



ISSN 2278 – 0211 (Online)

Pest Status of Black Bean Aphid on Common Beans in Agro-Ecological Zones of Western Kenya

David Wamalwa Wosula

Ph.D. Student, Masinde Muliro University of Science and Technology (MMUST), Kenya

Hassan Karakacha Were

Professor, Department of Virology, MMUST, Kenya

Robert Kiptabut Leitich

Ph.D. Student, MMUST, Kenya

Bernard Mukoye

Ph.D. Student, MMUST, Kenya

Bonphace Collins Mang'eni

Ph.D. Student, MMUST, Kenya

Warren Aranaitwe

Plant Pathologist, International Centre for Tropical Agriculture (CIAT), Uganda

Abstract:

Aphis fabae, *Scopoli*, is one of the important pests of beans and causes significant yield losses in Kenya. The objective of this study was to determine *A. fabae* incidence/severity on common bean (*P. vulgaris*) varieties in pure stand and bean/maize intercrop in Agro-ecological zones (AEZs) of western Kenya. Two surveys were done during the short and long (2013) rain seasons in six AEZs: LM₁, LM₂, LM₃, LM₄, UM₁ and LH₁. Purposive and random sampling method in which participating and non participating farmers in legume improvement project were interviewed. Ten plants were randomly selected and sampled in each field. Analysis of Variance was used to determine mean aphid incidence/severity in various AEZs, Altitudes, among bean varieties and between pure stand and bean/maize intercrop. LSD was used to separate means at P<0.05 level of probability. Highest incidence (36.2%) and severity rating (1.6) respectively was recorded in LH1 in the short rains. In this period, lowest incidence of 0.7% and severity rating of 1.0 was in LM4. Highest incidence of 35.1% was during the short rains in altitude range of 1601-2000 m.a.s.l and the lowest (1.1%) in the same season in altitude 0-1200 m.a.s.l. Short rains recorded the highest severity scale rating of 1.6 in the altitudes 1201-1600 and 1601-2000 m.a.s.l. Lowest severity rating in both long and short rain seasons was 1.0 in the altitude 0-1200 m.a.s.l. Variety KK8 recorded the highest incidence and severity of 47.1% and 1.77 respectively in the short rains. On the contrary varieties Wairimu and GLP 1127 in the short rains and varieties Punda and Zaire in the long rains were not infested. There was significant difference in aphid infestation on beans between bean pure stand and bean/maize intercrop in the short rains. Higher incidence (31.3%) was in pure stand compared to 11.9% in bean intercrop. Similarly severity rating of 1.5 and 1.2 was recorded on pure stand and intercrop respectively. Findings of study will assist farmers in selecting varieties to plant in bean pure stand or bean/maize intercrop in the AEZs of Western Kenya.

Keywords: *Aphis fabae*, *Phaseolus vulgaris*, Incidence, Severity, Varieties, Agro-ecological zones

1. Introduction

The common bean (*Phaseolus vulgaris* L) is an important food and cash crop particularly for the human dietary protein, vitamins, minerals and dietary fibre requirements (Arulbalachandrans and Mullainathan, 2009). In Kenya the crop is ranked the second most important staple diet after maize (Kiya, 1997). According to FAO statistics *P. vulgaris* is globally grown on nearly 28 million hectares producing about 20 million tones of grains (FAOSTAT, 2008).

In Eastern Africa region, Kenya leads in bean production with over 500,000 hectares of land under the crop which produces actual yield of approximately 250 kg ha⁻¹ when intercropped and 700 kg ha⁻¹ in pure stands under farmer management conditions (GOK, 1997). These yields are lower compared to world average estimated at over 7000 kg/ha and the researchers yield under experimental conditions in the country of as much as 3000 kg/ha (Abate and Ampofo, 1996). These differences in yield gap between the rest of the world including researchers and that of farmers in Western Kenya could be attributed to several constraints such as low soil fertility, diseases and pests. Among the insect pests of common beans is *A. fabae* which is considered an important pest of beans limiting its production and accounting for yield losses ranging from 37 to 90% (Abate *et al.*, 2000).

2. Materials and Methods

A survey was conducted in six counties of Western Kenya, namely, Busia, Bungoma, Vihiga, Siaya, Homa Bay and Nandi. These counties fall in the agro-ecological zones (AEZs) LM₁, LM₂, LM₃, LM₄, UM₁ and LH₁. The area covered in the surveys lies between 34⁰ and 35⁰ East longitude and latitude 00 15' N and 1 45' S and altitude range of 1140-2500 m.a.s.l (Jaetzold *et al.*, 2007).

Two surveys were done covering the above areas of western Kenya in 2013 during both long (March-July) and short rain seasons (September-December) in six agro-ecological zones, LM₁ (Butula, Teso, Rongo and Rangwe Districts), LM₂ (Busia, Bungoma and Rangwe), LM₃ (Siaya, Sirisia and Teso), LM₄ (Bondo and Suba), UM₁ (Vihiga, Nandi South and Nandi North) and LH₁ (Nandi North, Central and South). 184 and 327 farms were randomly selected and sampled during the short and long rainy seasons respectively. Both participating (farmers trained by the local NGOs) on legume husbandry practices and non-participating farmers' (not trained) fields were sampled.

Purposive sampling method was used for selecting participating farmers, while random sampling was applied to choose non-participating ones. The survey lasted for three weeks per season. On each farm ten plants were randomly selected and visually scored for incidence expressed as percentage (number of infested plants divided by total number of plants sampled x 100). Severity scoring was on the scale of 1-5 (Ogenga-Latigo *et al.*, 1993).

1 = no. aphids

2=1-100 aphids

3 = 101 – 300 aphids

4 = 301 -600 aphids

5 = over 600 aphids

3. Data Analysis

Analysis of Variance was used to determine mean aphid incidence/severity in various AEZs, altitudes, among bean varieties and between pure stand and bean/maize intercrop. LSD was used to separate means at P<0.05 level of probability.

4. Results

4.1. Effect of Agro- Ecological Zones on Aphid Incidence and Severity

There was significant (P<0.05) difference in the incidence of aphids on common beans among the different agro-ecological zones in both the long rains and short rain seasons (Table 1). During the long rains aphid incidence was highest (16.77%) in AEZ LM1 and lowest incidence (4.29%) was recorded in AEZ LM4. Aphid incidence during the short rains significantly (P<0.05) differed among AEZs with highest incidence (36.2%) recorded in AEZ LH1 and lowest (0.7%) incidence observed in AEZ LM4. AEZs had significant (P<0.05) differences in mean aphid severity during both the long and short rain seasons. During the long rain season, AEZ LM1 had the highest severity rating of 1.2 in AEZs LH1, LM1, LM3 and UM1. During the short rains, highest severity rating of 1.6 was recorded in AEZ LH1 and lowest (1.0) in LM4.

AEZ	Incidence		Severity	
	LR	SR	LR	SR
LH1	12.19a	36.2a	1.2a	1.6a
LM1	16.77a	8.2b	1.2a	1.1bc
LM2	6.85b	8.1b	1.1b	1.1bc
LM3	9.8ab	13.8ab	1.2a	1.2b
LM4	4.29b	0.7b	1.1b	1.0bc
UM1	12.79a	25.4a	1.2a	1.5a
LSD	6.821	14.25	0.1	0.3

Table 1: Mean aphid incidence (%) and severity in AEZs in 2013

Means with the same alphabetical letter within a column are not significantly different at 5% probability using LSD value.

4.2. Effect of Altitude on Aphid Incidence and Severity

There was significant (P<0.05) effect of altitude on aphid incidence during the long and short rain seasons (Table 2). Incidence was highest (25.0%) in altitude range of 2001-2400 m.a.s.l and lowest (3.5 %) in altitude range of 0-1200 m.a.s.l during the long rain season. During the short rains season highest incidence (35.1%) was observed in altitude range of 1601-2000 m.a.s.l and lowest(1.1%) in altitude range of 0-1200 m.a.s.l.

Similarly, there was significant (P<0.05) difference in aphid severity rating in different altitudes in the long and short rain seasons (Table 2). Highest severity score (1.5) was recorded in altitude range of 2001-2400 m.a.s.l and lowest score (1.0) in altitude range of 0-1200 m.a.s.l during the long rain season. Severity score significantly (P<0.05) differed during the short rains with highest score (1.6) in altitude range of 1201-1600 and 1601-2000 m.a.s.l. and lowest severity score (1.0) recorded in altitude range of 0-1200 m.a.s.l.

Altitude (m.a.s.l)	Incidence		Severity	
	LR	SR	LR	SR
0-1200	3.5bc	1.1bc	1.0b	1.0b
1201-1600	10.9b	10.9b	1.2a	1.6a
1601-2000	10.1b	35.1a	1.2a	1.6a
2001-2400	25.0a	-	1.5a	-
LSD	8.7	16.5	0.5	0.3

Table 2: Mean aphid incidence (%) and severity in each altitude in 2013

Means with the same alphabetical letter within a column are not significantly different at 5% probability using LSD value.

4.3. Effect of Bean Varieties on Aphid Incidence and Severity

During the short rains there was significant ($P < 0.05$) difference in aphid incidence among bean varieties (Table 3). Variety KK8 had the highest (47.1%) incidence whereas no aphid infestation was recorded on varieties Punda, KAT 41 and GLP 1127 during the short rain season. Varieties significantly ($P < 0.05$) differed in severity rating during the short rains (Table 3). Highest aphid severity rating of (1.77) was observed on variety KK8 whereas varieties KAT 41 and GLP 1127 were not infested in the short rains.

Bean varieties	Incidence (%)		Severity	
	LR	SR	LR	SR
Canadian wonder	6.15a	10.0bc	1.06a	1.13d
GLP 1127	-	0.0c	-	1.00d
GLP 69	15.00a	-	1.20a	-
K72	10.00a	-	1.10a	-
KAT B1	10.00a	-	1.20a	-
GLP X2	14.30a	17.3bc	1.23a	1.28c
GLP X92	16.67a	13.3bc	1.18a	1.17c
KAT 41	-	0.0c	-	1.00d
KAT X 56	7.00a	15.0bc	1.08a	1.21c
KK071	0.00a	30.0b	1.00a	1.50b
KK15	9.00a	10.0bc	1.11a	1.20c
KK8	10.33a	47.1a	1.14a	1.77a
Local	7.11a	17.5bc	1.10a	1.26c
Punda	0.00a	0.0c	1.00a	1.00d
Wairimu	0.00a	9.3bc	1.00a	1.47b
Zaire	0.00a	10.0bc	1.00a	1.13d
LSD value	32.203	14.25	0.78	0.15

Table 3: Aphid incidence (%) and Severity on bean varieties in 2013

Means with the same alphabetical letter in a column are not significantly different at 5% probability using LSD value, (-) refers to missing data.

4.4. Effect of Bean /Maize Intercropping on Aphid Incidence and Severity under Farmer

During the short rain season there was significant ($P < 0.05$) difference in aphid incidence between bean pure stand crop and that in bean/maize intercrop (Table 4). Pure bean stand had higher mean aphid incidence of (31.3%) compared to maize/bean intercrop with incidence of (11.9%). In the same period severity rating score differed significantly ($P < 0.05$) between pure bean stand and bean/maize intercrop crop (Table 4). Severity score of (1.5) was recorded in pure bean stand compared with (1.2) recorded in bean/maize intercrop.

Crop mix	Incidence		Severity	
	LR	SR	LR	SR
Bean pure stand.	13.48a	31.3a	1.20a	1.50a
Bean/maize intercrop	10.39a	11.9b	1.15a	1.20b
LSD value	5.117	7.60	0.12	0.20

Table 4: Mean Aphid incidence (%) and severity for pure bean stand and bean/maize intercrop in 2013

Means with the same alphabetical letter in a column are not significantly different at 5% probability using LSD value.

5. Discussion

During the long and short rain seasons, LH1 and UM1 had higher aphid incidence and severity than the other agro-ecological zones. AEZ LM4 during the two rain seasons showed the lowest mean aphid incidence and severity. According to Jaetzold *et al.* (2007) the altitude for LH1 falls between 1830-2200 m.a.s.l and mean temperature range of 17.4-14.90 °C. Altitude for UM1 is 1520-1800 m.a.s.l and mean temperature range 19.2-17.60 °C. LM1 characterized by altitude range of 1200-1770 m.a.s.l and mean temperature range of 19.3-18 °C recorded the highest aphid infestation during the short rains compared to AEZs LM2, LM3 (920-1280 m.a.s.l) and LM4 (760-1220 m.a.s.l). It was observed that temperatures in AEZ LM1 were cooler than those in AEZs LM2, LM3 (22.9-20.6 °C) and LM4 (23.7-22.1 °C) hence LM1 provided suitable environment for aphid multiplication. As altitude increased, mean temperatures decreased which favoured rapid reproduction of aphids. This is in agreement with the findings of Swaine, (1969) who documented that *Aphis fabae* in East Africa infest common beans in highlands. Further, UM1 and LM1 were derived savanna and LH1 humid forest areas which had many secondary/alternative host plants for the aphids which enhanced faster reproduction of the aphids. In the lower midland zones (LM2, LM3 and LM4) the vegetation cover was sparse, temperatures high, humidity low and the air was mostly dry over prolonged periods. These environmental conditions caused higher aphid mortality resulting from non-availability of food source necessary for growth and survival. This is consistent with the research outcomes of Cammell (1981) stating that suitable host plants as source of food are key to the survival and reproduction of aphids.

Mean aphid incidence and severity for varieties GLP X92, GLP X2, GLP 69, KAT B1 and KK8 was higher than the other varieties because they were more preferred by aphids due to their low resistance levels. On the other hand varieties Punda, Zaire, Wairimu and GLP 1127 were either not infested or had negligible infestation levels. Varieties Punda and Zaire are landraces hence low aphid infestations. Teshome *et al.* (1997) described a landrace as “variable plant populations adapted to local agro-climatic conditions which are named, selected and maintained by the traditional farmers to meet their social, economic, cultural and ecological needs”. A landrace has also been defined as a variety with a high potential to tolerate biotic and abiotic stresses, resulting in high yield stability and an intermediate yield under low input agricultural systems (Zeven, 1998). Further, some modern cultivars such as GLP 1127 have been bred to have higher tolerance against aphids which is in tandem with the work of Parker and Biddle (1998).

Reduced aphid incidence and severity on beans that was intercropped with maize could be attributed to the trapping effect on aphids by the tall maize plant (Ogenga-Latigo *et al.*, 1993). Maize most likely altered plant host quality including morphology and chemical composition which is in certainty with the findings of Lange *et al.* (2007). Further, maize plants could have changed the microclimate in the field thus favoring multiplication and effectiveness of natural enemies in the field. This concurs with the argument by Risch (1979) that there are favorable environmental conditions and increased performance of natural enemies on pests of beans in intercropped fields as compared to pure bean stand crop. This is also in line with the explanation offered by Sinthanantham *et al.* (1990) who observed lower incidence of black bean aphids on beans intercropped with maize than on sole beans.

6. Conclusion

Aphis fabae infested common beans in all AEZs of western Kenya. However, degree of infestation differed from one AEZ to another with LM1, UM1 and LH1 being highly infested contrary to LM4 which recorded lowest infestation. Aphid incidence and severity was greater in higher altitude areas compared to the lower ones. Generally, landraces exhibited more resistance to pest infestations than other varieties. Intercropping maize and common beans reduced aphid infestation.

7. Recommendation

Extension messages by agricultural change agents should include identification of suitable agro-ecological zones for growing beans, use of tolerant varieties and intercropping beans with maize. Integrated Pest Management (IPM) strategies should be adopted for control of *Aphis fabae* in Western Kenya. IPM approach is key in avoiding development of pest resistance and in the protection of the environment from effects of chemical sprays, the conventional control method.

8. Acknowledgement

I sincerely acknowledge the funding from McKnight Foundation that made this research work possible. My appreciation also goes to Masinde Muliro University of Science and Technology staff for supervision and academic support.

9. References

- i. Abate T, Ampofo JK (1996). Insect Pests of Beans in Africa: their ecology and management. *Journal of Annual Review Entomology*. 41: 45-73.
- ii. Abate T, Van Huis A, Ampofo JKO (2000). Pest management strategies in traditional agriculture: an African perspective. *Annual Reviews of Entomology*. 45: 631-659.
- iii. Arulbalachandran D, Mullainathan L (2009). Changes on protein and methionine content of black gram (*Vigna mungo* (L.) Hepper) induced by gamma rays and EMS. *American-Eurasian Journal of Scientific Research*. 4: 68-72.
- iv. Cammell ME (1981). The black bean aphid, *Aphis fabae*. *Biologists*. 28: 247- 258
- v. CIAT (2004). Regional bean variety testing in Southern Africa. Highlights, CIAT in Africa. 20: 1-2. CIAT, Cali, Colombia. Retrieved from <http://ciat.library.ciat.cgiar.org/site>. Accessed in October, 2014
- vi. FAOSTAT (2008). Food and Agriculture Organization statistics. Retrieved from <http://faostat.fao.org> in Nov. 2014
- vii. GOK, “Government of Kenya Economic Survey. (1997),” Central Bureau of Statistics, Nairobi.

- viii. Jaetzold, Schmidt, Hometz, Shisanya (2007). Farm management handbook of Kenya Volume II Natural conditions and farm management information 2nd ed part C, Eastern Kenya subpart C Eastern province.
- ix. Kiiya WW (1997). A review of production practices and constraints for grain legumes with special emphasis on dry beans. In: Rees DJ, Nkonge C (eds). A review of agricultural practices and constraints in the North Rift Valley Province, Kitale, Kenya.p. 60-83.
 - x. Langer V, Kinane J, Lyngkjær M (2007). Intercropping for pest management. The ecological concept.
- xi. Ogenga-Latigo MW, Ampofo JKO, Balidawa CW (1993). Factors influencing the incidence of the black bean aphid, *Aphis fabae* Scop. on common beans intercropped with maize. African Crop Science Journal. 1: 49-58.
- xii. Parker WE, Biddle AJ (1998). Assessing the damage caused by black bean aphid (*Aphis fabae*) on spring beans. Proceedings of the Brighton Crop Protection Conference-Pests and Diseases p. 1077–1082.
- xiii. Risch SJ (1981). Insect herbivores abundance in tropical monocultures and polycultures: an experimental test of two hypotheses. Ecology. 62: 1325-1340.
- xiv. Sinthanantham S, Sohathi PH, Kaunatyan J, Haciwa HC (1990). Preliminary studies of bean aphid BCMV management in Zambia. Proceedings of the 9th SUA/CRSP and 2nd SADCC/CIAT bean research workshop held at Sokoine University of Agriculture, Morogoro, Tanzania, 17-22 September, 1990. Bean Research. Vol 5.
- xv. Swaine G (1969). Studies on the biology and control of pests of seed beans (*Phaseolus vulgaris*) in Northern Tanzania. Bulletin of Entomology Research. 59: 323-38
- xvi. Teshome A, Baum BR, Fahrig L, Torrance JJD (1997). Sorghum (*Sorghum bicolor* (L.) Moench) landrace variation and classification in North Shewa and South Welo, Ethiopia. Euphytica.97: 255-263.
- xvii. Zeven AC (1998). Landraces: A review of definitions and classifications. Euphytica. 104: 127-139.