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Effect of Nitrogen Fertilizer Application on Population of Green Peach Aphid (*Myzus persicae*) on Garden Pea (*Pisum sativa*) in Tharaka Nithi County, Kenya

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors designed the study, wrote the protocol and wrote the first draft of the manuscript, reviewed the experimental design and all drafts of the manuscript, managed the analyses of the study, did the data collection, performed the statistical analysis. Both authors read and approved the final manuscript.

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ABSTRACT

Garden pea *(Pisum sativa.z)* is an annual crop in Kenya, for horticultural export. The green peach aphid (*Myzus persicae)* is one of the most important pests. Nitrogen fertilizers have been increasingly used to most annual crops to improve crop production. However, excessive nitrogen fertilizer application has been found to aggravate aphid infestation. The study therefore, determined the level of infestation by the green peach aphid under different nitrogen levels on garden pea .The experiment was laid out in a Completely Randomized Block Design with four treatments replicated thrice. Treatments included: 0 g, 1 g, 1.5 g and 2 g of nitrogen foliar feed per litre of water. Data was collected weekly for 3 consecutive weeks on aphid population. It was analyzed using SAS, subjected to ANOVA and least significant difference for means separation at 5%. Highest aphid number was recorded on 2 g treatment. Treatments 1.5 g and 1g recorded lower aphid number. Control treatment had a declining aphid population. There was no significant difference on the first

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sampling days. However, week 3 recorded no significant difference across all treatments except on the 2 g treatment. Based on the study, it is possible to influence aphid performance by altering nitrogen level.

Keywords: Myzus persicae; Pisum sativa; nitrogen fertilizer.

1. INTRODUCTION

Garden pea is an annual crop grown in the cool season in many parts of the world. It originated in the Middle East and in the Mediterranean region [1]. In Kenya, it is grown in Central, Eastern, Rift Valley and Western regions. The pea, commonly green, purple or golden yellow, is eaten immature and fresh. It is a major horticultural export and a major vegetable representing 40 to 50% of vegetable production [2]. Garden pea is consumed for high protein content, vitamins and minerals [2]. Unique phytonutrient in garden pea provide key anti-oxidant and anti-inflammatory benefits. They are rich in starch. They have a unique assortment of healthy protective phytonutrient. Garden pea is a nitrogen fixer and hence helps maintain soil fertility.

Major production constrains include: harsh environmental conditions such as frost, drought and excessive heat. Diseases include: powdery mildew, downy mildew and fusarium wilt. The crop is affected by field pests such as thrips and leaf miners that affect its productivity [3]. However, the major pest of importance that affect the garden pea is the green peach aphid (*Myzus persicae*). It has a wide host range and is widely distributed in many parts of the world.This pest inflicts serious damage on garden pea where the nymph and adult extract food material leading to retarded growth. They also extract large quantities of sap that reduce leaf photosynthesis affecting production. Feeding by large numbers discolours foliage, curls leaves and damages developing buds. In other cases, the plants are covered by a sticky substance, honeydew, that reduces the efficiency of the natural enemies. Saliva injected by the *Myzus persicae* introduces pathogenic viruses that transmit diseases on garden pea.

Broad spectrum insecticides such as malathion and dimethoate have been widely used to control high population of aphids. Aluminium foil backed cardboard mulches have been used to control small population of aphids. In other cases, strong spray of running water in garden horse is used to flash off the aphids to the ground where they starve to death. Intercropping garden peas with lemon, grass and onions and using ash mixed with water in vegetable kitchen gardens has also been used in control of aphids in garden peas. Proper care of garden peas through proper cultivation and hygiene has been used to control aphids.

However, aphid population on garden peas remain high despite all these control approaches. Nitrogen is one of the most yield limiting nutrient for crop production in the world. It is the nutrient element applied in the largest quantity for most annual crops [4]. Increase in the use of nitrogen fertilizer for enhancing the agricultural production has been under consideration for the last fifty years [5]. Most developing countries with intensive production systems have continuously used increased levels of nitrogen [6], but still nitrogen losses into the environment have also increased with adverse effect on crop productivity. Hence farmers apply too much nitrogen fertilizers on their crops thus aggravating the damage posed by aphids.Nitrogen is an important nutrient that influences herbivore performance and yield of the crop, especially in case of aphids since it is low in the phloem. Therefore higher Nitrogen fertilization has been positive for aphids and other sucking insects. High levels of nitrogen favors the attack by aphids. Excess nitrogen promote shoot development with relatively poor root growth. They relatively develop excess shoot development, promote succulence highly preferred by aphids.

Research shows, insect herbivore populations often respond to host plant fertilization with increased rate of growth and population, in comparison to non-fertilized plants [7]. Furthermore, fertilization of host plants may affect predator behaviour and population dynamics either directly (e.g. by inducing chemical changes in volatile chemical emissions, or indirectly (e.g. through change in the density of the prey, [8]. Sustainable fertilizer management is thus essential to promote plant attributes that help resist pest.This necessitated the need to evaluate different nitrogen application rates.

2. MATERIALS AND METHODS

The research study was carried out at the Chuka University farm. Chuka is 2000 m above sea level with a temperature range of 16-24℃ and a rainfall of 1000 mm p.a. Completely Randomised Block Design (CRBD) was used. This consisted of 4 levels of nitrogen 0 g, 1 g, 1.5 g and 2 g/ litre of water (nitrogen foliar feed) on one variety of garden pea. The treatments were replicated thrice and randomized across the blocks.

The pea seeds were planted in perforated polythene pots, each filled with soil at a ratio of 2:1:1:1 of normal soil, gravel, manure and sand respectively. Five seeds were planted per pot, thinned back to 4 per pot.

Crop maintenance activities involved irrigation, weeding and thinning to minimise competition and maintain a healthy crop. Watering was done once every other day to avoid overwatering using a watering can. Three weeks after planting, the plants were top dressed using CAN fertilizer at a uniform dose across all the treatments.

Inoculation of the aphids was done on the fourth week after planting. The aphids were collected from a local garden pea farm in Meru (neighbouring county) by picking up highly infested leaves and putting in a jar covered with a net to allow in air. They were inoculated on the same day by brushing off the aphids from the infested leaves onto the crop. The collected aphids were distributed equally among the 12 treatments. Then the aphids were allowed to get accustomed into the new environment for 7 days before applying the treatments. The experiment was set up within a yellow polythene shade. The shade provided a microclimate suitable for the aphids. This is because aphids tend to shy away from direct sunlight in the field and normally inhabit the leaf underside because of the shade. This shade also permitted adequate sunlight for the garden peas.

The treatments with different nitrogen doses of 1 g, 1.5 g and 2 g N per dm^3 of water was carried out a week after inoculation. The nitrogen fertilizer used was Easygro which is an NPK 27:10:16 plus other trace elements. A straight nitrogen fertilizer could not be used because it scorches the crop. The nitrogen foliar spray was applied twice at three day intervals. The control was only sprayed with pure water.

Aphid numbers were recorded on each randomly selected data crop in each pot from the fifth week. Data was recorded weekly from the beginning of March 2015 for three successive weeks. The first sampling date was on 2nd March, followed by 9th March, then 16th March 2015. Data collected on aphid population was analyzed using Statistical Analysis Software (SAS) subjected to Analysis of Variance(ANOVA) and Least Significant Difference (LSD) was used for separation of means at 5%.

3. RESULTS

Higher populations were recorded on plants treated with highest fertilizer rate i.e. 2g per litre water solution of nitrogen fertilizer.

Pots supplied with medium level of nitrogen fertilizer (1.5 g) registered a steady increase in aphid population. Pots supplied with low level of nitrogen fertilizer (1 g) had only a slight and insignificant rise in aphid population. Data taken indicated that pots supplied with no nitrogen had a declining aphid population with subsequent data collection dates.

There was no significant difference for the population of aphids on the first sampling dates, on 10th March and 17th March. Aphid population on the 24th March registered significant difference compared to earlier sampling dates. The difference in population between the treatments was significant. ($F=1.49$, $df=3$, $p=0.05$).

Figures labelled with the same lower case letter indicate no significant difference while those with different lower case letters indicate significant difference ($p=0.05$) The one with both lower case letters indicate no significant difference with either.Values are means (±S. E.) from 3 replicates.

In the first week after inoculation, there was no significant difference in the number of aphids in the all the treatments. Following the 2nd week, treatments also showed no significant differences .However, on the 3rd week, there were no significant differences across the treatments except for the highest level of nitrogen application i.e. 2 g concentration (Table 1).

4. DISCUSSION

In Kenya garden peas*, Pisum sativa* is an important vegetable crop both for local consumption and export produce. The most

important pest for garden peas is green peach aphid [3].These pest's population exploded as a result of the wide use of synthetic insecticides in the late 1950s [9].In this particular study, nitrogen fertilizer management was evaluated for possible use in the control of the green peach aphid (*Myzuspersicae*).Different fertilizer rates were tested for the proper control of aphid population.

Table 1. Table showing effects of varied levels of nitrogen fertilizer on aphid population

Treatment	Weeks after inoculating		
	1	2	3
Control (0 g)	17.00a	8.67a	6.67a
Least(1 g)	3.00a	4.80a	6.00a
Moderate (1.5 g)	5.33a	8.00a	9.67ab
High(2 g)	5.67a	13.33a	21.00b

In the 1st and 2nd week after inoculation, population of aphids was not-significantly different across all the treatments (Table 1). The aphids were stabilizing and adapting to the new environment. Over the 3rd week, there was significant differences in the number of aphids probably since the aphids had adapted and located suitable host. The difference was majorly evident in treatments with the moderate and highest level of nitrogen application i.e. 1.5 g and 2 g.

Highest aphid population levels were recorded on pots receiving highest nitrogen rates (Table 1) though there were no significant differences along the 3weeks. Aphids preferred nitrogen–rich plants and settled more frequently and fed for longer on them, hence higher reproduction and larval output. In a similar study by [10] also recorded maximum aphid infestation at high level of nitrogen. According to a research by Godfrey, cotton aphid (*Aphis gossypii*) in California cotton, high nitrogen rates also resulted to high aphid populations due to the positive effect of the fertilizer at individual level. The quality of the host plant is important for herbivores feeding on it [11] and [7]. Fertilization and nutrient availability can alter the nutritional quality of the plant and this can influence herbivore growth and reproduction [7]. Nitrogen is one of the plant nutrients that plays an important role for herbivore performance [12]. This is especially true in the case of aphids, because nitrogen content is very low in the phloem. Phloem sap contains 0.004-0.60% nitrogen weight/volume while most plant tissues contain at least 1% nitrogen of dry weight [12]. Nitrogen fertilization of the plant has, in many cases, been positive for aphids, or sucking insects reviewed by [7].

Control plots (zero nitrogen treatments) had aphids at the beginning whose population continued to decrease. [13] also found indications of a positive effect of nitrogen fertilization on aphid performance as intrinsic rate of increase was positively influenced by nitrogen. This can be a possible explanation as to why zero nitrogen rate had a negative effect on aphid population. However, there were no significant difference in the control and least application rate(1 g) by the 3rd week.

5. CONCLUSION

The results of this study, show that it is possible to influence aphid performance with plant fertilization. This supports the theory that plant fertilization can be used to reduce insect pests by altering the nutrient quality of their food. Very high levels of nitrogen fertilizer application only accelerate the problem of aphid infestation in garden pea. Zero application of nitrogen is not advisable since even though aphid level is low, the plants are not healthy enough to produce many pods. Extremely high levels of nitrogen fertilizer should also be discouraged since this leads to too much succulence of the plant tissues that accelerates high aphid infestation. A moderate level of nitrogen fertilizer is therefore recommended to control aphid infestation.

DISCLAIMER

"The title of this manuscript was previously presented in the following conference.
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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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