CFPA	SAAPPA / SASPA / SAT	DFTS	Winetech
Canning Fruit Producers' Assoc. Submit to: Wiehahn Victor Tel: +27 (0)21 872 1501 inmaak@mweb.co.za	Fruitgro Science Submit to: Louise Liebenberg Tel: +27 (0)21 882 8470/1 louise@fruitgro.co.za	Dried Fruit Technical Services Submit to: Dappie Smit Tel: +27 (0)21 870 2900 dappies@dtd.co.za	Submit to: Jan Booysen Tel: +27 (0)21 807 3324 booysenj@winetech.co.za

	x		x

Indicate (X) client(s) to whom this final report is submitted.
Replace any of these with other relevant clients if required.

FINAL REPORT
FOR 2011

PROGRAMME & PROJECT LEADER INFORMATION

	Programme leader	Project leader
Title, initials, surname	Prof. M.J. Samways	Dr Pia Addison
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PROJECT INFORMATION

Project number	US E PA 02
Project title	Scoping study to investigate the effect of mulches on insect communities in pome fruit and vines.
Project Keywords	

Industry programme	**CFPA**	
	Deciduous	
	DFTS	
	Winetech	
	Other	

Fruit kind(s)	Pome fruit and vines
Start date (dd/mm/yyyy)	01 January 2010
End date (dd/mm/yyyy)	31 December 2010

FINAL REPORT

(Completion of points 1-5 is compulsory)

1. Executive summary

Give an executive summary of the *total* project in no more than 250 words

The effects of mulches on arthropod assemblages in fruit orchards is not well documented. The aim of this project is to do initial scoping to establish the most effective research direction for a trial investigating mulches from an entomological perspective. Regardless of the crop, some general recommendations can be made for future research, based on some preliminary sampling in orchard and vineyards:

- Use of pitfall traps, sticky traps, pheromone traps and visual observations important
- Sample entire arthropod assemblage, including Springtails; possibly include earthworms and centipedes as well.
- Sampling over at least two seasons to determine effects over seasonal and annual climate. Longer term sampling will also reflect changes in the arthropod community over time.
- Use of mealybugs, their parasitoids and ants as a surrogate example to answer more complex questions of effects of mulches on tri-trophic interactions in vineyards.

2. Problem identification and objectives

State the problem being addressed and the ultimate aim of the project.

The benefits of the use of mulches in orchards and vineyards are well documented. However, the effects of these on insect communities remain largely un-researched. The increasing use of mulches in the South African fruit and wine industry requires that the effects of such practices on insect communities within orchards and vineyards be investigated. The ultimate aim of this project is to do initial scoping to establish the most effective research direction for a trial investigating mulches from an entomological perspective. It is envisaged that the second stage of this project would investigate the effects of mulches in a multidisciplinary trial environment.

3. Workplan (materials & methods)

List trial sites, treatments, experimental layout and statistical detail, sampling detail, cold storage and examination stages and parameters.

1. In depth literature review of the effects of composting and mulching on insect communities in all crops. This will form part of an honours assignment.
2. Gather and collate information on current composting and mulching practices in South African orchards and vineyards. This will involve discussions with growers and technical advisers in the field.
3. Collect field data (monitoring data from producers (from a variety of orchards and vineyards currently being treated with mulches and composts. Collate and analyse data.
4. Preliminary sampling took place from March - June 2010 (every second week) in five different vineyards: Spier, Uitzicht, Heron Ridge, Vrede & Lust, and Backsberg. In each of the five vineyards one plot with mulch and one plot without (control) were selected. Plots were about one hectare in size. Complete monitoring included 15 ml pitfall traps placed in each of 20 plots per site. All arthropod biodiversity was sampled and identified to family level. Pitfall traps are the most widely-used sampling method for arthropods active on the soil surface (Woodcock 1997).
5. Consult and coordinate research with other researchers involved in investigating the effects of composing and mulching in the local fruit and wine industries. If possible establish a research forum to coordinate multi-disciplinary research associated with mulching and composting.
6. Draw up future research programme (new project motivation if found to be feasible).

4. Results and discussion

State results obtained and list any benefits to the industry. Include a short discussion if applicable to your results. This final discussion must cover ALL accumulated results from the start of the project, but please limit it to *essential* information.

Milestone	Achievement
1. Survey of locally available mulch materials and mulching methods (July 2010)	Straw, compost (e.g. grape pomace), woodchips and plastic sheeting.
2. Small scale preliminary monitoring	Completed over a two month period during May-June 2011.
3. Framework of local requirements (December 2010)	The Soil Science Department at ARC Infruitec-Nietvoorbij and Viticulture Department at Stellenbosch University are interested in participating in join planning for a mulch trial in future. Due to plot size requirements, Entomology would determine suitable trial sites, in collaboration with above Departments. Other factors that could be monitored include: Topsoil (0-5 cm) carbon content, environmental conditions (temperature, moisture/humidity) and biological composition at the soil-mulch interface.
4. Discussion on suitable experimental methods/designs (December 2010)	Standard monitoring system for vineyards, as described by de Villiers & Pringle (2008), using multivariate analysis, such as Cluster analysis or Correspondance Analysis, to analyze data. Use of traps discussed.
5. Determination of target insect pests and beneficials (December 2010)	

Mulching in general is not an uninvestigated topic and several authors have written about the influence of mulching on insect communities in agriculture. Representative is the work of Thomson and Hoffman (2007), which compares the influence of straw and compost ground cover on natural enemies and soil macro invertebrates in vineyards in Gruyere, Australia. Although no superiority of one of the mulches was found, natural enemies caught in pitfall traps increased in both cases, compared to no mulch. However, no published entomological research is done on vineyards in South Africa.

Different types of mulching can be applied. Most commonly used in the Western Cape are straw, compost and woodchips (personal communication with extension officers and producers). Cover crops are also used widely, but are not considered as mulch for this project, since living mulches have different functions in the soil system. In our trial sites, all of the above mulches were tested. On 'Uitzicht' two different mulching materials and a control plot were monitored (making three plots in total) (Table 1). All control plots were weed free and relatively clean at the time of sampling.

Table 1. Description of mulches applied at each site (vineyard) from March to June 2010.

FARM	MULCH
Backsberg (BM)	Woodchips (2011), placed on towards end of monitoring
Heron Ridge (HM)	Woodchips (2008)

Uitzicht (HM)	Woodchips (2011)
Uitzicht (HMT)	Compost (mostly grape pomace), new dense layer
Vrede & Lust (VM)	Old straw layer, many clear patches of soil in between

Vineyard monitoring using pitfall traps

A total of forty different families of insect and springtail were found in pitfall traps over 9 sites. A list of insects and springtails can be found in Table 2. There was a greater diversity of insects in the mulch trials than in the no mulch sites when data were combined. More pest insects were found in the no mulch sites than in the mulched sites.

Fig. 1 shows insect abundance in mulch versus no mulch (control) sites. Springtails (Arthropleona and Symphypleona) and ants are separated from the other insect families due to the difference in scale of abundance. Dung beetles were surprisingly high in control plots, but this was due to a single occurrence on one farm (Uitzicht) and may therefore not be a true reflection of the situation. It should be noted that Uitzicht generally had a high diversity of insects, probably due to their vineyard management practices (organic/biodynamic). Average number of insects overall (excluding springtails and ants) for control and mulch plots were very similar (1.5 and 1.6, respectively), while numbers of springtails was much higher in control than mulch sites, with a similar situation for ants, although not as pronounced. Both these taxa are ground dwelling and a possible explanation could be that mulches inhibit movement of these groups, and therefore could restrict samples caught in the pitfall traps (Thomson and Hoffmann, 2007). Springtails are common prey for many predators and this trend could also reflect a greater abundance of predators (notably earwigs and assassin bugs) in the mulch plots, therefore the reduced numbers of Springtails there. Members in the family Scelionidae are egg parasitoids which have previously also been documented as being increased in abundance in mulch plots. The family Encyrtidae (mealybug parastioids) were also represented in pitfall traps, although numbers were very low and therefore no clear trend could be detected. More encyrtids were found in mulch sites than in control sites, which was also found in a previous study (Thomson and Hoffmann, 2007).

The mean number of insects found per site are shown in fig. 2. Heron Ridge had the highest number in the control site, but almost the lowest in the mulch site. The high number in the control site can be ascribed to an even distribution of springtails throughout the vineyard, which were not found in the mulch site. Variation (± SE) of these means were very high (now shown here), which does reflect that certain groups of insects are often responsible for trends seen, and not necessarily that all insects are in high abundance in these sites. Results of the cluster analysis is shown in fig. 3. Cluster analysis organizes data into meaningful structures, with linkage distances determining similarity between groups. According to this analysis, therefore, the mulch sites are indeed grouped together, showing a high degree of similarity based on the arthropod diversity from pitfall traps.

DISCUSSION AND CONCLUSION

This study was a preliminary investigation into differences in arthropod diversity in mulch and no mulch vineyards. Pitfall traps were found to be very useful in determining species diversity in these sites, and highlighting differences between sites. However, it is recommended that additional sampling methods also be incorporated, in particular for parasitic wasps, such as sticky traps and arboreal sampling. Sampling the entire arthropod diversity was found to be vital to explain potential effect of mulches, as the factors affecting the arthropod assemblage is not only climatic, but also biotic in nature. In other words, predatory interactions, for example, play a large role in determining species composition. This was also found by Gaigher (2008), working in South African vineyards, and Thomson & Hoffmann (2007), working in Australian vineyards. It was further recommended by the latter authors that a predatory/prey interaction would be immensely useful in explaining the ultimate value of mulches. We therefore recommend that more appropriate sampling techniques which would incorporate vine mealybug/ mealybug parasitoids and ants be used, such as pheromone traps and direct stem observations, in addition to pitfall traps. This interaction would be a good surrogate example to highlight the effects that mulches could have, with economic considerations. No major pest differences were found in this study (pitfall traps were not suitable for sampling mealybugs in this trial, although above ground observations also did not show high numbers), with mostly aphids and leafhoppers being potential pest species in wine grape vineyards and these being more predominant in control plots. Thomson and Hoffmann (2007) found no differences in pest species in mulch versus no mulch treatments, but increase in natural enemies was found in mulches. Gaigher (2008), who compared conventional, integrated vineyards with organic vineyards found an increase in general arthropod diversity in organic vineyards.

Our study, as a preliminary investigation, could well agree with these findings, but a study over at least two seasons would result in much more concrete data, as seasonal influences, and therefore climate variation, was not sampled here. Climate would influence the effect that a mulch has on the microclimate of a cropping system. Our study is therefore a good baseline, which can be used to plan a full scale trial in future.

SUMMARY OF RECOMMENDATIONS FOR FUTURE MULCH TRIALS

- Use of pitfall traps, sticky traps, pheromone traps and visual observations important
- Sample entire arthropod assemblage, including Springtails; possibly include earthworms and centipedes as well.
- Sampling over at least two seasons to determine effects over seasonal and annual climate. Longer term sampling will also reflect changes in the arthropod community over time.
- Use of mealybugs, their parasitoids and ants as a surrogate example to answer more complex questions of effects of mulches on tri-trophic interactions.

REFERENCES

Woodcock, B.A. 1997. Pitfall trapping in ecological studies. In: S. Leather (ed.). Insect sampling techniques in forest ecosystems, Chapter 3, Blackwell Publishing, Oxford.

Gaigher, R. 2008. The effect of different vineyard management systems on the epigaiec arthropod assemblages, in the Cape Floristic Region, South Africa. MSc thesis, Stellenbosch University.

Thomson, L.J. and Hoffmann, A.A. 2007. Effects of ground cover (straw and compost) on the abundance of natural enemies and soil macro invertebrates in vineyards. *Agricultural and Forest Entomology* 9: 173 – 179.

Table 2. List of families/suborders caught in pitfall traps in vineyards with and without mulches from March – June 2010. Description of predominantly preferred food type in brackets: V = vegetarian; P = predatory; O = omnivorous. Generally acknowledged pest insects are indicated in bold.

MULCH		**NO MULCH**	
Arthropleona	Elongate springtails (V)	Arthropleona	Elongate springtails (V)
Symphypleona	Globular springtails (V)	Symphypleona	Globular springtails (V)
Acrididae	**Grasshoppers** (V)	Acrididae	**Grasshoppers** (V)
Aphididae	**Aphids** (V)	Anthocoridae	Pirate bugs (P)
Apidae	Honey bees (V)	Aphididae	**Aphids** (V)
Bostrychidae	Borer beetles (V)	Asilidae	Robber flies (P)
Carabidae	Ground beetles (P)	Bostrychidae	Borer beetles (V)
Cecidomyidae	Gall midges (V)	Calliphoridae	Blow flies (O)
Curculionidae	**Snout beetles** (V)	Carabidae	Ground beetles (P)
Drosophilidae	Vinegar flies (V)	Chrysomelidae	**Leaf beetles** (V)
Encyrtidae	Parasitic wasps (P)	Cicadellidae	**Leafhoppers** (V)
Formicidae	**Ants** (O)	Curculionidae	**Snout beetles** (V)
Forficulidae	Common earwigs (O)	Encyrtidae	Parasitic wasps (P)
Gryllidae	Crickets (O)	Flatidae	Moth bugs (V)
Labiduridae	Long-horned earwigs (O)	Forficulidae	Common earwigs (O)
Meloidae	CMR beetles (P)	Formicidae	**Ants** (O)
Muscidae	House flies (V)	Gryllidae	Crickets (O)
Myrmeliontidae	Antlions (P)	Lepismatidae	Silverfish (O)
Nitidulidae	Nitidulids (O)	Muscidae	House flies (V)
Pentatomidae	Stink bugs (V)	Pentatomidae	Stink bugs (V)
Phoridae	Coffin flies (O)	Phoridae	Coffin flies (O)
Psocoptera	Booklice (V)	Pyrrhocoridae	Cotton stainers (V)
Pteromalidae	Pteromalids (P)	Reduviidae	Assassin bugs (P)
Pyrrhocoridae	Cotton stainers (V)	Scarabaeidae	Dung beetles (V)
Reduviidae	Assassin bugs (P)	Scelionidae	Parasitic wasps (P)
Scarabaeidae	Dung beetles (V)	Tenebrionidae	Darkling beetles (O)
Scelionidae	Parasitic wasps (P)	Tephritidae	**Fruit flies** (V)
Sciaridae	Fungus gnats (V)	Tettigoniidae	**Grasshoppers** (O)
Staphylinidae	Rove beetles (P)		
Tenebrionidae	Darkling beetles (O)		
Tephritidae	**Fruit flies** (V)		
Tettigoniidae	**Grasshoppers** (O)		

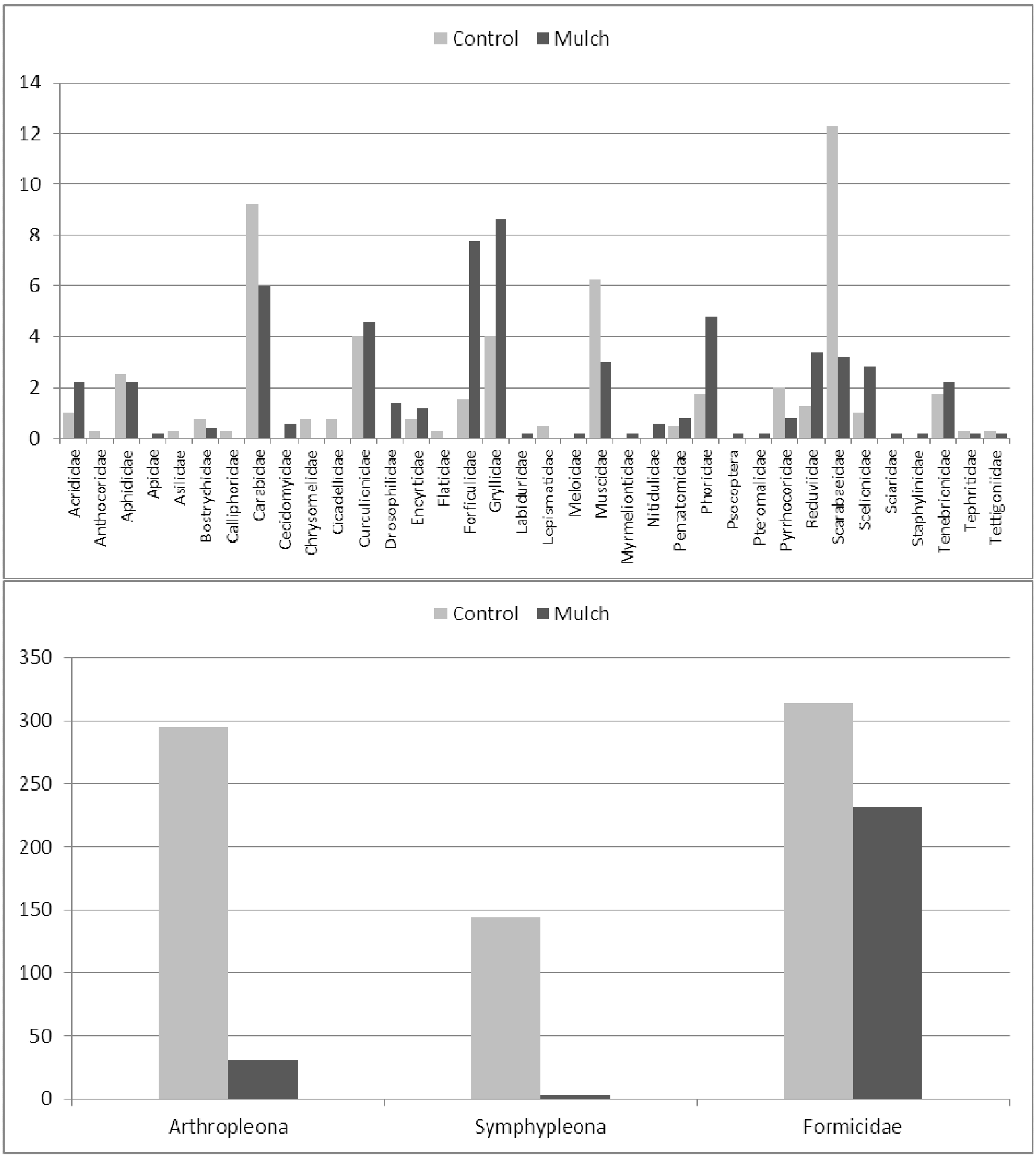

Fig. 1. Average number of insects found in control (no mulch) and mulch sites (vineyards) during March – June 2010 using pitfall traps.

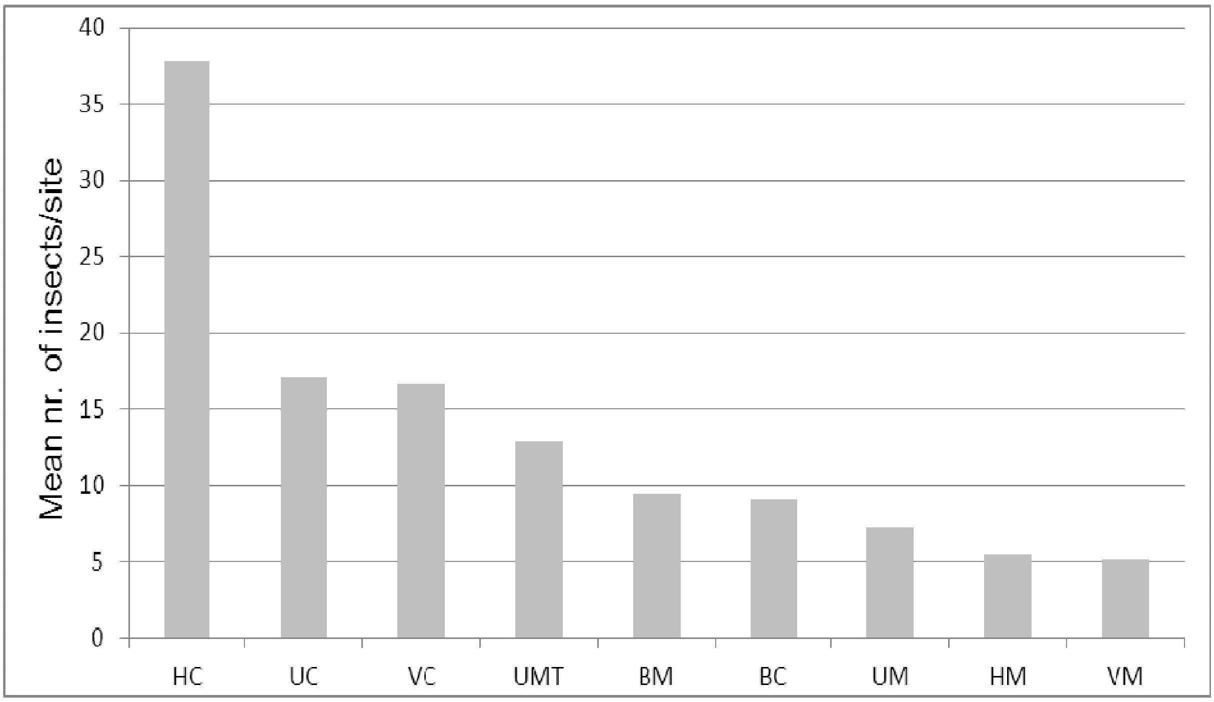

Fig. 2. Mean number of insects per site found in mulch and control (no mulch) sites (vineyards) during March-June 2010. Vineyards: H = Heron Ridge; V = Vrede & Lust; U = Uitzicht; B = Backsberg. Treatments: C = control (no mulch); M and MT = mulch.

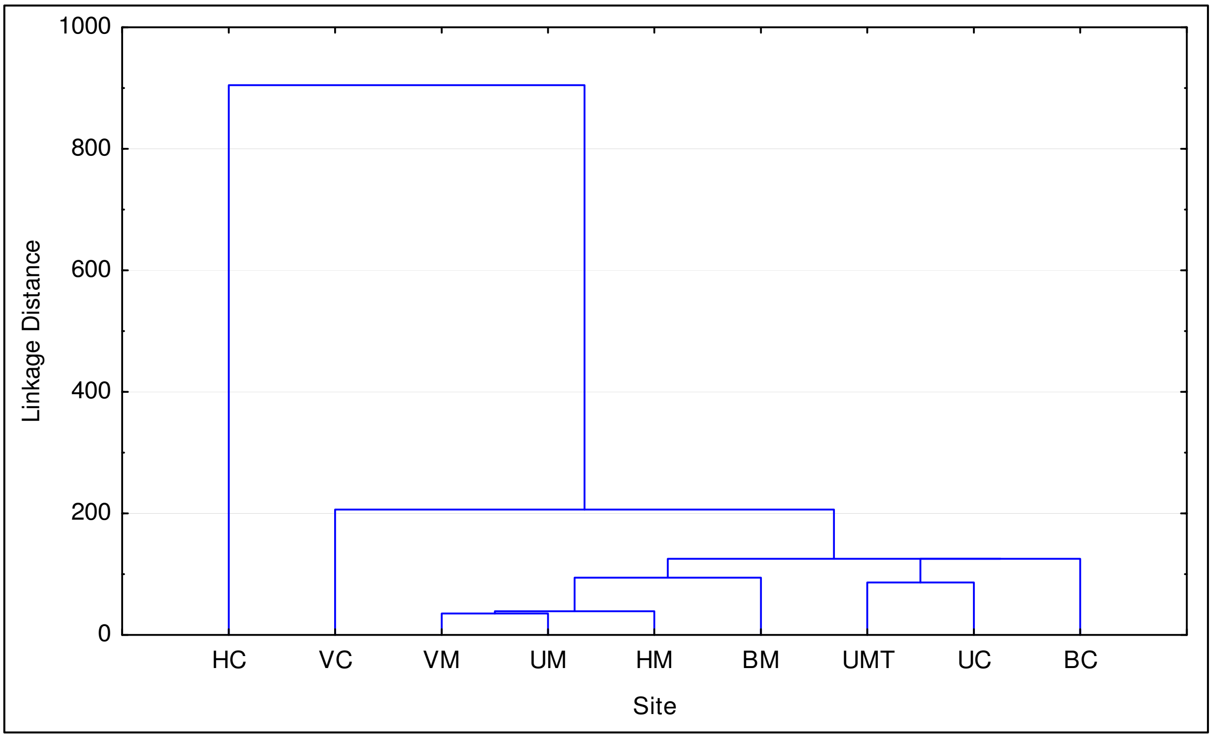

Fig. 3. Cluster analysis indicating linkage distances per site, based on arthropod diversity in each site. Vineyards: H = Heron Ridge; V = Vrede & Lust; U = Uitzicht; B = Backsberg. Treatments: C = control (no mulch); M and MT = mulch.

5. Accumulated outputs

List ALL the outputs from the start of the project.
The year of each output must also be indicated.

Technology development, products and patents

Indicate the commercial potential of this project (intellectual property rights or a commercial product(s)).

None

Human resources development/training

Indicate the number and level (e.g. MSc, PhD, post doc) of students/support personnel that were trained as well as their cost to industry through this project. Add in more lines if necessary.

	Student level (BSc, MSc, PhD, Post doc)	Cost to project (R)
1.	BScHons (Entomology) x1	-
2.		
3.		
4.		
5.		

Publications (popular, press releases, semi-scientific, scientific)

Addison, P, Baauw AH & Groenewald, G. Preliminary investigation into the effect of mulches on arthropod diversity in orchards and vineyards. Short communication in preparation: *African Entomology*.

Presentations/papers delivered

None

4. Total cost summary of project

	Year	CFPA	Deciduous	DFTS	Winetech	THRIP	Other	TOTAL
Total cost in real terms for year 1	2010		10 080		10 080	10 080		**30 240**
Total cost in real terms for year 2								
Total cost in real terms for year 3								
Total cost in real terms for year 4								
Total cost in real terms for year 5								
TOTAL			10 080		10 080	10 080		**30 240**