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# Occurrence, Severity and Farmers' Cultural Practices for Management of *Fusarium* Wilt (*Fusarium udum* Butler) Disease of Pigeonpea

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**Pigeonpea [*Cajanus cajan* (L.) Millsp.] is an important grain legume of rain-fed agriculture in semi-arid tropics and ranks next to chickpea in area and production in India. Fusarial wilt, one of the major constraints of low yield in Pigeonpea is widely prevalent in north and central parts of the country causing yield loss ranging from 30 to 100%. In perspective of the importance of the disease field surveys were conducted at 115 farmers field in 15 major pigeonpea growing districts of eastern U.P. during 2007-08 and 2008-09 with the aims of assessing wilt severity, farmers' current perception and knowledge of pigeonpea wilt and practices for its management and identifying points of potential intervention in the development of integrated disease management (IDM) programmes. The survey was made at pre-flowering stage and at pod stage of the crop. In each of the selected villages 4m X 4m plots of three fields were randomly selected to calculate the disease incidence and the respective farmer was interviewed. Disease incidence and severity varied among districts up to cropping pattern, cropping system, altitude and management practices. The proportion of total field area exhibiting symptoms of wilt spanned from less than 1% to over 70%. The disease was observed in all the fifteen districts surveyed except few villages. The average incidence of pigeonpea wilt in different districts of eastern Uttar Pradesh was 7.36%. The disease was found in 70 per cent fields of total 115 villages surveyed during 2007-08 and 74 per cent during 2008-09. Incidence of wilt in individual field ranged from 1 to 70% whereas overall incidence in districts ranged from 0.75 to 18.75% during 2007-08 and 1.0 to 19.50% during 2008-09. Very few farmers showed any elements of IDM strategies, probably due to their limited knowledge of the biology of pigeonpea diseases as the pigeonpea is a minor crop they use a poor irrigated, poor fertile land to grow the crop. These results suggest that improvement of pigeonpea wilt could be achieved by enhancing farmers' knowledge and developing and deploying IDM practices (crop rotation, inter cropping, resistant varieties *etc.*) involving a multidisciplinary approach, which encompasses addressing other production constraints.**

**Key words:** *Fusarium udum,* Pigeonpea, Occurrence.

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is an important grain legume of rain-fed agriculture in the semi arid tropics. It is cultivated in more than 25 tropical and subtropical countries either as a sole crop or intermixed with cereals such as sorghum (*Sorghum bicolor*), pearl millet (*Pennisetum glaucum*) or maize (*Zea mays*). In India, pigeon pea is mainly grown in the state of Uttar Pradesh, Madhya Pradesh, Maharashtra, Karnataka, Bihar, Gujarat, Tamil Nadu and Andhra Pradesh. India being the largest producer of pigeonpea in the world contributes about 85% of the total production. During 2009-10 the total production in India was 2.88mt in the area of 3.89mha[1]. The total area under pigeonpea production in India has been increasing steadily

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in recent years, making the crop the second most important pulse crop after chickpea. Even though the area under pigeonpea production has been increasing, yields (estimated to be 0.75tons/ha) are below the potential productivity of the area. Continuous cultivation, *use of minor lands*, prevalence of diseases and pests, lack of quality seed are among the factors suggested by researchers as responsible for the low productivity. It is estimated that approximately 30 – 100% of the crop is lost to wilt annually in India[2]. Following the limited capability of resource constrained farmers to control wilt, optimum control and management of the disease in the tropics is likely to be achieved only through development and implementation of integrated disease management (IDM). However, poor adoption of IDM technologies by resource poor farmers in the developing countries is widely documented[3]. More than 50 diseases have been reported to affect pigeonpea however only few of them are of economic importance. These include wilt (*Fusarium udum* Butler), sterility mosaic, Phytophthora blight (*Phytophthora drechsleri* Tucker f. sp. *cajani*), Phoma canker (*Phoma cajani* Rangel), Macrophomina stem canker (*Macrophomina phaseolina* Tassi) witches broom (virus & mycoplasma), Rust (*Uredo cajani*) and leaf spot (*Cercospora cajani* Henn.). It is a serious disease in Kenya and Malawi and has also been reported from Bangladesh, Mauritius, Ghana, Tanzania, Uganda, Indonesia, Thailand, Grenad and Trinidad[4]. Fusarium wilt is one of the major constraints of low yield of pigeonpea being soil & seed borne in nature[5]. Between crops, it survives in residual plant debris as mycelium and all its spore form. The disease usually appears in early stage of plant growth but recorded in serious form during flowering and podding stages. The infected seedlings show loss of turgidity, inter-veinal clearing, chlorosis of foliage sometimes become yellow before wilting. The characteristic symptoms of the disease are browning of the xylem vessels from the root to the stem which can be seen as black streaks in vascular region. The mycelium advances through xylem causing vascular plugging followed by wilting of plants. The isolates of *Fusarium udum* from the same site or diverse geographical origins have been shown to exhibit high variability in culture characteristics[6, 7] and virulence or pathogenicity on pigeonpea genotypes[7, 8]. The study had three objectives: (1) to examine and record incidence of wilt disease at farmers field; (2) to determine agronomic practices and other cultural practices that may influence wilt severity and control; and (3) to determine farmers' knowledge and perception of wilt and its relative importance to other production constraints.

## MATERIALS AND METHODS

### Study locations

The selection of the districts was based on pigeonpea cultivation in Eastern U.P and accessibility by road. In perspective of the importance of the disease field surveys were conducted at different locations (villages at road side) in Varanasi, Allahabad, Faizabad, Ambedkar nagar, Mirzapur, Ghazipur, Mau, Pratapgarh, Jaunpur, Barabanki, Gorakhpur, Basti, Sultanpur, Raibareilly and Bhadohi districts of Eastern Uttar Pradesh. A total of 115 villages were surveyed for the presence of Fusarium wilt of pigeon pea (FWP) in the concerned areas.

### Survey

Fields were sampled randomly at intervals of 5-10 km along roads and distances between fields depended on the topography and the relative importance of pigeonpea cultivation within each district. The structured roving survey was conducted during the crop season 2007-08 and 2008-09. The fields were selected randomly along survey routes. The first survey was made at pre-flowering stage and second at pod stage of the crop. FWP incidence (the percentage of wilted plant) was assessed by sampling 4m X 4m plots at 2 locations in each field for disease. Several affected plants were collected at each field site and stored in paper envelopes. The questionnaire assessed the general agronomic practices, farmers' perceptions on production constraints, variety selection, wilt disease, its causes, control and fungicide use, perceived yield loss and its management.

## RESULTS AND DISCUSSION

### Disease observation

The disease was found in 70 per cent fields of total 115 villages surveyed during 2007-08 and 74 per cent during 2008-09. *Fusarium* wilt

and sterility mosaic were regarded by farmers as the most important diseases in the regions surveyed (Table 1). All farmers interviewed were not much aware of Fusarial wilt and had experienced it in their farm. More than half of the farmers surveyed (54%) reported *Fusarium* wilt as being a serious problem on their farms (Table 1).

None of the fifteen districts surveyed had zero incidence of *Fusarium* wilt. Among the fifteen districts *viz*., Varanasi, Allahabad, Faizabad, Ambedkar nagar, Mirzapur, Ghazipur, Mau, Pratapgarh, Jaunpur, Barabanki, Gorakhpur, Basti, Sultanpur, Raibareilly and Bhadohi districts. Incidence of wilt in individual field ranged from 1 to 70% whereas overall incidence in districts ranged from 0.75 to 18.75% during 2007-08 and 1.0 to 19.50% during 2008-09 (Table-1). The disease was regarded to be a serious problem in Pratapgarh, Jaunpur, Gorakhpur and Faizabad where mostly all fields were affected with fusarial wilt in both the crop years with average incidence of 19.12, 11.75, 9.00, and 8.33% respectively. Maximum incidence (45%) was recorded in Tala village of Pratapgarh followed by Darshan nagar (42.5%) village of Faizabad, Narainpur village of Mirzapur (40%) and Jafrabad (35%) village of Jaunpur district. The incidence of the disease in 2008-09 was considerably more than during 2007-08. The pathogen was successfully recovered from all the diseased samples from various field surveyed. Among virtually all surveyed cultivars of pigeonpea, the severity of disease in the second planting was much higher than that observed in the first planting. The field which was intercropped with sorghum had considerable reduction in wilt disease severity in comparison to sole crop.

**Crop rotation and field sanitation**

The advantages of crop rotation were not clear to most farmers as nearly all farmers used to sow the same field year after year because of limited land. Most farmers grew pigeonpea in the same piece of land for up to three crops before rotating.

**Farmers' perception of the wilt importance and other constraints**

Most farmers were concerned and viewed diseases as the most serious constraint to pigeonpea production in the regions surveyed, followed by insect-pests and unavailability of proper land on their farms. All farmers had not a fair knowledge about the wilt, majority of them did not know that the disease was soil borne in nature and will appear year after year if they use the same field. Very few farmers could accurately diagnose the disease their causes and control.

**Farmers' wilt control and management practices**

The majority (70%) of the farmers used their own seed. Very few farmers (30%) obtained seed from formal sources. Farmers attributed the low use of certified seed to the high cost and low availability. The majority of the farmers expressed preference for bahar variety. Farmers apparently did not relate pest and disease resistance to yield even though they indicated that yield was the most important attribute in variety selection.

The key to efficient wilt management is using integrated programmes, which incorporates knowledge of the pathogen, cultivar resistance and edaphic factors[9]. Unfortunately very few farmers in the thirteen districts showed any elements of IDM practices. This may be due to farmers' lack of understanding of wilt biology and interaction with environment. Even though most of the farmers were unaware of wilt and their understanding about the biology of the disease.

Flowering and podding stage have been shown to be important in the development of wilt. Generally, farmers have good knowledge about objects that they can easily see like plants, soil and insects but farmers often have limited knowledge about less conspicuous things like disease pathogens. Thus, farmers rarely know the cause of plant diseases[10, 11]. Such lack of farmers' knowledge on diseases and pests emphasizes the need for education that can be helpful in identifying the principle causes of and potential management of diseases and pests.

Intercropping with sorghum produced a large reduction in wilt incidence in pigeon pea in the first year (down to 55%) and thereafter it stabilized at about 20–30%. Severity increased during the successive year due to the monoculture of the crop[12]. One possible reason for the differences in severity of Fusarium wilt among various fields may be different planting dates and the presence of wilt inoculum sources of seed and selection.

The constraints associated with the disease control, use of resistant cultivars as well as crop rotation is viewed as the most promising

**Table 1.** Occurrence and Per cent Disease Incidence (PDI) of wilt during two successive years

| S. No. | Districts | Villages | PDI(Average) (2007-08) | PDI(Average) (2008-09) | Cropping Pattern |
|---|---|---|---|---|---|
| | Mirzapur | | | | |
| 1. | | Narainpur | 32.5 | 40.0 | Solecrop |
| 2. | | Bharpura | 00.5 | 00.0 | Solecrop |
| 3. | | Gurkhulae | 00.0 | 00.0 | Mixcrop |
| 4. | | Tedia | 03.5 | 04.0 | Solecrop |
| 5. | | Dherara | 00.0 | 00.0 | Solecrop |
| 6. | | Dagmagpur | 00.0 | 00.0 | Mixcrop |
| 7. | | Umeria | 00.0 | 00.0 | Mixcrop |
| 8. | | Rampur | 06.5 | 10.0 | Solecrop |
| 9. | | Kailhat | 02.0 | 07.0 | Mixcrop |
| 10. | | Jamui | 05.5 | 07.0 | Solecrop |
| 11. | | Arjunpur | 00.0 | 00.0 | Mixcrop |
| 12. | | Sagarpur | 01.0 | 02.5 | Mixcrop |
| 13. | | Baripur | 01.0 | 01.0 | Solecrop |
| 14. | | Lalpur | 03.5 | 05.0 | Mixcrop |
| 15. | | Cheksaari | 00.0 | 01.0 | Mixcrop |
| 16. | | Basaratpur | 02.0 | 03.5 | Solecrop |
| 17. | | Persodha | 06.0 | 07.0 | Solecrop |
| 18. | | Chunar | 00.0 | 00.0 | Solecrop |
| | | Average | 03.55 | 04.88 | |
| | Varanasi | | | | |
| 19. | | Babusarai | 03.0 | 02.5 | Mixcrop |
| 20. | | Thathara | 02.0 | 03.0 | Mixcrop |
| 21. | | Rupapur | 06.5 | 04.0 | Solecrop |
| 22. | | Jagatpur | 02.5 | 03.5 | Mixcrop |
| 23. | | Dhulanpur | 03.0 | 02.0 | Mixcrop |
| 24. | | Rajatalab | 03.0 | 07.0 | Solecrop |
| 25. | | Byepass | 06.5 | 07.0 | Solecrop |
| 26. | | Chiraigaon | 00.0 | 00.0 | Mixcrop |
| 27. | | Ashapur | 00.0 | 01.0 | Solecrop |
| 28. | | Harauha | 05.0 | 05.0 | Solecrop |
| 29. | | Mirzamurad | 03.5 | 06.0 | Solecrop |
| 30. | | Cheelpur | 04.0 | 05.0 | Solecrop |
| 31. | | Lakhanpur | 00.0 | 00.0 | Mixcrop |
| 32. | | Kachawa | 02.5 | 07.5 | Mixcrop |
| | | Average | 02.96 | 03.82 | |
| | Mau | | | | |
| 33. | | Dohrighat | 06.5 | 05.5 | Solecrop |
| 34. | | Tajaepur | 05.5 | 09.0 | Solecrop |
| 35. | | Ghosi | 07.5 | 10.0 | Solecrop |
| 36. | | Rasra | 09.0 | 12.5 | Solecrop |
| 37. | | Kusumaur | 02.5 | 04.0 | Mixcrop |
| 38. | | Pipridih | 05.0 | 11.0 | Solecrop |
| 39. | | Muhmdabad | 07.5 | 10.0 | Solecrop |
| | | Average | 06.21 | 08.86 | |
| | Gorakhpur | | | | |
| 40. | | Kaudiram | 05.0 | 06.0 | Solecrop |
| 41. | | Bhujaini | 09.0 | 16.0 | Solecrop |
| 42. | | Badhalganj | 02.5 | 05.0 | Mixcrop |
| 43. | | Kaantae | 07.5 | 15.0 | Solecrop |

| | | | | | |
|---|---|---|---|---|---|
| 44. | | Gida | 07.5 | 10.0 | Solecrop |
| 45. | | Kabirnagar | 12.0 | 12.5 | Solecrop |
| | | Average | 07.25 | 10.75 | |
| | Basti | | | | |
| 46. | | Vikramjot | 03.0 | 03.5 | Mixcrop |
| 47. | | Harraiya | 02.0 | 03.0 | Solecrop |
| 48. | | Kaptanganj | 01.5 | 03.5 | Mixcrop |
| 49. | | Khalilabad | 02.5 | 02.0 | Mixcrop |
| 50. | | Katya | 09.0 | 11.0 | Solecrop |
| | | Average | 03.06 | 04.60 | |
| | Ghazipur | | | | |
| 51. | | Udiara | 05.5 | 05.0 | Solecrop |
| 52. | | Saidpur | 06.5 | 08.0 | Solecrop |
| 53. | | Parsani | 06.5 | 08.0 | Solecrop |
| 54. | | Kaithi | 06.0 | 08.0 | Solecrop |
| 55. | | Sidhauna | 05.5 | 07.0 | Solecrop |
| 56. | | Sadaat | 06.5 | 11.0 | Solecrop |
| 57. | | Markandae | 02.5 | 03.5 | Mixcrop |
| | | Average | 05.57 | 07.21 | |
| | Pratapgarh | | | | |
| 58. | | Patti | 15.0 | 11.0 | Solecrop |
| 59. | | Biharganj | 20.0 | 20.0 | Solecrop |
| 60. | | Tala | 37.5 | 45.0 | Solecrop |
| 61. | | Gadwara | 02.5 | 02.0 | Mixcrop |
| | | Average | 18.75 | 19.50 | |
| | Raibareilly | | | | |
| 62. | | Inhauna | 02.5 | 02.5 | Mixcrop |
| 63. | | Chaubisi | 03.5 | 03.0 | Solecrop |
| 64. | | Barai | 05.0 | 05.5 | Solecrop |
| 65. | | Latwa | 03.5 | 04.5 | Solecrop |
| 66. | | Mangalpur | 02.0 | 01.0 | Mixcrop |
| 67. | | Bhilwal | 06.0 | 07.5 | Solecrop |
| 68. | | Gangaganj | 04.5 | 05.0 | Solecrop |
| 69. | | Khusdahi | 04.5 | 02.5 | Mixcrop |
| 70. | | Arjunganj | 02.5 | 01.0 | Mixcrop |
| | | Average | 03.78 | 03.61 | |
| | Sultanpur | | | | |
| 71. | | Chaanda | 06.5 | 02.0 | Solecrop |
| 72. | | Lamhua | 09.0 | 07.5 | Solecrop |
| 73. | | Byepass | 04.0 | 05.0 | Solecrop |
| 74. | | Dhanpatganj | 06.0 | 08.5 | Solecrop |
| | | Average | 06.37 | 05.75 | |
| | Jaunpur | | | | |
| 75. | | Khanpur | 06.5 | 05.0 | Solecrop |
| 76. | | Kajisasai | 02.5 | 02.5 | Mixcrop |
| 77. | | Dulhanpur | 10.0 | 12.5 | Solecrop |
| 78. | | Khalispur | 06.0 | 07.5 | Solecrop |
| 79. | | Zafarabad | 30.0 | 35.0 | Solecrop |
| | | Average | 11.00 | 12.50 | |
| | Akbarpur | | | | |
| 80. | | Malipur | 03.5 | 06.0 | Solecrop |
| 81. | | Kathari | 07.5 | 11.5 | Solecrop |
| 82. | | Khetasarai | 02.5 | 03.5 | Mixcrop |
| 83. | | Bilvaharipur | 07.5 | 10.0 | Solecrop |
| 84. | | Ahirauli | 07.0 | 12.5 | Solecrop |

| | | | | | |
|---|---|---|---|---|---|
| 85. | | Chachipur | 02.5 | 05.0 | Mixcrop |
| 86. | | Gosainganj | 03.5 | 07.5 | Solecrop |
| 87. | | Gopalpur | 02.5 | 05.0 | Mixcrop |
| | | Average | 04.56 | 07.62 | |
| | Faizabad | | | | |
| 88. | | Mawai | 03.0 | 06.0 | Mixcrop |
| 89. | | Darshan nagar | 40.0 | 42.5 | Solecrop |
| 90. | | Khandasa | 02.0 | 03.0 | Mixcrop |
| 91. | | Pithala | 08.5 | 12.5 | Solecrop |
| 92. | | Rudauli | 06.0 | 05.0 | Solecrop |
| 93. | | Tatibaba | 04.5 | 06.0 | Solecrop |
| 94. | | Maholi | 02.5 | 04.0 | Mixcrop |
| 95. | | Kaantae | 04.0 | 05.0 | Solecrop |
| 96. | | Arkuna | 05.0 | 05.0 | Solecrop |
| 97. | | Sohawal | 04.0 | 06.5 | Solecrop |
| 98. | | Jaganpur | 05.5 | 08.0 | Solecrop |
| 99. | | Mumtaznagar | 05.0 | 06.5 | Mixcrop |
| | | Average | 07.50 | 09.17 | |
| | Barabanki | | | | |
| 100. | | Purae delai | 03.5 | 02.5 | Solecrop |
| 101. | | Ramsanehighat | 04.0 | 08.0 | Solecrop |
| 102. | | Dariyabad | 02.0 | 03.5 | Mixcrop |
| 103. | | Bhitariya | 09.0 | 06.5 | Solecrop |
| 104. | | Dhamapur | 00.0 | 00.0 | Mixcrop |
| 105. | | Kotwa | 02.5 | 03.5 | Mixcrop |
| | | Average | 03.50 | 04.00 | |
| | Allahabad | | | | |
| 106. | | Jhunsi | 00.0 | 00.0 | Mixcrop |
| 107. | | Haripur | 00.5 | 00.0 | Solecrop |
| 108. | | Handia | 00.0 | 00.0 | Solecrop |
| 109. | | Bhiti | 01.0 | 02.5 | Solecrop |
| 110. | | Jangiganj | 00.0 | 00.0 | Mixcrop |
| 111. | | Vikrampur | 03.0 | 03.5 | Solecrop |
| | | Average | 00.75 | 01.00 | |
| | Bhadohi | | | | |
| 112. | | Gopiganj | 01.0 | 02.5 | Solecrop |
| 113. | | Amawa | 03.5 | 03.0 | Solecrop |
| 114. | | Aurai | 00.0 | 01.0 | Solecrop |
| 115. | | Ghosia | 1.12 | 1.62 | Mixcrop |
| | | Average | 01.40 | 02.03 | |

strategy for a more reliable and sustainable way of managing wilts[13]. The results, however, suggest that farmers did not always prefer resistant cultivars. Farmers more often choose cultivars for higher productivity reasons other than resistance and different regions had specific preferences. It therefore indicates, for any variety to be accepted, it should combine resistance with other attributes, and development of varieties should be region-specific to meet the different preferences. Research on use of tolerant cultivars and adjustment of fungicide usage depending on levels of cultivar resistance need to be explored and how this could be exploited to offer attractive economic advantage to farmers for production and quality selection. Major failure of IDM programmes in developing countries has been attributed to the tendency to excessively concentrate on a particular pest or disease alone rather than on a broader spectrum of constraints including agronomic, social and economic constraints[14] and limited knowledge[15]. Integration of resistant cultivars along with fungicide schemes could be used to improve disease management while simultaneously lowering costs of production. However, in order to implement all the effective methods, farmers will

need to be trained on the various aspects of the biology and ecology of wilt pathogen. A clear understanding of the disease progression will give farmers a basis for improving some of their common cultural practices.

**Recommendations**

Keeping in view that the data presented in this report, preliminary findings and is subject to confirmation by further studies; there are some recommendations that can be made concerning the management of Fusarium wilt of pigeonpea.

1. Every effort should be made to prevent the spread of contaminated soil from known locations of *Fusarium oxysporum* f. sp. *udum* to "clean" fields by workers and equipment. These precautions should be maintained even when crops other than pigeon pea are grown in infested fields.
2. Avoid Fusarium wilt infected areas and the crop must not plant on sites known to contain the pathogen.
3. Based on the preliminary data report, one could choose a planting site where there was no previous crop of pigeonpea and select a cultivar that sustained little to no disease at the planting site.
4. For the vast majority of pigeonpea production fields where *Fusarium oxysporum* f. sp. *udum* is not known to occur, maintain vigilance to prevent the introduction of the pathogen into your fields and use your normal criteria for resistant cultivar and intercropping with sorghum crop.

The development of an affordable management scheme for *Fusarium* wilt in pigeon pea is needed.

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## REFERENCES

1. Anonymous. Directorate of Economics and Statistics, *Department of Agriculture and Statistics*, 2011.
2. Reddy, M. V., Nene, Y. L., Kannaiyan, J., Pigeon pea lines resistant to wilt in Kenya and Malawi. *Int. Pigeon pea Newsl*, 1990; **12**: 25-26.
3. Trutman, P., Voss, J., Fairhead, J. Local knowledge and farmer perception of bean diseases in the Central African Highlands. *Agriculture and Human Values*, 1996; **13**: 64 – 70.
4. Nene, Y. L. (ed): A world list of pigeonpea and chickpea pathogens. ICRISAT Pulse Pathology Progress report 8 Patancheru , A.P. India, 1980.
5. Chaudhary, R.G., Kumar, K., Prajapati, R.K., Gangwar, R.K. Seed borne nature of infection of *F.Udum* in pigeonpea and its location. *Farm Science Journal*, 2003; **12**(2): 141-142.
6. Reddy, N. P. E., Basu Chaudhary, K. C. Variation in *Fusarium udum*. *Indian Phytopathology*, 1985; **38**: 172-173.
7. Gaur, V. K., Sharma, L.C. Variability in single spore isolates of *Fusarium udum*. *Mycopatholgy*, 1989; **107**: 9-15.
8. Reddy, M. V., Raju, T. N. Pathogenic variability in pigeonpea wilt pathogen *Fusarium udum* in Murlidharan, K. and Reddy, C. S. *Plant disease problems in central India*, 1993; 32-34.
9. Fry, W. E., Shtienberg, D. Integration of host resistance and fungicide to manage potato diseases. *Canadian Journal of Plant Pathology*, 1990; **12**: 111-116.
10. Bentley, J. W. The epistemology of plant protection: Honduras campesinos knowledge of pests and natural enemies. In R. W. Gibson and A. Sweetmore (eds). Proceedings of a Seminar on Crop Protection for Resource-Poor Farmers. Chatham: CTA/NRI, 1992; 107 – 118.
11. Bentley, J. W. What farmers don't know? *Ceres*, 1993; **141**: 42-45.
12. Natarajan, M., Kannaiyan, J., Willey, R. W., Nene, Y. L. Studies on the effects of cropping system on fusarium wilt of pigeonpea. *Field Crops Research*, 1985; **10**: 333-346.
13. Wang, J. F., Ling, C. H. Integrated Management of Tomato bacterial Wilt. 2005; 7-10.
14. Zelazany, B., Chiarappa, L., Kenmore, P. Integrated pest management in developing countries. FAO *Plant Protection Bulletin*, 1985; **33**: 147-158.
15. Nathaniels, N. Q. R., Sijaona, M. E. R., Shoo, J. A. E., Katinila, N. IPM for control of cashew powdery mildew in Tanzania. 1: Farmers' crop protection practices, perceptions and sources of information. *Int. J.Pest Man.*, 2003; **49**: 25-36.