Effect the age of barley plant inoculated with *Barley yellow dwarf virus* (BYDV) on grain yield and its control by seed treatment

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Abstract. Field study was performed during the agricultural season of 2013/2014 at Al Hamdaniyya district in Nineveh governorate. The study included two approved varieties of barely cultivation; Iba’a 99 and Al Khair. These two varieties were artificially inoculated with Barley yellow dwarf virus (BYDV), the infection was inflicted by resident aphids on two different stages of the crop growth (three leaves stage and tillering stage). The results showed that the loss in the crop yield due to the infection varied from one variety to the other and from one period of age to other during the infection. In addition, the results showed that using pesticide Gaucho (Imidacloprid) lowered the infection rate of BYDV in both varieties examined, in addition to increase of the production compared to the non-treated inoculated plants.

1-Introduction

Barely *Hordeum vulgare* L. is usually cultivated in Iraq after the first rain of winter from October to December yearly late seeding is possible in irrigated lands. *Barely yellow dwarf virus* (BYDV), *Luteovirus* genus, *Luteoviridae* family, is considered to be one of the most important viruses that infects herbage crops such as barely, causing heavy yield losses in their fields with varied ranges according to the spread of the virus, its species, the sensitivity of the cultivated varieties and the environmental conditions, losses might exceed 50% of the product in some countries [1]. Different means have been used to limit the effect of BYDV on barley. For example, different chemical methods were exploited including the terated of seeds with Imiaclopride and Deltamithrine [2; 3; 4]. Furthermore, there were many attempts to combine more than one method together as integrated control [5; 6]. Many cultural practies such as planting date, plant densities and use of insecticides were investigated [7]. As well as, many other studies performed in Australia were succeeded in controlling the spreading of this virus by using the combined effect of the cultivation date and some pesticides [8; 9].
This virus is important in Iraq and studies related to control it are few. Therefore, this research aimed to find the growth stages of barley plant that are more vulnerable to infection with the virus by inoculation different varieties of barely, and the possibility of lowering the infection rate by seed some chemicals dressing before planting.

2. Materials and Methods:

2-1. Samples infected plant collection and diagnostic the virus under study
Barely samples were fetched during the spring season in the year 2012-2013 from Al Hamdaniyya district in Nineveh governorate for the period from February- April during the cultivation season. About 500 samples were collected and they carry the symptoms of (yellowish, Mosaic, dwarf) which imply viral infection. All the samples were tested by using an antibodies against the Barley yellow dwarf virus using the Tissue-blot immunoassay (TBIA) method on the nitrocellulose membrane [10] Figure (1).

![Figure 1](image)

**Figure 1.** Schematic diagram showing the pattern of reactants in the tissue-blot immunoassay (TBIA). NCM= Nitocellulose membrane, GAR-AP= Goat antirabbit-alkaline phosphatase, NBT/BCIP= Nitoblue tetrazolium (Sigma N-6876)/ 5-bromo-4-chloro-3-indolyl phosphate (Sigma B-8503).

2-2. Breeding of aphids carrying the virus
Many aphid insects resident on barley plant were brought then bred inside special cages planted with both varieties of barely used in the experiment, to be later used in bio- inoculation of the virus [11]. Figure (2).
2-3. The effect of plant age and the varieties of Barely infected with the virus on productivity

Field experiment was performed in the next agricultural season at the same survey area in Al Hamdaniyya in two different age stages for each variety (Three leaves and tillering). The experiment was implemented by designing complete random sectors taking two duplicates, where each one of them included (the experimental segment of three duplicates with three planting lines of 1m length/line and a distance of 30 cm between one line and another with an average of 60 seeds/ line. After two days of inoculation by aphids carrying the virus, all the segments were sprayed with (Actara) pesticide with an average of 0.5 gm. / L. to kill all the insects. At the end of the season the middle meter was harvested for every experimental segment and the percentage of loss was estimated compared with the healthy plants (control).

2-4. The effect of dusting seeds on the percentage of infection with the virus

The two varieties under study were used and the seeds were treated with Gaucho (Imidacloprid) before seeding and the average used was 1.4gm./kg. The treatment of the control seeds for both varieties was dust free. The experiment was implemented by designing the random complete segments with two duplicates and each duplicate included 3 lines of planting with 1m length/line and with a distance of 30 cm between the lines with an average of 60 seeds for each line. Infection with BYDV was inflicted via aphids carrying the virus with an average of 10 insects for each plant at the age of 3 leaves. Segments of the control were left without inoculation. After two days of inoculation all the segments were sprayed with pesticide Actara with an average of 0.5gm. /L. , and after two months of infection, samples were collected of all the experimental segments and tested with plant (TBIA), and the percentage of infection was estimated for each treatment. At the end of the season, the middle meter was harvested of each experimental segment and the loss percentage in the product was calculated compared to the non-infected segments.

3. Results and Discussion

The results showed that 40% of the samples collected from the field were infected with the Barely yellow dwarf virus as it gave positive results in the plant tissue print test on the nitrocellulose membrane, [1] indicated that the TBIA test is one of the efficient tests to detect the BYDV virus; it was detected in infected phloem cells due to their purple-blue color on NCM after six days of virus infected by means of aphids carrying it. (Figure 3).
According to the results, we found that the loss in the product due to infection with the virus, varied from one kind to the other as well as their ages at infection, figure (4), early infection in both varieties led to increased losses in the product especially in Al Khair variety which might be more vulnerable towards viral infection than Iba’a 99.

The results showed that the systematic pesticide, Gaucho (Imidacloprid), played a role in reducing the percentage of infection with the Barley yellow dwarf virus in both varieties used. This affected the productivity of barely; the percentage of infection for the segments treated with Gaucho was low (8.49) compared to the control (39.53) in Iba’a 99, whereas in Al Khair the infection percentage in the dusted plants was (18.3) compared to the control (50.9)(infected with the virus but non-treated with Gaucho). Hence, using Gaucho reduced the infection percentage by 78% in Iba’a 99 and 63.6% in Al Khair.
Table (1): The effect of treating seeds with Gaucho before seeding, on the infection with the virus and its effect on the product

| Variety  | Treatment      | % of infection | % of product loss |
|----------|----------------|----------------|-------------------|
| Iba’a 99 | Gaucho treated | 8.4            | 23                |
|          | Non- treated   | 39.5           | 48                |
| Al Khair | Gaucho treated | 18.3           | 31                |
|          | Non- treated   | 50.9           | 56                |

Treating seeds with Gaucho also increased the product with a moral difference of (725.2 gm./ experimental segment), thus, using Gaucho increased the product by 9.2% compared to the control.

This influenced the grains product; it increased by the use of dusting with Gaucho with a moral difference compared to the control, it was high and reached (5259 gm. / experimental segment). Accordingly, the use of Gaucho pesticide increased the grains product with (45-46%) compared to the control treatment.

This distinguished effect of Gaucho pesticide is in agreement with many of the previous studies [2; 3]; found that Gaucho reduced the life and fertility of the aphids, also their nymphs were not completely developed where some parts of the mouth, antennule and legs were missing [12]. It also increased the mass death of winged aphids and this lead to limit the percentage of infection. This indicated the pesticide had influenced the development of aphids’ colonies and their fertility, and accordingly, it lessened the secondary infection.

Previously mentioned [13] that treating seeds with Gaucho offers protection for the plants for 3-5 weeks after germination, and this means lessening the chances of infection with Barley yellow dwarf virus in the plants at a sensitive stage for infection i.e. the phase of seedling.

Through this study, we concluded that the Gaucho pesticide (Imidacloprid) played an important role in limiting the viral infection when used before sowing, thus, the productivity remained intact and not influenced by infection, especially in early stages of the plant’s life which is more vulnerable towards infection. Accordingly, we can screen the adopted classes in the region to approve them as varieties carrying resistance quality towards infection with this virus, such as (Iba’a 99) and this result is one of the active choices in reducing the percentage of infection with one of the most dangerous viruses to the barely crop.

4. Conclusions
Through this study, we concluded that the Gaucho pesticide (Imidacloprid) played an important role in limiting the viral infection when used before sowing, thus, the productivity remained intact and not influenced by infection, especially in early stages of the plant’s life which is more vulnerable towards infection. Accordingly, test tissue-blot immunoassay (TBIA) will help in identifying BYDV.

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