Asian Journal of Plant Sciences

ISSN 1682-3974

Asian Journal of Plant Sciences 2 (12): 932-935, 2003
ISSN 1682-3974

Antixenosis to the Peach-potato Aphid, *Myzus persicae* (Sulzer) in Potato Cultivars

A.U.R. Saljoqi, [1]H.F. van Emden and [2]He Yu-rong
Department of Plant protection, NWFP Agricultural University, Peshawar, Pakistan
[1]Department of Horticulture, School of Plant Sciences, University of Reading,
Whiteknights P.O. Box 221, Reading, RG6 6AS, England, United Kingdom
[2]Department of Entomology, South China Agricultural University, Guangzhou, 510642, China

Abstract: Field studies were conducted to determine the antixenotic resistance against the peach-potato aphid, *Myzus persicae* (Sulzer) in different potato cultivars i.e. Cardinal, Ultimus and Desiree. These cultivars were studied in the paired tests as Cardinal vs. Desiree and Cardinal vs. Desiree for antixenosis (systemic insecticide-based test). In Desiree vs. Ultimus, no significant difference was found for the preference of *M. persicae*, while in case of Cardinal vs. Desiree, there was a significant preference for Desiree. Cardinal clearly showed antixenosis to *M. persicae*.

Key words: *Myzus persicae*, antixenosis, plant resistance, potato cultivars

Introduction

Potato has emerged as an important cash crop and one of the leading vegetables in Pakistan, with an average total production of 1, 105, 000 tons potato tubers. Due to various soil and environmental conditions, three crops of potato are grown in Pakistan. Autumn and spring crops are grown in plain areas, while summer crop in hilly areas. The per hectare national yield is only about 10.5 tons, which is very low compared to the world average (16.1 tons) (Anonymous, 2000).

In Pakistan potato is attacked by a number of insect pests: aphids, cutworms, slugs, free living nematodes, wireworms, Colorado beetle, capsid bugs, leafhoppers and potato tuber moth (Zanoni, 1991). Of these aphids and especially *Myzus persicae* (Sulzer) is the most important (Shah, 1988). They cause damage by extraction of plant sap, injection of toxic secretions while feeding, transmission of viral diseases and excretion of honeydew, which fouls the plant and encourages the growth of moulds. The most important problem is usually their role as vectors of several viruses, which, although seldom lethal, reduce plant vigour and yield potential of seed tubers (Hille Ris Lambers, 1972; Hooker, 1981; Radcliffe *et al.*, 1993). Potato leaf roll virus (PLRV) and potato virus Y (PVY) are the most important of these viruses limiting potato yield and quality (Banttari *et al.*, 1993). Heavy infestation of this aphid can cause considerable damage to the potato crop by severely dwarfing and curling the leaflets and by dwarfing and spindling the tops. In extreme cases, the whole plant may be killed (Painter, 1951).

Aphid-resistant potato cultivars can be an effective means of controlling aphids and restricting virus spread within the crop (Adams, 1946; Gibson, 1974). Antixenosis is one of the important mechanisms of plant resistance to aphids (Ellsbury *et al.*, 1985; Holt and Wratten, 1986). In integrated pest management (IPM), other control methods are practiced along with resistant varieties. Such other methods include the use of insecticides, different cultural practices and biological control. The activities of natural enemies may be greater on resistant than on susceptible varieties (Gowling, 1989).

In a pot experiment outdoors, three potato cultivars (Desiree was chosen the susceptible comparison with Cardinal and Ultimus as the resistant varieties in antibiotic terms) were selected from the eight potato cultivars which were screened for their relative antibiosis in the field to *M. persicae* (Saljoqi, 1999), to see whether the antibiotic resistance in these cultivars towards *M. persicae* was reflected by antixenosis.

Materials and Methods

Plant materials: Each antibiotic cultivar (Cardinal and Ultimus) was compared separately with Desiree.

***M. persicae* culture:** Aphids were collected from the potato plants in the field of Agricultural Research Farm of NWFP Agricultural University, Peshawar, Pakistan, when the infestation started. The culture was maintained at a photoperiod of 14:10 h (light:dark) regime. The minimum temperature fluctuated between 16-21.5°C while the maximum temperature ranged between 23-46.5 °C. Cultures were maintained in muslin cages and Perspex cages, each containing two pots. One pot, containing the oldest plants, was removed at weekly intervals and replaced with a new one. The frequent replacement of pots of seedlings was to avoid overcrowding of the aphids. Care was also taken to keep the stock of *M. persicae* free from other aphid species, parasitoids and predators. *M. persicae* was moved from plant to plant with a fine brush which was wetted with distilled water. To avoid damage to the aphids, care was taken to make sure the styles were withdrawn before the aphids were removed. Sometimes a leaf with a healthy population was placed on the leaves of the new plants. When dried, this leaf portion was removed from the cage, the aphids having moved from it to the new leaves to start new colonies.

Pirimicarb: Pirimicarb is a strong pyrimidine carbamate insecticide, with strong aphicidal properties. It can be systemic and also has excellent contact, fumigant and translaminar activity. Pirimicarb is applied in the field as foliar sprays and also as a soil drench. When applied as a soil drench, it is taken up by the roots and moves apoplastically through the plant (Worthing, 1987).

Cages for the antixenosis test: Large clip cages (35 mm diam. and 5 mm high) were used.

Pots and planting medium: 24 cm inner diam. earthen pots were used for growing the plants. Each pot was thoroughly cleaned and dried before filling it with the potting medium. John Innes No. 2 compost was used as the planting medium.

The antixenosis test: Three potato cultivars, i.e. Cardinal, Ultimus and Desiree had been selected for antixenosis tests. Desiree had been selected as the most aphid susceptible cultivar, while Cardinal and Ultimus both showed some aphid resistance in terms of antibiosis. A novel technique (systemic insecticide-based test) (van Emden *et al.*, 1991), was used for this study. Cardinal and Ultimus were each paired separately with Desiree. Sixteen replicates for each pairing treatment were made. Half the pots of each cultivar were treated with 55 ml pot^{-1} of pirimicarb (500 gm kg pot^{-1}), applied as a soil drench at the recommended dose of 0.5 g litre pot^{-1}. Twenty four hours after application, by which time the insecticides would have been mobilized to the leaves, twenty aphids were caged in each of the larger clip cages. A pot of Cardinal or Ultimus was then paired with a pot of Desiree. A leaf from an insecticide treated plant of one cultivar was always paired with an untreated leaf of the other and an equal number of replicates of each of the cultivars in the comparison received pirimicarb. The clip cages were set up so that each covered an equal area of both paired leaves. The aphids were thus allowed to choose between the two cultivars. Forty-eight hours after caging, the cages were opened and mortality was recorded with the assumption that the dead aphids had selected treated leaves and had reached the phloem. As each trial involved equal numbers of treated and untreated plants of the two plant types being compared, it was possible to allow for any repellence or attraction from the insecticides in the statistical analysis (van Emden *et al.*, 1991). The results obtained were analyzed by a chi-square (X^2) test, in which expected values are based on the total numbers dead on each cultivar (van Emden *et al.*, 1991). A statistically significant chi-square for choice ($X^2_{1\,d.f.}$) was only accepted if the heterogeneity between replications ($X^2_{n-1\,d.f.}$) was not significant.

Results

Desiree vs cardinal: The results are presented in Table 1 and the statistically analysis presented in Table 2. More *M. persicae* settled on Desiree (55.94%) than on Cardinal (44.06%). This preference was statistically significant ($P<0.05$). A non significant heterogeneity X^2 validated the results.

Desiree vs ultimus: The results of the experiment are shown in Table 3 and the statistical analysis shown in Table 4. The experiment indicates that *M. persicae* again showed an overall slight numerical preference for Desiree (50.94%), this time compared with Ultimus (49.06%). Although the analysis showed non-significant heterogeneity between the replicates, this small difference of preference was not statistically significant ($P>0.05$).

Discussion

In Desiree vs. Ultimus, no significant difference was found for the preference of *M. persicae*, while in case of Cardinal vs. Desiree, there was a significant preference for Desiree. Cardinal clearly showed antixenosis to *M. persicae*. van Emden *et al.* (1991) developed this systemic insecticide-based test for wheat varieties and concluded that the use of systemic aphicide provides a simple and practical way of assessing the relative antixenosis to aphids on two host plants and that the experimental design described carries the necessary safeguards against any interaction between variety and treatment with aphicide. They preferred this method over many other techniques, not only because of simplicity, but also because it quantified the end product of all stages of the host selection process.

There are some possible reasons for the antixenosis of Cardinal towards *M. persicae*, though they have not been investigated here. Plants exhibiting antixenosis may produce olfactory repellents which cause insects to move away from the plants (Dethier *et al.*, 1960; Picket *et al.*, 1982; Picket, 1988; Picket *et al.*, 1992). However, repellents may not always be olfactory, because it could also be the

Table 1: Chi-square analysis for antixenosis to *Myzus persicae* (Sulzer)

Replicates		Desiree		Cardinal	
Treated cultivar in brackets		Observed values	Expected value	Observed value	Expected value
1	(Cardinal)	11 alive	9.56	9 dead	10.44
2	(Cardinal)	10 alive	9.56	10 dead	10.44
3	(Cardinal)	12 alive	9.56	8 dead	10.445
4	(Cardinal)	11 alive	9.56	9 dead	10.44
5	(Cardinal)	11 alive	9.56	9 dead	10.44
6	(Cardinal)	11 alive	9.56	9 dead	10.44
7	(Cardinal)	10 alive	9.56	10 dead	10.44
8	(Cardinal)	10 alive	9.56	10 dead	10.44
9	(Desiree)	13 dead	10.44	7 alive	9.56
10	(Desiree)	11 dead	10.44	9 alive	9.56
11	(Desiree)	14 dead	10.44	6 alive	9.56
12	(Desiree)	12 dead	10.44	8 alive	9.56
13	(Desiree)	8 dead	10.44	12 alive	9.56
14	(Desiree)	6 dead	10.44	14 alive	9.56
15	(Desiree)	14 dead	10.44	6 alive	9.56
16	(Desiree)	15 dead	10.44	5 alive	9.56
Total		179	160	141	160
Total alive = 153		Total dead = 167			

Table 2: Chi-square analysis table

Chi for effect on choice (1 d.f)	4.512*
Chi for heterogeneity between replicates (15 d.f)	14.711ns
Total chi for 16 d.f	19.224

* = significant at P<0.05 ns = not significant (P>0.05)

Table 3: Chi-square analysis for antixenosis to *Myzus persicae* (Sulzer)

Replicates		Desiree		Ultimus	
Treated cultivar in brackets		Observed values	Expected value	Observed value	Expected value
1	(Desiree)	11 dead	9.56	9 alive	10.44
2	(Desiree)	8 dead	9.56	12 alive	10.44
3	(Desiree)	12 dead	9.56	8 alive	10.44
4	(Desiree)	9 dead	9.56	11 alive	10.44
5	(Desiree)	10 dead	9.56	10 alive	10.44
6	(Desiree)	11 dead	9.56	9 alive	10.44
7	(Desiree)	8 dead	9.56	12 alive	10.44
8	(Desiree)	9 dead	9.56	11 alive	10.44
9	(Ultimus)	11 alive	10.44	9 dead	9.56
10	(Ultimus)	10 alive	10.44	10 dead	9.56
11	(Ultimus)	9 alive	10.44	11 dead	9.56
12	(Ultimus)	12 alive	10.44	8 dead	9.56
13	(Ultimus)	12 alive	10.44	8 dead	9.56
14	(Ultimus)	11 alive	10.44	9 dead	9.56
15	(Ultimus)	9 alive	10.44	11 dead	9.56
16	(Ultimus)	11 alive	10.44	9 dead	9.56
Total		163	160	157	160
Total alive = 167		Total dead = 153			

Table 4: Chi-square analysis table

Chi for effect of treatment on choice (1 d.f)	0.112ns
Chi for heterogeneity between replicates (15 d.f)	5.084ns
Total Chi for 16 d.f	5.197

ns = not significant (P>0.05)

plant juices tasted by the aphids that may cause repellence. Several types of plant morphological defenses are employed by plants to deter insect feeding and oviposition, such as leaf surface hairs, foliar striations and toughness and structure of the cuticle (Smith, 1989).

So from these findings, Cardinal was selected as antixenotic. It was also selected as partially antibiotic among eight potato cultivars in a field experiment by Saljoqi (1999). Ultimus showed no significant anitixenosis. These descriptions relate to comparison with Desiree, which proved the most susceptible cultivar in the field trial (Saljoqi, 1999). Desiree was also the most susceptible cultivar amongst different selections of potato cultivars screened by Bintcliffe and Wratten (1982) and Nderitu and Mueke (1986).

Acknowledgments

The financial assistance given by the World Bank assisted Agricultural Research Project-II is gratefully acknowledged.

References

Anonymous, 2000. Agricultural Statistics of Pakistan. Ministry of Food and Agriculture and Cooperative, Economic Wing, Government of Pakistan, Islamabad, Pakistan, pp: 290.

Adams, J.B., 1946. Aphid resistance in potatoes. American Potato J., 23, 1-22.

Banttari, E.E., P.J. Ellis and S.M.P. Khurana, 1993. Management of diseases caused by viruses and virus like pathogens. In : R.C. Rowe (Ed.). Potato Helth. Manage. APS Press, St. Paul, pp: 127-133.

Bintcliffe, E.J.B. and S.D. Wratten., 1982. Antibiotic resistance in potato cultivars to the aphid *Myzus persicae*. Ann. Applied Biol., 100: 383-393.

Dethier, V.G., L. Barton-Browne and G.N. Smith, 1960. The designation of chemicals in terms of the responses they elicit from insects. J. Eco. Entomol., 53: 134-136.

Ellsbury, M.M., R.G. Pratt and W.E. Knight, 1985. Effects of single and combined infection of narrow leaf cover with bean yellow mosaic virus and *Phytophthora* sp. on reproduction and colonization by pea aphids (Homoptera: Aphididae). Environ. Entomol., 4: 356-359.

Gibson, R.W., 1974. The induction of toproll symptoms on potato plants by potato aphids, *Macrosiphum euphorbiae* Thomas. Ann. Applied Biol., 76: 19-26.

Gowling, G.R., 1989. Field and Glasshouse studies of aphids on the interaction of partial plant resistance and biological control. Ph.D thesis, University of Reading.

Hille Ris Lambers, D., 1972. Aphids: their life cycles and role as virus vectors. In : J.A. de Bokx (Ed.). Viruses of Potatoes and Seed Potato Production. Int. Agril. Centre, Wagningen, pp: 36-56.

Holt, J. and S.D. Wratten, 1986. Components of resistance to *Aphis fabae* in faba bean cultivars. *Entomologia Experimentalis et Applicata*, 40: 35-40.

Hooker, W. J., 1981. Compendium of Potato Disease. The American Phytopathological Soc., St. Paul., pp: 125.

Nderitu, J.H. and J.M. Mueke, 1986. Aphid infestation on eight potato cultivars (*Solanum tuberosum* L.) in Kenya. Insect Science and its Application, 7: 677-682.

Painter, R.H., 1951. Insect Resistance in Crop Plants. McMillan, New York, pp: 520.

Picket, J.A., 1988. The future of semiochemicals in pest management. Aspects of Applied Biol., 17: 19-21.

Picket, J.A., G.W. Dawson., R.W. Gibson., D.C. Griffiths., A.D. Rice., R.M. Sawicki, M.C. Smith and C.M. Wood, 1982. The controlling aphid behaviour. Les Mediateures Chimiques against Sur Le Comportment des Insects, pp: 243-252.

Picket, J.A., L.J. Wadham., C.M. Woodcock and J. Hardie, 1992. The chemical ecology of aphids. Ann. Rev. Entomol., 37: 67-90.

Radcliffe, E.B., D.W. Ragsdale and K.L. Flanders, 1993. Management of aphids and leafhoppers. In: R.C. Rowe (Ed.). Potato Helth. Manage. APS Press, St. Paul, pp: 117-126.

Saljoqi, A.U.R., 1999. Integrated management of Potato Aphid, *Myzus persicae* (Sulzer) in Pakistan. Ph. D thesis, University of Reading, England, U.K.

Shah, S.Q., 1988. Taxonomic studies of aphids of the summer vegetables in Peshawar region. M.Sc. thesis, NWFP Agricultural University, Peshawar.

Smith, C.M. (Ed.), 1989. Use of plant resistance in insect pest management systems. Plant Resistance to Insects, John Wily, USA, pp: 243-269.

Van Emden, H.F., P. Vidyasagar and M.H. Kazemi, 1991. Use of systemic insecticides to measure antixenosis to aphids in plant choice experiments. *Entomologia Experimentalis et Applicata*, 58: 69-74.

Worthing, C.R. (Ed.), 1987. The Pesticide Manual; A World Compendium. Lavenham Press, Suffolk, pp: 1081.

Zanoni, U. (Ed.), 1991. Potato Atlas and Compendium of Pakistan. Pakistan Agri. Res. Council, Islamabad Pakistan, pp: 258.