease progress was recorded accordingly. Tested germplasm lines were found to be sensitive to attack, though the germplasm line 2010517 suffered considerably less than then the other two germplasm lines, which showed initial symptoms within 23 to 24 days. No such symptoms were observed in any of the 14 plants of germplasm line no. 2010517 (Table 1). Floral symptoms started appearing at 25 days after grafting. In addition, no witches' broom development occurred in germplasm line no. 2010517 and affected plants of this germplasm line frequently showed partial recovery and produced fertile flowers.

Influence of ambient temperature on disease phenology: Faba bean plants of all the experimental lines grown at 20-22 ^{0}C invariably showed virescence within 28 days following grafting taking less time as compared to 15-18 ^{0}C (Table 2). Subsequent disease development normally continued as describe earlier. Contrarily, at temperature between 15-18 ^{0}C, only two transmissions out of ten successful grafts were obtained and floral symptoms started after 38 days after grafting. In addition, partial infection was common among these plants and most of them produced numerous fertile flowers. Plant growth was highly favourable at temperature of 15-18ºC with increase growth rate and larger plant size than at 20-22ºC. Temperature seems to play a major role in symptoms expression and subsequent disease development. Polyhouse temperature of 15-18ºC appear to favour plant growth while suppressing symptom development (Singh *et al*., 2012a). At higher temperature of 20-22ºC, plant maintained vigorous growth through readily developing symptoms. The results obtained in the present study are in conformity with the findings of Conti (2000) and Singh *et al*. (2012a) on faba bean. Phyllody and Witche's broom disease are

Table 1 : Days taken for development of disease symptoms in affected faba bean plant

Line No	Stage of symptom development (Mean time taken in days)					
	Initial symptoms I		First floral SymptomII		Witches' broom Growth III	
	Mean time in days	T.P.S.S/ in days	Mean time T.N.T.P	T.P.S.S/ T.N.T.P	Mean Time in days	T.P.S.S/ T.N.T.P
2010312	24	12/12	31	10/12	49	9/12
2010411	23	14/14	29	14/14	45	10/14
2010517	-	0/14	25	2/14	-	0/14

T.P.S.S=Total plant showing symptoms; T.N.T.P=Total number of tested plant

Table 2 : Effect of different temperatures on symptom development

Symptom development	Temperature range	
	15-18 ºC	20-22ºC
Floral symptoms	Floral symptoms appeared after 38 days of grafting	Floral symptoms appeared after 23 to 24 days of grafting
Fertile flowers	Numerous fertile flowers	Few fertile flowers
Virescence development	Virescence within 32 days after grafting	Virescence within 28 days after grafting

devastating diseases that mainly affects legumes including faba bean. At time under sever infested condition some time no harvest is also reported. Since under Bihar condition the pathogens was not reported and preventions is better than cure for any disease, an attempt was made to replicate the same environment under control conditions to know the etiology of the disease to prevent its occurrence of the inoculums of disease where this disease was not reported previously. It was noticed that there was significant correlation with the set of agro climatic conditions and if similar situation occurs it is advisable that one should go for plant protection measure without further delay. For sustainable management crop rotation should be followed strictly.

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