Populations of *Aphis gossypii* on different pepper cultivars, fertilized with different rates of NPK

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**Abstract.** Cotton aphid (Glover), (*Aphis gossypii*) (Hemiptera: Aphididae), is one of the main insect pests of chili plants in Indonesia. Excessive use of insecticide has caused resistance in the pest to insecticides in many places. Besides that, a high dose of fertilizer could trigger a population increase of many aphid species. Therefore, effective and safer alternative aphid control methods must be sought; hence the purpose of this study was to determine the resistance of different chili cultivars against the pest and the optimal dosages of the compound fertilizer of nitrogen, phosphate, and potassium (NPK) to suppress the aphid populations. The study was conducted in the Experimental Farm of the Faculty of Agriculture, Hasanuddin University, Makassar, from March to August 2019. This experiment was arranged in a complete randomized block design in factorial. The first factor was red pepper cultivars: Lado F-1 and Pilar F-1, and the second factor was NPK fertilization rate: 1, 2, 4, 8 g per plant. The results showed that the number of aphids was significantly lower on Lado F-1 than on Pilar F-1. There was a tendency that as the fertilizer rate increased, the number of aphids also increased. Plants fertilized with 8 g NPK per plant had a significantly higher number of aphids compared to the other treatments. However, the numbers of aphids on other treatments were not significantly different from each other. Therefore, the results suggested that in order to suppress the aphid population, farmers should use the Lado F-1 and fertilization rate of 1 to 4 g per plant as important components in an integrated pest management program.

**1. Introduction**

The cotton aphid, *Aphis gossypii* (Glover) (Hemiptera: Aphididae) is a cosmopolitan insect with a vast distribution encompassing tropical, sub-tropical, and temperate regions [1]. The cotton aphid has been reported causing damages on numerous species of plants, belonging to 18 families [2].

The insect can directly damage crops by sucking their sap, resulting in leaf distortion and curling. The upper leaf surface is sticky due to honeydew produced by the aphid while it is feeding, which is suitable for sooty mold to grow. Leaves covered by sooty mold become less effective in photosynthesis, while sooty mold-covered fruits lose their aesthetic values. Besides that, the cotton aphid can also damage plants indirectly by acting as a vector of viruses on pepper [3]. At high population, the aphid can cause leaf and fruit falls [4] and reduce the number of flowers formed [5]. Pepper growers depend heavily on insecticides to control the aphid; hence there is an increasing concern of detrimental effects on consumers, environment, workers, and non-target organisms [6].
Excessive use of insecticides has caused resistance in *A. gossypii* against those insecticides and killed the aphid natural enemies [7].

The fluctuation of aphid population is surely affected by the quantity and quality of food available in the plant host. Plant nitrogen component is crucial for phytophagous insects, such as *A. gossypii*. Fertilizers are intensively used by pepper growers to produce high quality and quantity crops. Studies have shown that the population growth rate and development of phytophagous insects are not only influenced by the plant nutrient level but also the nutrient ratio. Therefore, the purpose of the study was to determine the effects of pepper cultivar and NPK fertilizing rate on *A. gossypii* population in the field.

2. Methodology

A field trial was conducted in the Experiment Farm, Faculty of Agriculture, Hasanuddin University from March to August 2019. The treatments were arranged in a complete randomized block design in factorial. First factor was cultivar: Lado F-1 and Pilar F-1, and the second factor was NPK fertilizer (N = 15, P = 15, and K = 15): 1, 2, 4, and 8 g per plant. Each treatment had four replications of a plot each. Plot size was 4 rows wide and 6 m long and planting space used was 60 cm between rows and 40 cm within a row.

Three weeks old seedlings were transplanted on 21 April 2019 after transplanting, the number of nymphs and adults were counted by randomly picking up three leaves from four plants (top, middle, and bottom leaves) from each plot. The leaves were then brought back to the Laboratory of Insect in Relation to Plant Disease, Faculty of Agriculture, Hasanuddin University for identification and counting under a dissecting microscope. The number of aphids per leaf was determined every seven days on 18 June, 25 June, 2 July, 9 July, 16 July, 23 July, 30 July, and 6 August 2019.

The aphid count data were transformed using square root before being subjected to ANOVA (P = 0.05). If a significant difference was detected then the means were separated using the least significant different test (P = 0.05).

3. Results and discussion

The initial infestation of the cotton aphid, *A. gossypii*, was recorded on 18 June 2019, three weeks after plants were transplanted to the field. The number of aphids (nymph + adult) fluctuated throughout the duration of the field experiment (figure 1). The aphid numbers found on plants fertilized with 8 g NPK per plant were consistently higher than the numbers of the aphids on the other treatments throughout the course of the experiment. Aphid population on plants fertilized with 8 g NPK per plant reached its peak of 22 individuals per leaf on 9 July. Immediately after that, the population dropped to 9 aphids per leaf on 16 July and then, it increased and reached the second peak of 14 aphids per leaf on 30 July.

![Figure 1. Number of nymphs + adults per leaf for the NPK treatments: 1, 2, 4, and 8 g/plant.](image-url)
There was a general tendency that the aphid population increased as the fertilizer rate increased (figure 2). The highest number of nymphs per leaf was found on the plants fertilized with 8 g NPK per plant and it was significantly higher than the number of aphids on the plants fertilized with 1 g NPK, but it was not significantly different from those found on the plants fertilized with 2 and 4 g NPK per plant. Similarly, the number of adults found on plants treated with 8 g NPK per plant was significantly higher than the numbers of aphids per leaf in all other treatments. However, no significant differences in the number of adults the number of nymphs per leaf were detected among the treatments of 1, 2, and 4 g NPK per plant.

![Figure 2. The number of nymphs or adults per leaf (Means ± SE) for the NPK treatments: 1, 2, 4, and 8 g/plant.](image)

When the numbers of nymphs and adults per leaf were added up, the number of aphids per leaf found on plant treated with 8 g NPK per plant was significantly higher than the numbers of aphids per leaf in all other treatments (figure 3). However, no significant differences in the number of aphids per leaf were detected among the treatments of 1, 2, and 4 g NPK per plant. Previous research showed that that as nitrogen rate increased in chrysanthemum (*Dendranthema grandiflora* (Tzvelev) the number of *A. gossypii* per plant also increased [8]. In addition, aphid body size and fecundity were positively correlated with nitrogen fertilizer rates. Aphids on nitrogen-fertilized plants were significantly bigger than those on unfertilized plants [9].

![Figure 3. Number of nymphs + adults per leaf (Means ± SE) for the NPK treatments: 1, 2, 4, and 8 g/plant.](image)
The aphid numbers found on pepper plants were significantly different between both cultivars (figure 4).

Figure 4. Number of nymphs + adults per leaf on pepper cv. Lado F-1 and Pilar F-1.

Lado-F1 consistently had lower numbers of aphids per leaf in comparison to Pilar-F1 during the experiment. Aphid population on Pilar-F1 plants reached its peak of 19 individuals per leaf on 9 July. After that, the population decreased to 11 aphids per leaf on 23 July and then, it increased and reached the second peak of 23 aphids per leaf on 30 July and afterward it went down towards the end of the season. This is parallel to previous findings that plant cultivars could react differently to \textit{A. gossypii}: Chrysanthemum [11], cucumber [12], watermelon [7]. Our data indicated that Lado F-1 was more resistant to the aphid than was Pilar F-1. Therefore, Lado F-1 can be incorporated into an integrated pest management program. A resistant cultivar is an effective, ecological and economical pest control strategy [13]. Insect-resistant cultivars have been used successfully to control many food and vegetable crops. This tactic helps reduce the amount of insecticide use and food contamination.

4. Conclusion

The results indicated that the more NPK fertilizer was used, the higher the aphid population was. Plants fertilized with 8 g NPK per plant had significantly more aphids than did the plants fertilized with 1, 2, or 4 g per plant. In addition, the number of aphids on Lado-F1 significantly lower than those on the Pilar-F1 cultivar. Therefore, a combination of NPK fertilizer at 1, 2, or 4 g per plant and Lado-F1 provided a significant suppression on the aphid population and could be incorporated into an integrated management of the aphid pest.

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