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Effect of climatic factors on pea aphid, *Acyrthosiphon pisum* Harris (Homoptera:Aphididae) population and its Management through planting dates and biopesticides in field pea (*Pisum sativum* L.)

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Field experiment was undertaken to correlate pea aphid population with climatic factors, identify appropriate planting dates with cultivars and evaluate the effectiveness of biopesticides against pea aphid, *Acyrthosiphon pisum* Harris in field pea (*Pisum sativum* L.). Aphid population was increased when rainfall was reduced and the maximum temperature was increased. The effectiveness of planting dates showed that early and mid were not found effective because all plants were died at 5-10% podding stage due to heavy infestation of aphids (more than 100 aphids per plant) before reaching grain filling stage. Two cultivars such as Milky and Adi were found effective to suppress aphid population at late plating date. Among natural occurring insecticides, Neem Seed Kernel Extract (NSKE) and malathion (standard check) were better from other treatments and found significantly at par in all parameters (plant height, number of pods per plant, number of seeds per pod, and yield) except number of aphids per plant. Nimbicidine, *Milleitia ferrugenia* and cow urine were showed intermediate response in all yield parameters including number of aphids per plant. Thus, late planting with Milky and Adi cultivars and NSKE are recommended to manage pea aphid in field pea.

Key words: *Acrythosiphon pisum, Pisum sativum, Milleitia ferrugeina,* nimbicidine, neem seed kernel extract (NSKE), cow urine, malathion

Introduction

About 12 million metric tons of peas are grown worldwide each year. The total production of field pea has been estimated to be over 3.46 million tons per annum in Africa (FAO, 1999). However, the productivity per unit area is very low (0.6 t/ha) when compared with France (5.1 t/ha), UK (3.1 t/ha), Canada (2.1 t/ha) and China (1.8 t/ha). Field pea, *Pisum sativum* L. (2.13 million ha;

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231.94 million kg) is the third most important pulse crop after fababean (5.21 million ha; 688.67 million kg) and chickpea (2.27 million ha; 286.82 million kg) in Ethiopia in an area and production wise (CSA, 2008). As in the case with other crops, small-scale and resource-poor farmers undertake field pea production in Ethiopia (Beyene *et al*., 1994). The biotic stresses (insectpests and diseases) reduces yield because these crops are enriched in protein. Among insect-pests of field pea, pea aphid, *Acyrthosiphon pisum* is considered to be a serious pest because reduces both weight and caloric content of young pea plants by as much as 64 and 113%, respectively, depending on the number of feeding aphids (Barlow *et al*., 1977). Yield loss was estimated 22-48% in Ethiopia (Anonymous, 1987; Kemal and Tibebu, 1994). Kemal (1999) reported field pea yield loss of 49% in 1997 whereas yield loss was increased up to 59% in 1999 by increasing aphid population year by year. Limited work has been done in Ethiopia on the influence of planting dates to *A. pisum*. Delayed planting (late June) rather than early planting (mid May) of field pea has been reported to manage pea aphid at Adet in Ethiopia (Melaku, 2002). Effectiveness of neem (*Azadirachta indica*) products has been reported against *A. pisum* in laboratory condition (Kemal, 2002) but its effectiveness was not tested in field condition in Ethiopia. The significant insecticidal activity of *Milleitia ferrugenia* was recorded against larvae of sweet potato butterfly (Ferdu, 2006). The efficacy of *M. ferrugenia* was not tested against pea aphid in field pea in Ethiopia. Cow urine is applied to control pea aphid by local farmers in field pea. With this view, the present experiment was conducted to study the correlation between pea aphid population and climatic factors, the effect of planting dates with different cultivars and the effectiveness of naturally occurring plant and animal origin insecticides against pea aphid in field pea under field condition.

Materials and methods

Field experiment was conducted on the effect of climatic factors, planting dates with cultivars and effectiveness of naturally occurring plant and animal origin insecticides at Areka Agricultural Research Center (ArARC), Wolaita zone, Ethiopia during 2009-2010. Megene cultivar was used to correlate number of aphids with climatic factors in various weeks. Five cultivars of field pea i.e. Adi, Megene, Markos, Milky and local in three planting dates viz. early (06.07.2009), mid (20.07.2009) and late (03.08.2009) were used to study the effect of planting dates with cultivars. The cultivars were sown in plot size of 2x2 meter with 20 cm line spacing and 5cm plant spacing. Plants population were maintained by thinning after germination.

To identify the effectiveness of biopesticides, susceptible cultivar (Tegegnech) was sown on (14-08-2009) in plot size of 3 X 4m with six treatments namely Neem Seed Kernel Extract (NSKE) 10%, *Milleitia ferrugenia 5%*, cow urine (1 urine: 3 water), nimbicidine 0.03% (1500ppm), malathion 50%EC (0.075%) as standard check and untreated (local check). To prepare 10% NSKE, 100g of neem kernel was crushed by wooden mortar and pestle and soaked in one liter of water for 24 hours. Thereafter, soaked neem seed kernel powder was squeezed properly. The prepared solution was decanted properly before spraying to avoid clogging of nozzle. The same method was followed to prepare 5% Biribra (*M. ferrugenia*) solution (50g crushed seed soaked in one liter of water) (Ferdu, 2006). The treatments were applied when aphid population reached Economic Threshold Level (ETL) viz. 35% plants infested by pea aphids (Kemal, 1997). With the exception of malathion other treatments were sprayed twice. Experiments on planting date and effectiveness of biopesticides were laid down in randomized complete block design with four replications and observations were made on number of aphids per plant, plant height (cm), number of pods per plant, number of seeds per pod and yield (Kg/ha). Seven plants were selected randomly to count number of aphids, plant height, number of pods and number of seeds from each replication. Mean number of aphids were transformed using formula ($\sqrt{n+0.5}$). ANOVA was analyzed by using SAS program 2000 and means were separated by Duncan's Multiple Range Test (Little and Hills, 1978).

Results

Effect of climatic factors on aphid population

Rainfall was negatively correlated with aphid population (r =-0.98) means when rainfall was decreased, aphid population increased significantly at $P<0.05$ (Table 1). Negative correlation was also found between aphid population and minimum temperature (r =-0.20) but it was insignificant. Significant positive correlation was found between maximum temperature with aphid population (r =0.71). During the experimental period, pea aphid population was started from 20th August and crossed more than 100 aphids per plant after 5th September, however, peak population (173.43 aphids plant per plant) was recorded on 5th October (first week of October) in early and mid plantings.

Influence of planting dates with cultivars against pea aphid, A.pisum

Results revealed that early (06.07.2009) and mid (20.07.2009) planting were not found effective because more than 100 mean number of aphids per

plant (non-transformed value) were observed in third counting date on 05/09/2009 (58DAS) and in second counting date on 05/09/09 (44DAS), respectively, on used cultivars and all plants were died at 5-10% podding stage due to heavy infestation of aphids before reaching grain filling stage (Table 2). Observations were impossible to take on other parameters like plant height, number of pods, number of seeds and yield in case of early and mid planting dates due to complete dying of plants. Aphid infestations were initiated after 37 days of sowing and reached at peak when crop was in flowering and podding stage.

Results on late planting date are summarized in Table 3. Highest number of aphids (average of three counting) per plant was recorded on Megene (11.50) that was significantly different from other cultivars and the lowest on local (7.8). Maximum number of pods per plant was recorded on Adi followed by Markos, Milky, Megene and local. Number of seeds per pod was directly related with aphid infestation especially in case of Megene and local where lowest number of seeds per pod (1.96) and highest number of aphids (11.58) was recorded on Megene, however, highest seeds per pods (3.23) and lowest number of aphids (7.8) were on local. Plant height (cm) was varied from 110 to 54 and highest were on Milky and lowest on Megene. Plant height was decreased when aphid population was increased on Megene. The highest yield (Kg/ha) was recorded from Milky (493) and it was no significant difference with Adi (454), whereas, both the cultivars were significantly superior from Megene (334).

Effectiveness of naturally occurring plant and animal origin insecticides

Results showed that among the different tested bio-insecticides, lowest number of aphids per plant were on malathion after that NSKE, nimbicidine, *M. ferrugenia*, cow urine and untreated check, respectively (Table 4). As far as the number of pods is concerned, NSKE (10.66) was found significantly superior from nimbicidine (8.4), *M. ferrugenia* (8.33) and untreated (6.56), however, NSKE was found at par with malathion (9.2) and cowurine (9.86). There was no significant difference in terms of number of seeds per pod on malathion and NSKE and superior from *M. ferrugenia*, cow urine and untreated. Highest plant height was observed on NSKE followed by malathion, cow urine, *M. ferrugenia*, nimbicidine and untreated, respectively. Malathion and NSKE were found statistically superior from all treatments and no significant difference was in yield among malathion and NSKE. Nimicidine, *M. ferrugenia* and cow urine were not statistically different to each other but significantly better from untreated. Increase of aphid infestation was directly related with reduction of yield and vice-versa in case of untreated and malathion. NSKE 10% was

recorded most effective in all parameters i.e. maximum number of pods per plant, number of seed per pod, highest plant height (cm), lowest number of aphids per plant and highest yield (Kg/ha) except standard check (malathion). Effectiveness of synthetic neem formulation i.e. Nimbicidine was recorded significantly less effective from NSKE 10%, however, yield on Nimbicidine, *M. ferrugenia* and cow urine were found also effective and significantly higher than untreated check.

Table 1. Relationship between climatic data and mean number of aphid per plant

Date	Maximum (°C)	Minimum (°C)	Rainfall (mm)	Mean No. of aphidper plant
20/08/2009	23	14.9	82.5	3.5
28/08/2009	23.3	14.8	52	5.4
05/09/2009	23.5	14.6	102.8	10.7
15/09/2009	23.3	15.1	48.3	11.8
25/09/2009	25.1	14.3	23.2	12.7
05/10/2009	24	13.9	93	13.7
Correlation(P<0.05)	0.71*	-0.20	-0.98*	

Table 2. Effect of early and mid planting dates on pea aphid, *A. pisum*

Treatments	Mean No. of aphids per plant				
	Early planting date			Mid planting date	
	20/08/2009 (44DAS)	28/08/2009 (51DAS)	05/09/2009 (58DAS)	27/08/2009 (37DAS)	05/09/09 (44DAS)
Milky	3.5	5.4	10.7	6.1	10.8
Adi	3.6	6.8	11.8	5.2	10.8
Markos	3.6	6.7	12.3	6.6	10.6
Megene	4.2	6.8	12.8	6.0	10.8
Local	3.9	7.2	13.4	5.6	8.6
CD (P=0.05)	NS	NS	NS	NS	NS

NS= Not Significant

NB: Mean number of aphids was transformed using formula ($\sqrt{n}+0.5$)

Table 3. Effect of late planting date on pea aphid, *A .pisum* population and on yield components

Treatments	Mean No. of aphid/ plant	No. of pod/plant	No. of seed/pod	Plant height (cm)	Yield (Kg/ ha)
Milky	8.96b	5.33abc	2.76ab	110a	493a
Adi	9.23b	6.46ab	3.00ab	109a	454a
Markos	9.6b	6.03ab	3.23a	94a	386ab
Megene	11.58a	4.80bc	1.96b	54b	334b
Local	7.8c	4.46c	3.23a	94a	422ab
CD (P=0.05)	1.46	1.23	1.11	23	98.13

NB: Mean number of aphid was transformed using formula (√n+0.5)
Values followed by the same letter (s) with in a column are not significantly different from each other at P=0.05

Table 4. Effects of biopesticides on pea aphid, *A. pisum* population and on yield components

Treatments	No. of aphid/ plant	No. of pods/ plant	No. of seed/ pod	Plant height (cm)	Yield (Kg/ha)
Malathion	0.5d	9.2ab	4.78a	123ba	1347a
NSKE 10%	5.13c	10.66a	4.46ab	130a	1312a
Nimibicidine	6.26b	8.4bc	4.05bc	103dc	897b
M. ferrugenia 5%	6.56b	8.33bc	3.88c	110bc	810bc
Cow urine	7.3b	9.86ab	3.25d	113abc	801bc
Untreated	10.03a	6.56c	3.08d	91d	580c
CD (P=0.05)	1.06	2.05	0.57	18	261.4

NB: Mean number of aphid was transformed using formula (√n+0.5).
Values followed by the same letter (s) with in a column are not significantly different from each other at P=0.05.

Discussion

The present finding on the effect of climatic factors on aphid population was strengthened by Melaku (2002) and he observed positive correlation with maximum temperature and negative correlation with rainfall in response to aphid population. Heavy rainfall washed the aphid population but aphid population again reached at peak when rainfall was occurred in middle season of aphid infestation during study period in early and mid planting dates. Similar results were reported by Karungi *et al*. (2000) that aphid population killed by heavy rainfall early in the season. Kemal in 2002 found that aphid pressure was usually lower at Holetta than at the other two sites of Ethiopia i,e. Denbi and Kulumsa is believed to be attributed to the low temperature and high rainfall. Moreover, he observed that aphids first appeared in early August and then

increased to a peak in the latter half of August or first week of September at Denbi and Kulumsa. In the present study, aphid population was influenced by climatic factors (maximum temperature and rainfall) and also coincided with crop stage during flowering and early podding and aphid population was reached at peak in September and October. Melaku (2002) observed that pea aphid population reached at peak in August at Adet and in September at Zema in Ethiopia.

In the present investigation, late planting was effective, however, plants were completely died due to heavy infestation of aphids in early and mid plantings. It has been reported that best time for planting field pea against pea aphids in mid and late June rather than mid May at Adet in Ethiopia (Melaku, 2002). Kemal (2002) found that sowing date was not effective in reducing pea aphid population, might be due to narrow time gap between two plantings.

The results revealed that NSKE 10% and malathion (standard check) performed significant for yield parameters and reduction for aphid population whereas synthetic neem formulation nimbicidine, *M. ferrugenia* and cow urine gave intermediate response. Maximum plant height was on crude NSKE 10% might be due to alkaloids which increased the plant height. Mesele *et al*. (2004) found that the leaf and seed extract of *M. ferrugenia* caused mortality of the sweet potato butterfly larvae. Ferdu (2006) observed 10% *M. ferrugenia* suspension caused 90% sweet potato butterfly larval mortality in field condition. *M. ferrugenia* (10% solution) caused 79% mortality of enset root mealybug in laboratory and green house condition (Eyob, 2006). In present study, 5% *M. ferrugenia* suspension gave better result than cow urine and untreated check in aphid management and to get yield. Present studies on NSKE 10% and Nimbicidine was agreed with Kemal (2002) tested in laboratory condition that seed extract was most effective over Nimibicidine.

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