IDENTIFICATION OF POTATO VIRUS Y (PVY) AND ITS ECONOMIC IMPORTANCE ON POTATO CROP

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ABSTRACT:

This study was conducted to estimate disease incidence of potato virus Y (PVY) in Duhok Province/ Kurdistan Region/ Iraq and to investigate its effects on the growth and morphology of potato plant and its productivity. High rates of occurrence of viral symptoms in the surveyed field were recorded. The mainly included symptoms were mild to severe yellowing, mottling, necrosis, stunting and malformation of potato plants. The effect of the virus on potato crop was studied using Vegetative growth and yield characters of healthy, current season and tuber borne PVY infected plants. There is differentiation between the growth of the current season, tuber borne PVY-infected and the virus free potato plant. Results showed that infection by PVY leads to reduce many physiological functions of above and underground parts of host plant like size of leaf area, chlorophyll percentage, number of tubers, tuber weight and total yield of a plant. Depending on the results, because of reducing physiological functions of above ground part of potato plant (leaf area and chlorophyll percentage), the number and the weight of tuber decreased, so the productivity of the plant decreased.

KEYWORDS: *Date of Infection, Potato, PVY, Vegetative growth and Yield Characters.*

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the important world food and vegetable crops belongs to the Solanaceae family (United Nations Food and Agricultural Organisation, 2009) which planted commercially in Iraq since 1960 (Mattlob *et al.*, 1989). In this respect, it ranks the fourth world crop with a rate of nearly 325 million tons annual production (Nagib *et al.*, 2003).

Potato is a rich crop of nutrient substances so it is consumed in very large quantities. Each 100 g of potato tuber contains 72-75 g water, 2- 2.5 g protein, 0.15 g fatty acids, 16-20 g starch and 1-1.8 g fibers as well as it contains a little quantity of nutrient elements and some vitamins. It contains 0.17 mg thiamin, 0.4 mg Riboflavin, 2.2 mg Niasin and 42 mg vitamin C (United Nations Food and Agricultural Organisation, 2009).

Potato tubers can transfer many diseases and pests and these cause degeneration of the seed tuber and plants. Potato production is being seriously hampered due to certain viruses (Rolot and Seutin, 1999), like potato virus Y (PVY) which is the most dangerous virus. This virus was detected in commercial fields in single or mixed infection (Nascimento *et al.*, 2003 and Biswas *et al.*, 2005).

PVY belongs to Potyvirus genus from Potyviridae family (Posada and Crandall, 2001). Its symptoms on potato ranged between mosaic to necrosis and death of plants depending on cultivar and viral strain (Robert *et al.*, 2000). PVY is widespread in Iraq on potatoes and other plants (Al-Sameae, 2000; Kassim and Mohammad, 2002 and Kassim and Younis, 2003). This study aims to survey PVY in Duhok province/ Kurdistan region/ Iraq and to know the effect of the virus on potato crop on the basis of infection date.

MATERIALS AND METHODS

1. Field Surveying and Sampling of PVY Isolates

Ten donums of potato yield in Gre-gawre village/Duhok province planted with Santa cultivar were surveyed from April-July 2013, using X pattern. Surveying were done every ten days depending on visual observation of virus symptoms. Leaf samples were collected and kept in a deep freezer (-18 ºC) for detecting the virus using double antibody sandwich enzyme linked immunosorbent assay (DAS-ELISA) according to that of Koenig *et al.* (2008).

2. Plant Material

Three groups of potato plants selected in the field due to PVY in the following orders as well as tuber borne PVY, current season PVY and PVY-free. The plants in the first group were carried tuber borne PVY while the second group include the plants in fact were healthy but infected by PVY because of feeding of green peach aphid (*Myzus persicae*). PVY-free group includes healthy plants. To ensure the presence of the virus, all used plants were tested using double antibody sandwich enzyme linked immunosorbent assay (DAS-ELISA) (Koenig *et al.*, 2008).

3. Experimental Measurements

At the mid and end of season of growth of 2014, several characteristics of the plants were taken to determine the effect of PVY on plants depending on date of infection and compare them with control (healthy) potato plants.

3.1. VEGETATIVE GROWTH CHARACTERS

3.1.1. Leaves Area.Plant^{-1} (cm^2)

The leaf area per plant was measured. It was measured before harvesting in a randomly taken samples represented by several physiologically completed leaves of several plants from each group. Three discs were taken from each leaf and the average of each disc was counted and weighted. Moreover, the fresh weight of the disc and the leaf was taken. Then, on the basis of proportion ratio the leaf area was counted and the average of the leaf area was calculated (Bn Sultan, 1996). Single leaf area =Weight of the leaf area (g) × Known area of the leaf section (1cm^2) / Weight of the sections (g).

3.1.2. Percentage of Chlorophyll Content of Leaves

It was determined after 55 days from planting from several plants of inner rows in each group by using Chlorophyll Meter (Adrijana *et al.*, 2008).

3.2. YIELD CHARACTERS

3.2.1. Number of Tubers.Plant^{-1}

The number of tubers per plant was counted from each group at the end of the growing season.

3.2.2. Tuber Weight (kg.Tuber^{-1}) and Total Yield (kg.Plant^{-1})

The average weight of tuber was obtained by weighting the tuber of each group at harvest then divided by the tuber number in each experimental unit.

RESULTS AND DISCUSSIONS

1. Field Surveying and Sampling of PVY Isolates

The definitive symptoms observed in the surveyed field were severe mosaic, necrosis, yellowing and mottling. Disease incidence of such field was determined in the figure. The results showed that the disease incidence was high in potato crop in the beginning of the season and gradually increased to the end of season.

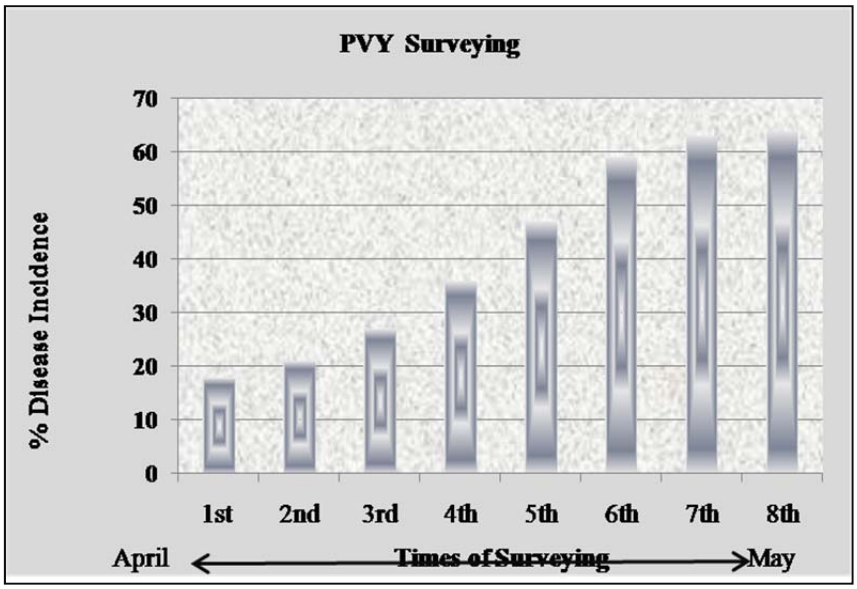

Figure (1): Disease Incidence of PVY in Surveyed Field

Virus disease incidence in potato field increased because of two reasons. Planting of uncertified potato seeds and the use of the tubers produced in the previous seasons which were heavily infected by the virus cause to a serious degradation of potato plants grown from such tubers and cause to increase virus disease incidence. This was in agreement with that of Jones *et al.* (2003) and Chatzivassiliou *et al.* (2008) who found that PVY was the more commonly spread virus through tubers harvested from infected potato plants. Hamm and Hane (1999) stated that disease incidence was increased by using viral infected potato seeds.

Another reason that caused gradually increase in the disease incidence from the beginning of the season to the end is green peach aphid (*Myzus persica*) which transmit PVY from diseased plant to healthy one. Study of Boiteau *et al.* (1998) was in agreement with our result. *Myzus persica* has been found to be most effective aphid in its role as a vector for PVY (Warren *et al.*, 2005). Sławomir (2010) stated that PVY is active after 17 hours of its acquisition on the aphid's stylet, so the epidemiology of the virus was increased. On the other hand, planting of the potato tubers that carry the virus and the presence of green peach aphid (*Myzus persica*) in potato field lead to increase the incidence of the viral disease of potato plants.

2. EXPERIMENTAL MEASUREMENTS

2.1. Vegetative Growth Characters

2.1.1. Leaves Area.Plant^{-1} (cm^2)

The average leaf area of healthy, tuber borne and current season PVY infected plants shows in table (1). Results showed that leaves area of infected plants significantly are smaller than control plants (6.42 cm^2). Leaf area of current season and tuber borne PVY infected plants were 4.30 and 2.33 cm^2, respectively.

Table (1): Effect of Current Season and Tuber Borne PVY Infection on Leaf Area (cm^2) and Total Chlorophyll Content (%) of Potato Plants Compared to Healthy Plants in Control

Trails	Treatment		
	Control (PVY-Free Plants)	Current Season PVY Infected Plants	Tuber Borne PVY Infected Plants
Leaf Area (cm^2)	6.42 a	4.30 b	2.33 c
Total Cholorophyll Content %	43.55 a	33.46 b	28.21 c

The average leaf area of current season and tuber borne PVY infected plants showed that the virus has a great effect on leaf area of infected plants compared to control plants. As noticed in the result, the effect of the virus is higher on the tuber borne infected plants than current season infected one and there are significant differences between leaf area of different types of plants. The result was in agreement with Fargette *et al.* (1988) and Hooks *et al.* (2008). They stated that, there is a significant difference in the size of leaf area between healthy and current season and tuber borne viral infected plants. They showed that certain aspects of plant growth may be affected by virus infection.

2.1.2. Total Chlorophyll Content of Leaves (%)

The average of total chlorophyll content of the virus free, tuber borne and current season PVY infected plants shows in table (1). It is noticed that total chlorophyll content of current season, tuber borne PVY infected and control plants were 33.46%, 28.21% and 43.55%, respectively. In the results, the significant differences between total chlorophyll content of healthy (control), current season and tuber borne PVY infected potato plants can be noticed. Our result is in agreement with Hooks *et al.* (2008) and Jakab-Ilyefalvi (2008). They found significant differences in total chlorophyll content of these different types of potato plants.

2.2. YIELD CHARACTERS

2.2.1. Number of Tubers.Plant^{-1}

The average number of tubers.plant^{-1} of different types of potato plants shows in the following table (2). Results showed that the number of tubers for each of PVY-free plants was as much as 9.60 compared to other types of plants (current season and tuber borne PVY infected plants) as well as 8.20 and 3.60, respectively.

Table (2): Effect of Current Season and Tuber Borne PVY Infection on Number of Tubers, Tuber Weight (kg) and Total Yield (kg) of Potato Plants Compared to Healthy Plants in Control

Trails	Treatment		
	Control (PVY-Free Plants)	Current Season PVY Infected Plants	Tuber Borne PVY Infected Plants
No. of Tuber.Plant^{-1}	9.60 a	8.20 a	3.60 b
Tuber Weight (kg.tuber^{-1})	0.40 a	0.12 b	0.10 b
Total Yield (kg.plant^{-1})	3.80 a	0.80 b	0.44 c

2.2.2. Tuber Weight (kg.Tuber^{-1}) and Total Yield (kg.Plant^{-1})

The average weights of a tuber and the total yield of a healthy, tuber borne and current season viral infected plant showed in the previous table (Table 2). As appeared in the table, tuber borne PVY infected plants had the lower average weight of a tuber and total yield.plant^{-1} (0.10 and 0.44 kg) compared to current season infected (0.12 and 0.80 kg) and control plants (0.40 and 3.80 kg). There are significant differences between different types of plants. As noticed to the results showed in the table (2), any increasing or decreasing in the number and the weight of a tuber.plant-1 leads to increase or decrease the average productivity of the plant, respectively as well as 3.80, 0.80 and 0.44 kg tubers as the final productivity of healthy, current season and tuber borne PVY infected plants. The result was in agreement with that of Fargette *et al.* (1988). Host plants have a wide range of responses to PVY infection. In fact, these responses were determined by potato cultivar and virus strain, and whether there is primary or secondary infection (Nie *et al.*, 2012). Virus infection has negative effects on plants by limiting their growth (Miteva *et al.*, 2005). Yield reduction of an infected plant with a virus was greater when plants were infected from the vegetative propagation materials than later by the vector (Fargette *et al.*, 1988). In the present study, there were several measurements of potato growth significantly differ from tuber borne and current season PVY-infected plants to control one. Fargette *et al.* (1988) showed that some properties of plant growth may be affected by virus infection. The symptoms caused by virus like mosaic surfaces, necrotic zones and reducing the size of leaf area lead to reduce chlorophyll content (Jakab-Ilyefalvi, 2008). Alterations in the biosynthesis of chlorophylls cause low chlorophyll content of infected plants. This has negative effect on the physiological factors including the metabolic processes.

Physiological disorders associated with low rate of photosynthesis lead to decrease the total chlorophyll content of infected vegetative parts of plants and this cause to reduce the productivity of infected plants (Chia & He, 1999 and Hook *et al.*, 2008).

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نیاسینا ڤایروسا وای یا پتاتێ و گرنگیا وێ یا ئابوری لسەر پتاتێ

کورتی:

ئەڤـە ڤەکولینە هاتە ئەنجام دان بۆ دیارکرنا ریژا روویدانا ئێشا ڤایروسێ پتاتێ وای و بۆ دەرئێخێستن و دیارکرنا کارتێکرنا ڤێ ڤایروسێ لسەر گەشە و سیفاتێن بەرجاڤـ یێن رووەکێن پتاتێ و هەروەسا بەرهەمئینانا وێ. ریژەکا بلند یا روویدان و دیاربوونا نیشانێن ڤایروسی ل زەڤی یێن روویپڤکری هاتە تومارکرن. ژ سەرەکیترین نیشانێن تومارکری زەربوون، پنی یێن رەنگی یێن زەر و کەسك یێن تێکەلاڤـ ، پنی یێن مرنا خانا، کورت مان و گهورینێن نەئاسایی ل سەر رووەکێن پتاتێ بوون. کارتێکرنا ڤایروسێ لسەر بەروبومێ پتاتێ هاتە دیارکرن بکارئینانا سیفەتێن کەسکاتیا کەشە بوونێ و بەرهەم ئینانێ یا رووەکێن ساخلەم، رووەکێن هەلگری ڤایروسێ ل وەرزێ و رووەکێن شینبوویی ژ توڤێن پتاتێ کو هەلگری ڤایروسێنە. جیاوازیەکا دیار لناڤبەرا گەشە بوونا ئەڤان رووەکان دا هەبوون. ئەنجامەکان دیارکرن کو نەخوشبوون ب ڤایروسێ پتاتێ ژ جورێ وای دبیتە ئەگەرێ کێم بوونا گەلەك ژ فرمانێن فیزیاوی یا بەشێن سەر و بن ئاخێ یا رووەکێ توشبوویی وەك رووبەرێ بەلگی، پێکهاتا تەمام یا کلوروفیل، ژمارە و کێشێن پتاتان و بەرهەما تەمام یا رووەکێ. ب پالبشتیا ئەنجامان، ژمارە و کێشێن پتاتان کێم بوون ژ بەر کێم بوونا فەرمانێن فیزیاوی یێن بەشێن سەر ئاخێ یا رووەکێن پتاتێ (وەك رووبەرێ بەلگی و پێکهاتا تەمام یا کلوروفیل) و ئەڤە ئەگەرەك بوو بۆ کێم بوونا بەرهەم ئینانا رووەکێ.

تشخيص ويروس البطاطا واي و اهميتها الاقتصادية على البطاطا

الخلاصة:

تم اجراء هذه الدراسة بهدف احتساب مدى حدوث المرض الفيروسي واي على البطاطا و لاختبار تأثيره في نمو و شكل و حاصل نبات البطاطا. تم تسجيل أعراض اصابة عالية المدى في الحقول التي مسحها. و تضمنت هذه الاعراض الاصفرار المعتدل الى الشديد، تبرقش و تبقع و تقزم و تشوه نباتات البطاطا. تم دراسة تآثير الفيروس في حاصل البطاطا السليمة و المصابة من خلال الاصابة الكامنة في تقاوي للموسم الجاري. سجلت اختلافات بين نمو نبات الموسم الجاري و المصابة بالفيروس الكامن في التقاوي و النباتات الخالية من الفيروس. أظهرت النتائج بأن الاصابة بهذا الفيروس قد ادى الى خفض كفاءة الوظائف الفسلجية للاجزاء الهوائية و الاجزاء الموجودة تحت التربة مثل المساحة الورقية و محتوى الكلوروفيل الكلي و عدد الدرنات و وزن الدرنات و الحاصل الكلي للبطاطا. و بناءأ على ذلك فان وزن الدرنات قد انخفض و أدى ذلك الى انخفاض الحاصل الكلي.