



Evaluation of Performance of Different Potato Seed Tubers Types Growing in Khartoum State

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Abstract: Two experiments were conducted during winter seasons of 2009/2010 and 2010/2011 at the Experimental Farm of the College of Agricultural Studies, Sudan University of Science and Technology at Shambat. The objective was to evaluate the performance of three different types of seed tubers (imported seed class E, first generation produced in Merowi Dam area and farmer's seed) using seed potato tuber of two varieties (Bellini and Mondial) for growth and yield. Parameters measured in the experiments included emergence, growth rate during growing season, yield and yield components and percentage incidence of potato leaf roll virus (PLRV) and potato virus Y (PVY) during two seasons. Farmer seeds and first generation seeds were comparable in days to emergence and were significantly higher than imported seed in both seasons. Numbers of stems were not significantly different between treatments in both seasons. For crop cover, all seed types were similar in season one, while farmer seed and first generation seed performed similarly and were far better than imported seed in season two. In the first season the results showed significant yield differences. The highest yield was obtained by first generation seed while basic seed gave the lowest yield. Local seed tubers (first generation and farmer seed) gave similar yield and were highly better than imported seed in second season. Two important viruses were identified namely PLRV and PVY, using sero-diagnosis Double Antibody Sandwich ELISA test (DAS ELISA test). The incidences of these viruses were in the range of 7.14-28.57% for PLRV and 0.0%-35.7 for PVY. The local multiplied farmer seed tubers showed the highest virus incidence compared to imported seed. First generation seed tuber recorded similar percentage and were better than farmer seed tubers. The lowest virus incidence was encountered by imported tubers.

Keywords: Potato, Seed tubers, leaf roll virus, potato virus Y.

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Introduction:

Abdalla and El-Shaffie (1983) reported that the production of seed potato locally is based on the import of a limited quantity of basic seed (class E) or certified seed every year from Europe mainly the Netherlands. Over the last ten years, many companies and

growers had been active in seed potato production. After a first year's multiplication, the harvest is kept for a second multiplication in the following year, there after; it is sold to farmers as seed for the production of war potatoes Anon (2009). Potato production is steadily increasing in Khartoum state; the acreage devoted to this

crop has increased to more than triple in the last ten years. The total acreage under potato cultivation in the Khartoum region amounts to about 6,500 hectares with yields of 17 to 25 ton/ha, Anon (2009). However, production costs of potatoes are high in comparison with those of other crops; seed potatoes have to be imported and this account for more than half of the total production cost of potatoes.

Elrasheed and Ballal, (2009). Found Limited volume and high prices of imported seed, few farmers can afford this high cost, arrived of these imported seeds late in the season, resulting in lower yields. Geneif (1986). For these reasons, cultivation of potato in the Khartoum region generally relies on local multiplication of seed material. Mohamed (1989) indicated that total yield of locally multiplied seed were comparable with imported seed. This is due to earlier planting of local seeds which compensate degeneration. Mutasim and Fayga (2009), Found that, total costs (production and marketing) were relatively large, with production cost representing the highest share (63%). The major production cost item was potato seeds (34.8%).

The other serious problem in potato production is the degeneration of seed tubers due to viral infection. A healthy tuber should be free of diseases such as viruses, brown rot and black surf. The importance of these diseases stems from the fact they survive and perpetuate in tubers, soil or weeds reducing plant vigor and yield. Kassanis (1950) and Morrenhof (1998) observed that, when a crop is infected with virus, its yield will be affected. The rate at which the yield reduction will take place depends on the intensity of the infection, the type of virus and combination of other yield affecting factors that are present. A crop that is already under stress from other factors, will suffer more from the virus infection. In general, a low infection level will have little effect on the yield, but high infection levels can result in yield losses up to 50% or more

in case of dangerous were used PVY and PLRV.

Beukema and van der Zaag, (1990) showed that viruses are major cause of degeneration. The virus within infested plants will be transported to the tubers resulting in infected daughter tubers. These infected tubers rest in secondary infected plants, which can be a source of primary infection through aphids or contact. In this way the percentage of virus diseased tubers gradually increase during subsequent field multiplications. The degeneration rate depends on the potato cultivar and the actual degeneration rate and in certain cultivar depends on the growing conditions and crop management. In Sudan there is an Informal seed production system where after a first year's multiplication, the harvest is kept for a second multiplication in the following year, there after; it is sold to farmers as seed for the production of war potatoes.

The objective of this study was to compare the performance of locally multiplied seed potato tuber saved in cool store (first generation and farmer seed) with the imported basic tuber seed (class E) from Netherlands, and to evaluate the effect of the three different seed tuber types on growth and yield and to examine virus's pressure (Potato virus Y and Leaf Roll Potato virus) of material collected during the field period using ELISA.

Materials and Methods

This research was conducted for two consecutive winter seasons (2009/2010) and (2010/2011) at the demonstration farm of the college of Agricultural Studies, Sudan University of Science and Technology at Shambat, Sudan. In each experiment three potato seed types of two different cultivars namely, Bellini and Mondial were used. The layout of the experiment was a randomized complete block design with four replicates. Plant material was imported potato tuber seed (class E) from Netherlands, First generations multiplied from (class E) at merowi dam area and farmer seed tubers.

Soil was ploughed, leveled and divided to ridges East West, 3m long, and 75cm between ridges. Plot size 4m x 4m with four ridges in each plot. The six types of seed tubers were placed under shad for 15 days. Sprouted seed tubers were planted in the North side of East-West ridge, in row spacing of 20cm. Planting was on 24th November 2009 and 4th December 2010.

Planted seed tubers were irrigated immediately after planting, and the second irrigation was after 7 days. The experiment was irrigated 10 times during the season at 7-10 days intervals. Weeds were cultivated twice by hand; first cultivation was four weeks after planting and second cultivation twelve days later.

NPK fertilizer in the form (15%N, 15%P and 15% K) was applied manually at the rate of 119 kg /ha at planting. Nitrogen fertilizer in the form of urea (46%N) was applied manually, at the rate of 130 kg/ha in two equal doses. The first dose was

applied after weeding four weeks after planting and the second was two week later at earthing up.

Earthing up was done after six weeks from planting manually. Protective spraying was performed to control aphids and fungal diseases. Plots were sprayed with the insecticide Folimat and Selecron against (Aphid) and fungicide Radomil and Score against (Early Blight), starting six weeks from planting. Spraying was repeated every ten days.

The crop was harvested at the stage of physiological maturity, when the vegetative growth turns from green to yellow, this occurred after about 95 days from planting. Harvesting was carried out manually. Tubers were harvested from the two middle rows, the area of (1m x 1.5 m) from each plot, and the harvested tubers were graded into three size classes; 1- large tubers (more than 50 mm); 2- medium tubers (28 – 50mm) 3- small tubers (less than 28 mm).

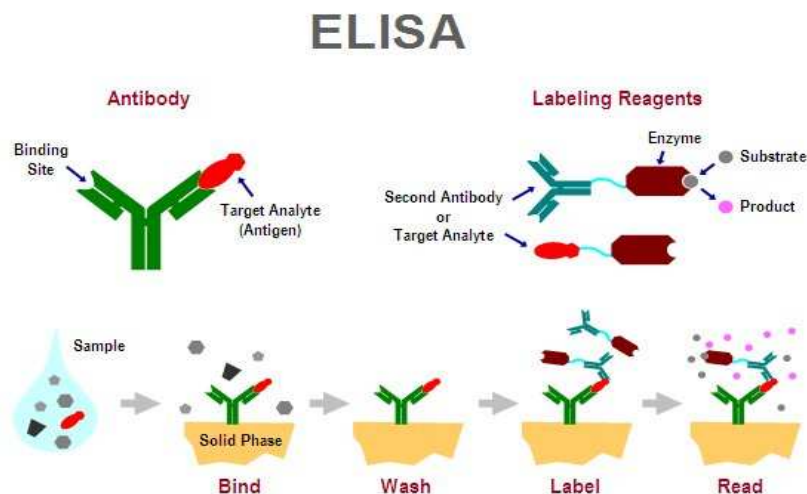


Figure 1: ELISA technique steps.

The procedure

The ELISA plastic microtitre plates were coated with 200µl antibodies in each well of the Elisa plates, the coating antibody diluted in coating buffer at rate of 1:1000, and placed in a humid box (tissue on the bottom

of the box). The box incubated at 37°C for 3 hours. Plates were then washed three times with washing buffer at intervals of 3 minutes. Fresh leaf samples were collected from the potato plants and sap tuber by mortars with pestles (fig. 1). Samples of

200µl plant extract were loaded in duplicate in the microtitre plate. Plates were then placed in a humid box (tissue on the bottom of the box), incubated over-night at 4 °C. After incubation, plates were washed thoroughly four times with washing buffer at an interval of three minutes each. Cross contamination of samples was avoided during washing. The enzyme – antibody conjugate (IgG-AP) was diluted in a conjugate buffer (1:1000) with 2% albumin, which was added freshly as rate of 0.04 for each 20 ml. 200µl of conjugate solution was added in each well then the plates were placed in a humid box (tissue on the bottom of the box) and incubated for 3 hours at 37°C. After incubation the plates were washed with washing buffer 4 times for 3 minutes. The freshly prepared substrate buffer was added to each well at the rate of 200µl and then incubated in the dark at room temperature (25 °C). Color reaction was monitored (Fig.3), visually observed for

the development of yellow colour in ELISA reader. Plates were read at several intervals (30 min, 1h and 2h) without stopping the reaction and the OD₄₀₅ values were recorded. ELISA readings were evaluated positive if OD₄₀₅ values are equal to or higher than two times the absorbance of the healthy controls. Mohamed (2004) the technique steps were showed in (fig, 1)

3.6. Virus assessment:

Savigny, and Voller, (1980), showed the virus infection levels were assessed according to the following formula:

$$+ve\ result = control + 3sd$$

The following formula was used to determine the virus incidence:

$$\text{Virus incidence (\%)} = \frac{\text{No of infected plants}}{\text{Total tested}} \times 100$$



Figure 2: Expressing sap from plant samples by pestle and mortar.



Figure 3: Colour development.

Data collection:

- i. Days to emergence
- ii. Emergence percentage
- iii. Crop cover
- iv. A random sample of five plants from each experimental unit was taken to study:
 - a) Number of stems /drill (hole)
 - b) Weight of tuber (g) / plant
 - c) Viruses incidence

Yield

Tubers of each class were collected and weighed, the yield of tubers were expressed as gram per m², while the final yield was expressed as ton per hectare.

From harvested tuber, the following records were taken according to following formula:-

$$\frac{\text{Mean of yield (g)} \times 1.5 \times \text{hectare}}{\text{Ton}}$$

Percentage weight grading of tubers in each class (small, medium and large size).

Data analysis

Collected data was subjected to analysis of variance. Duncan's multiple range tests with the aid of PASW computer program.

Results

Days to emergence:-

In the first season potato aerial stems emerged after 15 days for first generation and farmer seed, while imported seed emerged after 18 days.

In the second season stems emerged after 13 days in the both first generation and farmer seed. While after 16 days for Mondial class E and 20 days for Bellini class E

Crop cover: Fig (4-a) and (4-b), show crop cover percentage for basic seed, first generation seed and farmer seed. In the first season (2009/2010) no significant differences were noticed in crop cover by either of treatments or their interaction. However, in the second season (2010/2011) both basic seed, first generation seed and

farmer seed showed significant differences. Farmer seeds and first generation seeds behaved similarly and showed highest percent crop cover. The poorest crop cover was recorded by the basic seeds.

Number of stems: All tested seed types behaved similarly in number of stems in both seasons, (2009/2010) and (2010/2011) as presented in fig (5-a) and (5-b). The number of stems in the second season (ranging 2.3 to 5.0) was slightly greater than that of the first season (ranging 2.5 to 3.9).

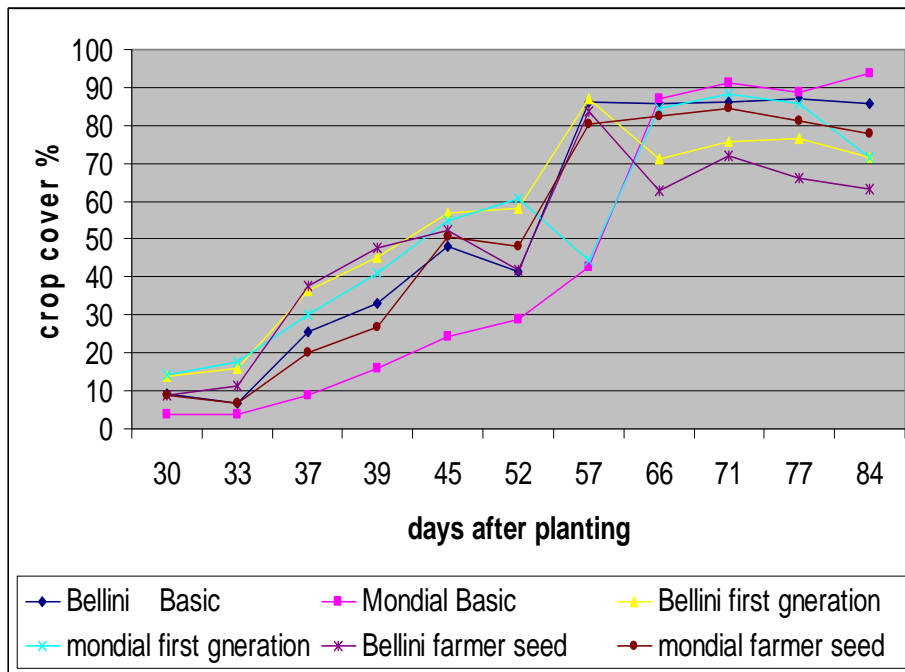


Figure 4-a: Crop cover percentage of different potatoes seed types season (2009/2010)

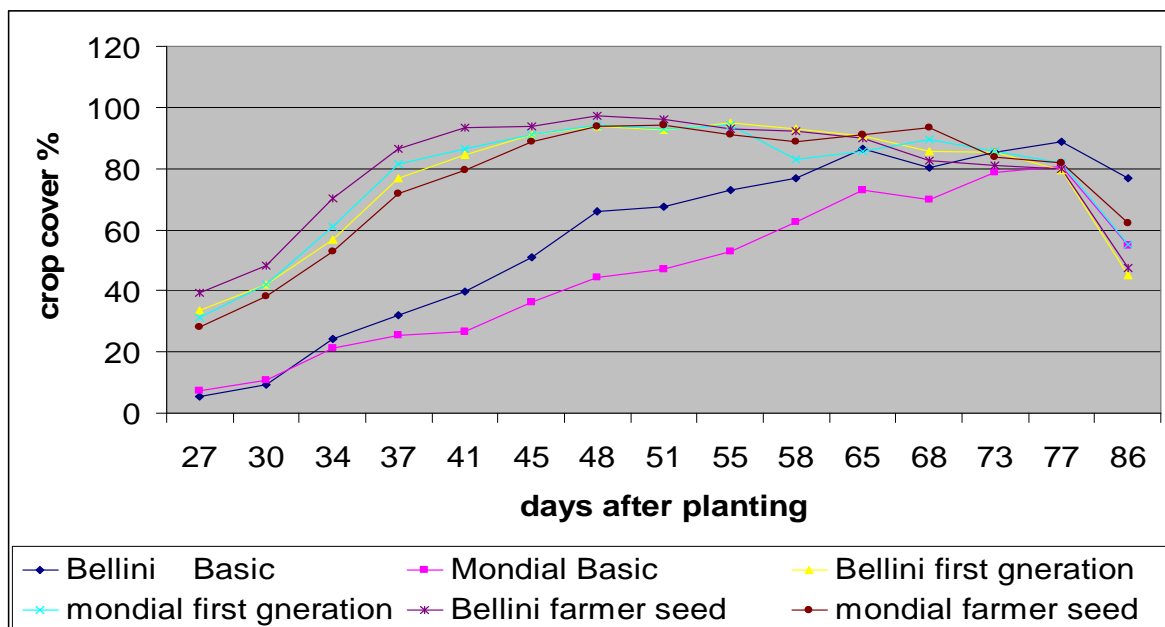


Figure 4-b: Crop cover percentage of different potatoes seed types season (2010/2011)

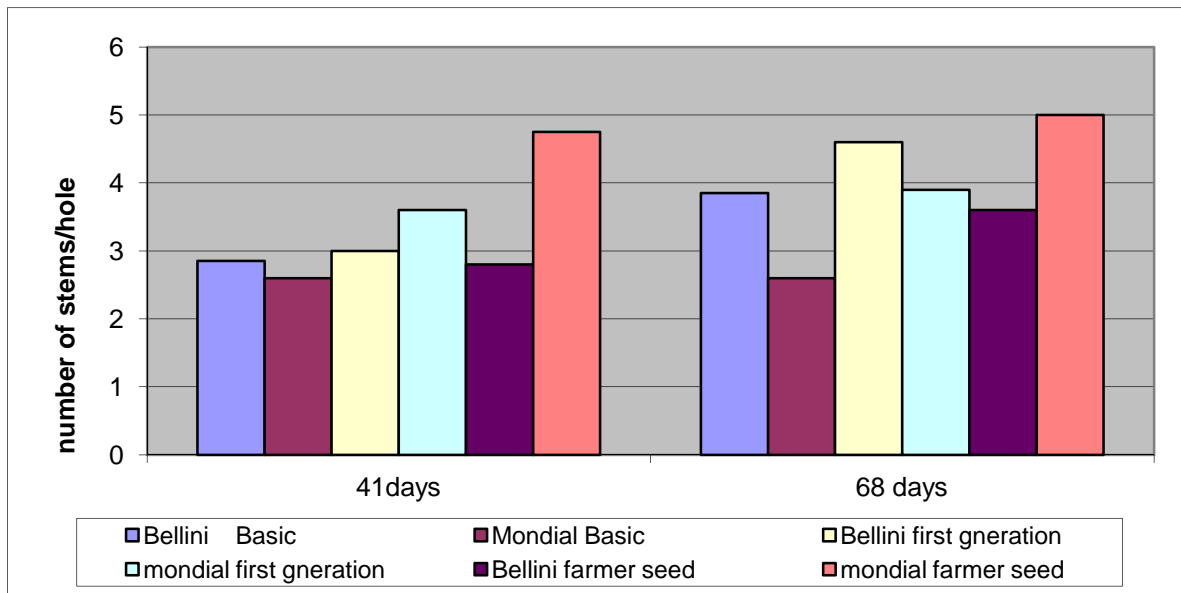


Figure 5-a: Number of stems per plant of different potato seed types season (2009/2010)

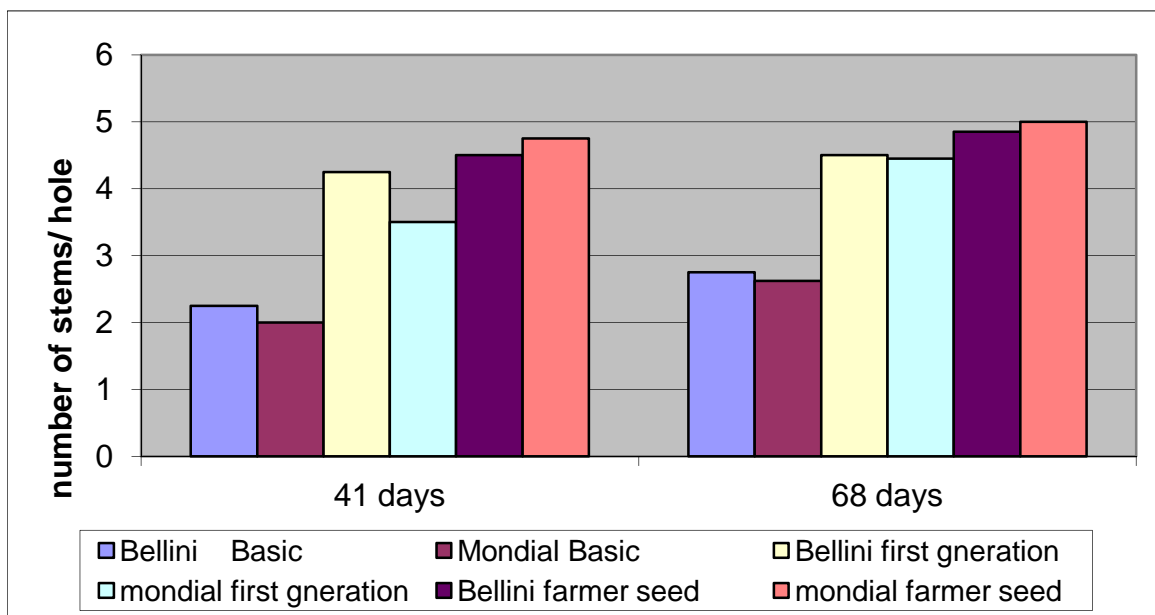


Figure 5-b: Number of stems per plant of different potato seed types season (2010/2011)

Yield:

Yield results in fig (6 a) and (6b) showed in the first season significant differences. Bellini first generation seed gave the highest tuber yield followed by Bellini class E,

Mondial first generation, Mondial and Bellini farmer's seed behaved similarly. Lowest yielder was recorded by Mondial class E.

In the second season (2010/2011) low tuber yield, were given by Bellini and Mondial class E. First generation and farmer seed of

both cultivars behaved similarly and gave higher tuber yields.

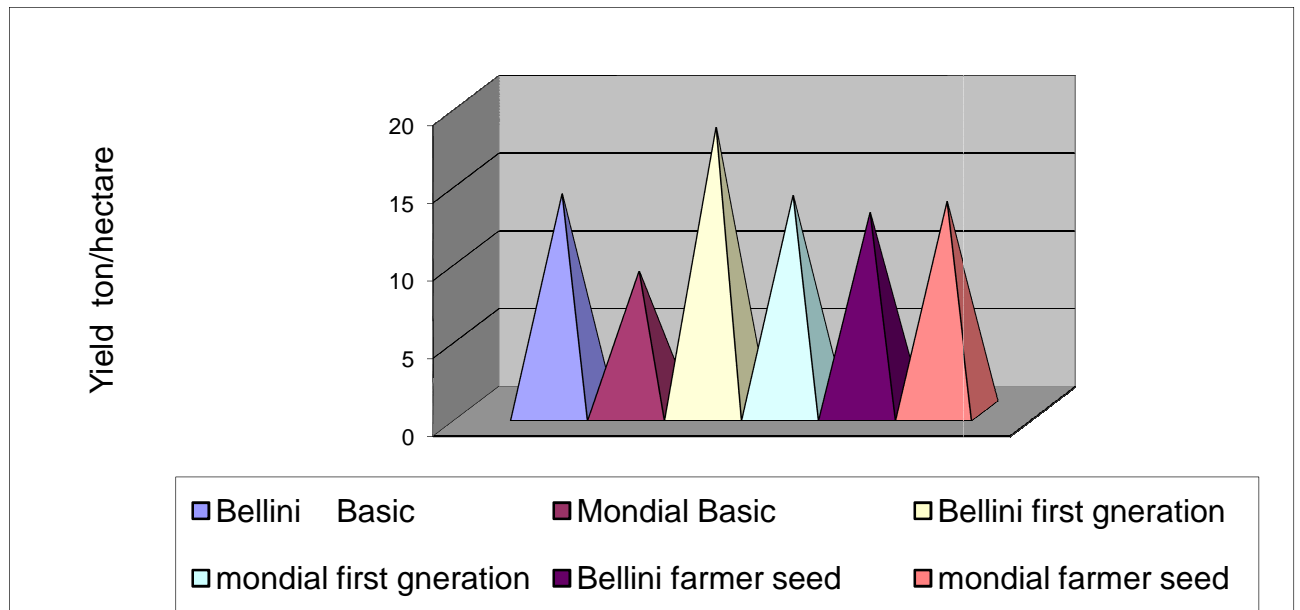


Figure 6-a: Tuber yield (ton/hectare) of different seed potato tuber types season (2009/2010)

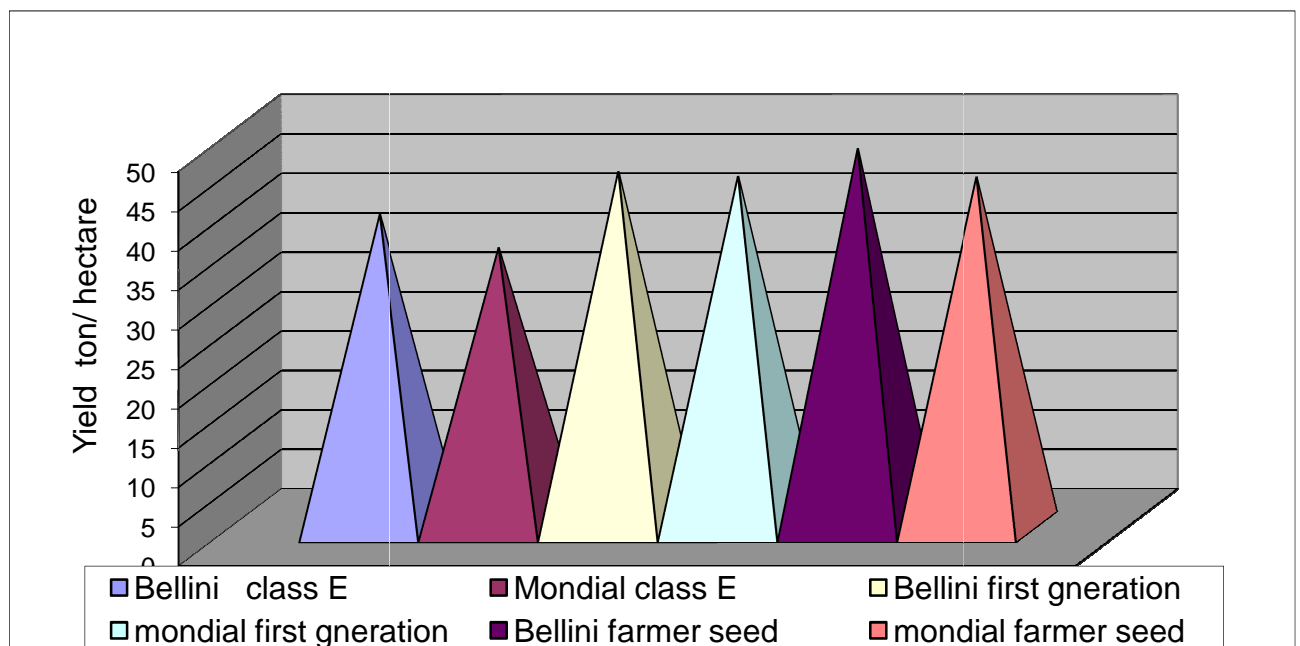


Figure 6-b: Tuber yield (ton/hectare) of different seed potato tuber types season (2010/2011)

Weight grading:

Medium size tubers (35-55) are favored in the market, of Sudan. Percentages of

medium tuber, given by Mondial class E (28.1 %), Bellini first generation (28 %),

Mondial farmer seed (26.6 %), Bellini class E (26.3%), Bellini farmer seed (25.45 %)

and Mondial first generation (25.4 %) as presented in figure (7).

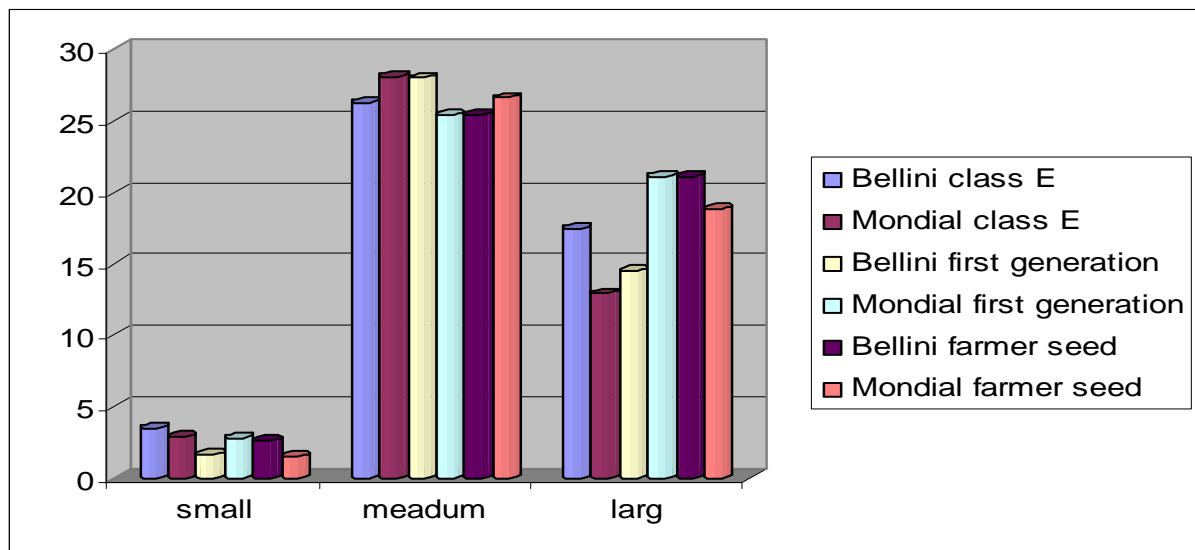


Figure 7: Tuber size percentage of different potatoes seed types season (2010/2011)

Viruses incidence: The result in fig (7-a) and (7-b) show that the different seed types to virus infection. The Mean potato Leaf Roll virus (PLRV) incidence ranged between (7.14% to 28.6%). Imported seed type Bellini and Mondial were gave the lowest infection percent (7.14), also Bellini first generation showed same infection percent(7.14), while Mondial first generation and Bellini seed farmer tubers expressed similar infection percent (14.29%). Mondial seed farmer tubers

expressed the highest infection percent (28.57%).

Potato Virus Y (PVY) results showed that the Mean incidence ranged between (0.0% to 35.7%). Varity Bellini and Mondial class E showed the lowest infection percentage 0.0% followed by Bellini and Mondial first generation which gave same level percentage 7.14%. Bellini farmer seed tubers gave infection percentage of 21.43 %. While Mondial farmer seed tubers gave the highest infection percentage 35.7%.

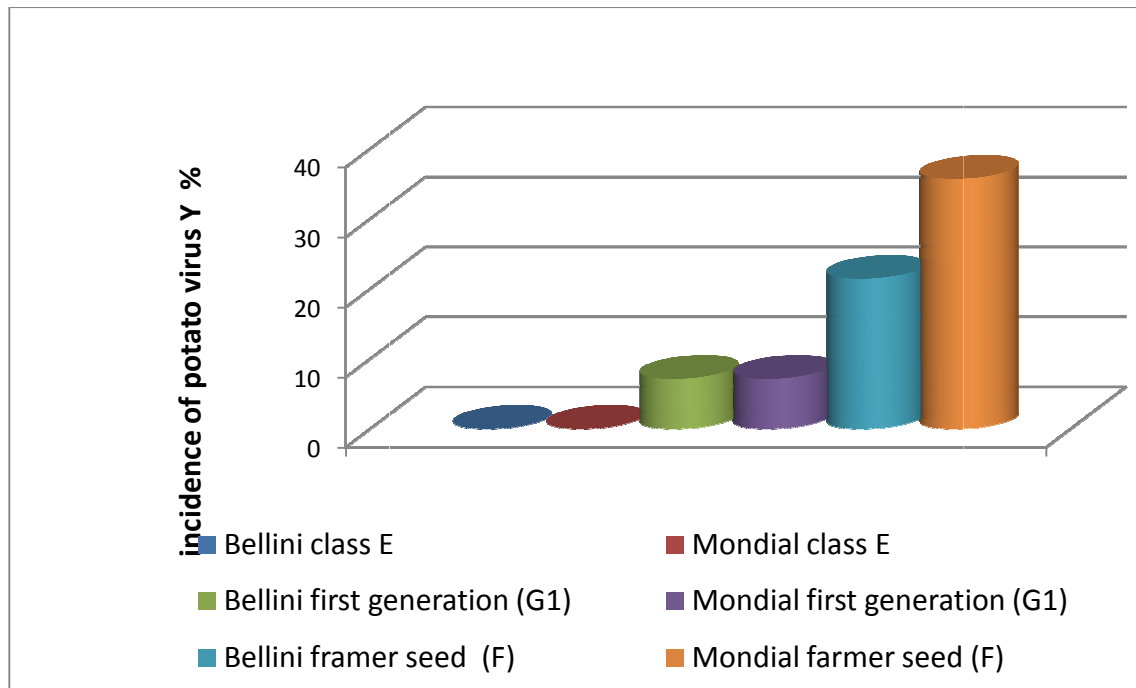


Figure 7-a: Incidence of potato virus Y % of different potato seed types season (2010/2011)

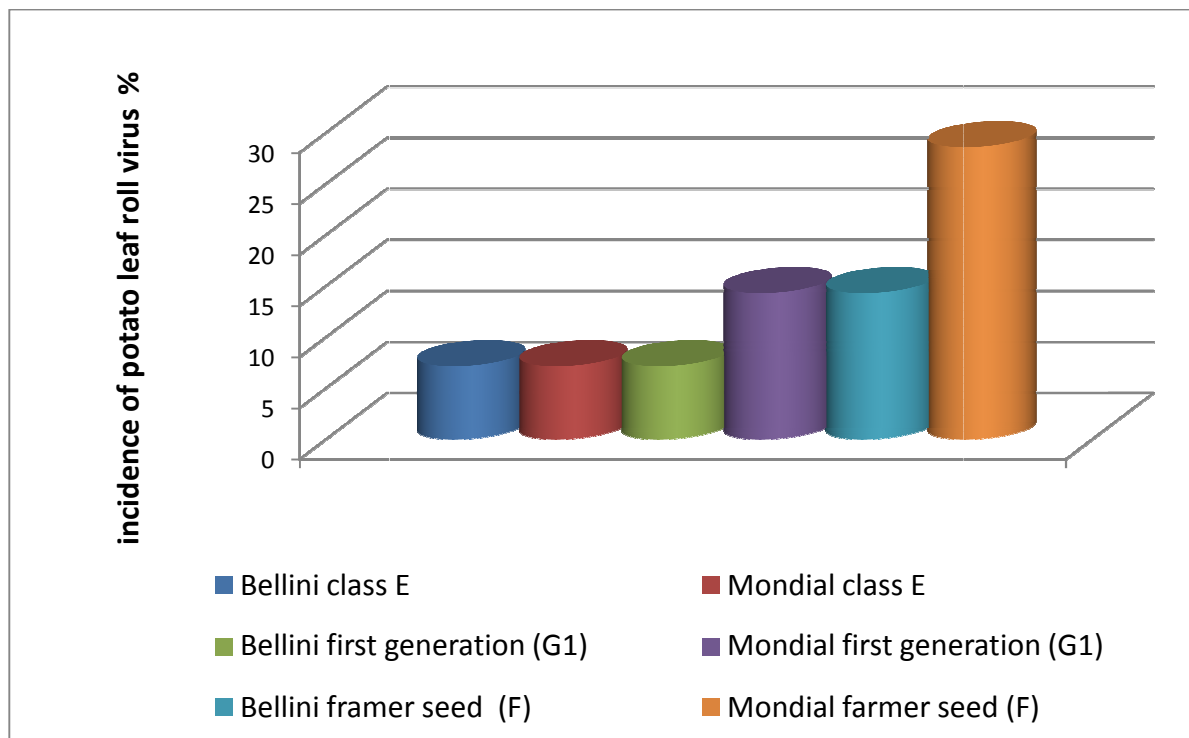


Figure 7-b: Incidence of leaf roll potato virus % of different potato seed types season (2010/2011)

Discussion

Differences in results between seasons may be due to the differences in weather conditions between seasons during the growing period. High temperature early in the season and high relative humidity during season 2010/ 2011 than that of 2009/2010 seems to be the main reason (Appendix 1).

Our results showed that the local seed tuber (farmer and first generation) were comparable in days to emergence and were significantly higher than imported seed for both seasons. This is in agreement with Iritani (1968) who reported similar findings in that physiologically old seed emerged faster than the physiologically young seed. Sportingly, El Bashir (2004) found that the local seed emerged faster than certified seed. The time between seed tuber planting and emergence, is expected to be influenced by sprouting and pre sprouting conditions of the seed tuber, physiological age of the tuber, planting depth and soil factors such as soil moisture and soil temperature. In accord with what was stated by Beukema and Van Der Zaag (1990), the age of the seed often affects the production pattern of the potato. Kawakami (1952) demonstrated that using old seed induces an earlier crop.

With regard to the number of stems, in the second season, there was slight variation between locally produced seed and imported seed. First generation and farmer seed for both Bellini and Mondial recorded highest number of stems per plant, while imported seed Bellini class E and Mondial class E recorded low number of stems per plant. These findings are supported by Struik and Wiersema (1999), who stated that, the number of main stems of seed tuber or seed piece is very important. It depends on seed size, cultivar and physiological age.

Larger crop cover is an important indicator of good growth. It is expected to affect tuber yield positively. As discussed by Burton (1989) and Beukema and Van Der Zaag (1990), it is also expected that wider spacing will exhibit poor crop cover than closer

spacing if the growing conditions are unfavorable or if spacing is designed to be more wider than crop ability to extend its shoots and foliage. Crop cover is considered as early indicator of potato tuber yield. Whenever crop cover is high, the tuber yield is expected to be high. In the second season of this study, local tuber seed gave highest percent crop cover and high yield compared with imported seed which showed lower percentage crop cover and poor yield. Farmer's seed and first generation seed tubers were physiologically mature and sprouted well with multiple stems which support their good crop cover. These results are in agreement with what Beukema and Van Der Zaag (1990) who found that yield is linearly related to the area of the ground covered with green foliage.

Mohamed (1989) indicated that total yield of local multiplied seed was comparable with imported certified seed and varieties were even better. This is due to earlier planting of local seed which compensated for the physiological and viral degeneration. The results in this study agreed with the results obtained by Mohamed (1989) and Baldo (2003).

The findings of this experiment showed that Mondial first generation seed and Bellini farmer seed produced higher percentage of large tuber compared to other seed tuber types, while Mondial class E and Bellini first generation gave higher percentage of medium size tubers. Bellini class E and Mondial class E produced higher percentage of small size tubers. Early crop establishment from well sprouted tubers end to bigger tuber size. These results are in line with previous findings of Demo (2000) and Manona (2000) they found that plants raised from multipliers yielded larger tubers and a higher number of tubers per plant, compared to imported seed.

Beukema and Van Der Zaag (1990) indicated that the reduction due to primary infection (infection that takes place during the growing season) is much lower than due

to secondary infections (in plants grown from seeds infected by a virus). Our results showed differences in levels of infection by potato leaf roll virus (PLRV) and potato virus Y (PVY). Local farmer seed tubers had high infection percentage compared to imported seed tubers and first generation tubers. The total potato Leaf Roll virus (PLRV) infection levels varied between 7.14% to 28.6%. Bellini class E, Mondial class E and Bellini first generation showed the lowest virus incidence, where as Mondial farmer seed tubers gave the highest record. Similarly, there are significant differences obtained between seed tuber types in total infection with potato virus Y (PVY). The imported seed tubers (E) displayed low incidence 0.0%. The total potato virus Y incidence in farmer seed tubers reached 35.7%. These results clearly indicate that the choice of healthy seed source or grade and the maintenance of health standards of seed are particularly imperative. These two sets of factors were also implicated elsewhere in the sub-tropics Marco (1984) Innaou (1988). This result confirms investigation of Baldo (2010) that crops grown directly from imported certified seed and from "improved seed" produced in Sudan from imported basic seed, showed the lowest levels of PLRV and PVY compared with crops grown from Sudanese farmers saved seed. Sudan has short winter season the imported seed emerged late and harvested early this reason may be due to it gave the lowest yield while it has the highest quality.

Conclusion

- a. Local tuber seed emerged faster in the both season compared to imported seed.
- b. Farmer and first generation tuber seeds gave highest percent crop cover and giving high yield compared to imported seed.
- c. First generation seed and farmer's seed gave higher tuber yield

compared to imported high quality seed.

- d. The imported seed and first generation seed recorded lowest percentage of potato leaf roll virus (PLRV), while farmer's seed recorded highest percentage.
- e. Farmer's seed had high incidence of (PVY).

Recommendation:

Establishment of potato seed propagation program in Sudan to produce high quality seed that could be available at right time.

Increase Farmers awareness to hazard, of degeneration of seed tubers.

More studies on economies of local seed production need to be addressed

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Table : 1 Metrological data during the experimental period

Month	Season 2009/2010				Season 2010/2011			
	Soil Temp		Relative humidity %	Temp	Soil Temp		Relative humidity %	Temp
	Max	Min			Max	Min		
November	30.3	26.7	28	27.7	29.8	27.9	28	30.0
December	29.3	27.8	29	23.3	30.2	28.8	30	27.3
January	30.1	28.4	17	23.2	30.6	27.0	29	21.6
February	29.9	29.6	16	26.7	30.9	29.3	24	25.9
March	32.1	32.0	20	29.9	32.2	32.1	18	26.9

Source: Shambat Metrological Station

تقييم أداء أنواع مختلفة من تقاوي البطاطس زرعت في ولاية الخرطوم

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المستخلص

أجريت تجربتين زراعتين خلال موسم شتوي 2010/2009 و 2011/2010 بالمزرعة التجريبية التابعة لكلية الدراسات الزراعية جامعة السودان للعلوم والتكنولوجيا بشمبات . بغرض تقييم ثلاث أجيال (اساس مستوردة و جيل أول أنتجت بمنطقة سد مروى وتقاوي مزاعين) بإستخدام صنفى (بليني ومونديال) من حيث النمو والإنتاج. القياسات التي تم أخذها في التجربة هي الإنبات فوق سطح التربة, تقييم النمو خلال الموسم, الإنتاجية ومكونات الإنتاجية، محتوى المواد الجافة ونسبة الأمراض خلال الموسم. تقاوى المزارعين وتقاوي الجيل الأول كانت مقارنة فى زمن الإنبات كانت اعلى معنوياً من التقاوى المستوردة فى كلا الموسمين. عدد السيقان لم تكن هنالك فروقات معنوية بين المعاملات فى كلا الموسمين. بالنسبة لتغطية النبات ، جميع الأجيال كانت متشابهة فى الموسم الأول، بينما تقاوي المزارعين وتقاوي الجيل الأول شكلياً متماثلة وكانت اعلى وافضل من التقاوي المستوردة فى الموسم الثاني. فى الموسم الأول أظهرت النتائج فروقات معنوية للإنتاج. أعلى إنتاج سجله الجيل الأول ، بينما تقاوي الأساس أعطت أقل إنتاج . التقاوي المحلية (الجيل الأول و المزارعين) لقد أعطت نتائج متشابه أعلى وافضل من تقاوي الأساس فى الموسم الثاني. سجلت اثنين من فيروسات البطاطس المهمة وهى فيروس إنتفاف أوراق البطاطس (PLRV) وفيروس البطاطس Y (PVY) . اعتماداً على إختبار إليزا بالأحتواء الشائى للفيروس بالأجسام المضادة. حيث اظهرت نسب رصد الإصابة فى المدى: 7.14%-28.57% PLRV و 0.0%-35.7% PVY . تقاوي المزارعين كانت أعلى نسبة إصابة فيروسية وسجلت فروقات معنوية مقارنة بالتقاوي المستوردة، بينما تقاوي الجيل الأول سجلت نسب متقاربة وكانت أفضل من تقاوي المزارعين . أقل نسبة إصابة فيروسية رصدت بالتقاوي المستوردة.