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Growth and productivity of different potato varieties under Gaza Strip conditions

Ismail Ali Abu-Zinada[1], Wael Atteif Mousa[2]

1. Associate professor, Faculty of Agriculture & Environment, Al-Azhar University, Gaza, Palestine.
2. Assistant Professor, Faculty of Agriculture & Environment, Al-Azhar University, Gaza, Palestine.

Corresponding Authors email: isalznada@hotmail.com

ABSTRACT: Four potato cultivars were evaluated for their vegetative growth and tuber production.. Results revealed that plant length of Spunta and Mondial, number of main stems in Mondial and Alaska and leaf area in Alaska cultivar significantly increased. Yield as tubers weight plant^{-1} and number of tubers plant^{-1} in Mondial and larger tubers >60 mm in Mondial and Alaska significantly increased. Tuber properties as tuber weight of Spunta, Alaska and Mondial, tuber length of Spunta and Mondial, tuber diameter of Alaska, Spunta and Mondial, tuber dry weight% and starch % in Lady Rosetta and ash% in Mondial and Spunta showed significant higher increases. It could be recommended to substitute Spunta by Mondial cultivar for home consumption and Lady Rosetta for processing

Kewords: Potato yield; tuber properties; vegetative growth.

INTRODUCTION

Potato is one of the main agricultural products where the amount of protein, starch, carbohydrates and essential amino acids, vitamins and minerals are important in human nutrition (Akhavan, 2007). Spunta is rated the first cultivar where the crop area in Gaza Strip was 1401.8 hectares, constituted 24.6% of the vegetables open-field cultivated area, produced 33.03 tons hectar^{-1} (MoA, 213). The dry matter content is consider as the major quality factor for potato processing. If the dry matter content is too low, the French fries or crisps will be too soft or too wet (NIVAA, 2002). At industrial scale, the assessment of the dry matter content is simply based on the principle that there is a close relationship between the density of the potato tuber and the dry matter content of the potato tissue.

Fitzpatrick et al., (1964) categorized tuber specific gravity values as low (< 1.077), intermediate (between 1.077 and 1.086) and high (>1.086). Infenkwe and Alen, (1978) and Wurret et al., (1993) that potato Maris Piper and Desiree were different in number of tubers plant^{-1} and significant differences were detected among different cvs in number of stems plant^{-1}. Kabira and Berga, (2003) that a dry matter content of 20 to 24% are ideal for making French fries while those with up to 24% are for preparing crisps. Potato tubers should have a specific gravity value of more than 1.080 and those with less than 1.070 are generally unacceptable for processing.

The underwater weight or specific gravity depends on a number of factors such as variety, soil texture and reaction, fertilizers, soil moisture, temperature during growing season and maturity. Damavand and Asle-Gorgani, (2005) observed that number of stems plant^{-1} at maturity, stem and leaf dry weight at maturity, and tuber dry weight compared to shoot dry weight were significant due to cultivar and density. Alsharari, et al., (2007) reported significant differences among cvs in plant height, number of branches, leaf area, tuber number and tuber weight. Abong et al., (2009 and 2010) that specific gravity, dry matter and ash content differed significantly among the different potato cvs. Dorota et al., (2011) reported that potato cv. Raja was characterized by the lowest content of carbohydrate and ash, when compared with 4 polish cultivars. Hassanpanah et al., (2011) reported the existence of significant differences among the potato cvs and clones in tuber yield, dry mater, specific gravity and starch%. Ranjbar and Mirzakhan, (2012) indicated that cvs Cosima and Ramus were significantly superior to the other varieties in growth plant height, number of stems plant^{-1} number of tubers plant^{-1} and mean weight of tubers. that evaluation of 11 new potato clones showed the highest and the lowest yield for Clone No. 397031-1 and Lady Rosetta respectively (Belhjati et al., 2013). The lowest and the highest average number of main stems plant^{-1} was related to Lady Rosetta and clone No. 397067-2 respectively (Belhjati et al., 2013). Kaur and Aggarwal, (2014) reported that all quality characteristics such as specific gravity, dry matter, starch and ash content were affected by potato cultivars.

This investigation aimed at evaluation of vegetative growth parameters and productivity of different potato cultivars under Gaza Strip conditions.

MATERIAS AND METHODS

This trial was carried out on four potato (*Solanum tuberosum* L.) cultivars; Spunta (T1), Mondial (T2), Lady Rosetta (T3) and Alaska (T4) which were provided by the palestinan ministry of agriculture. The 4 cultivars were grown in the winter-spring season of 2014 at the farm of the experimental station of Palestine Ministry of Agriculture, Betlahya Village, North Governorate, Gaza Strip, Palestine.

The experiment layout was the randomized complete block design (RCBD) with 4 replications. Each replicate-plot contained 60 plants grown in 4 rows, spaced at 70 cm between rows and 25 cm between plants in each row.

Before planting, tubers of each variety were cut into portions of about 30 g then left for healing in a room under indirect sun rays. A sprinkler irrigation system was used and the horticultural practices were carried out according to recommendations of the Ministry of Agriculture.

Measurements:

Vegetative growth

Ten plants were devoted to determine the plant length, number of main stems plant^{-1}, plant fresh weight, plant dry weight and leaf area after 65 days of sowing.

Yield components

Fifty plants were harvested after 105 days of sowing to determine number of tubers plant^{-1} and width of tubers > 60 mm and 30 - 60 mm (g plant^{-1})

Tuber properties

A sample of 20 tubers from each replicate-plot was used to measure the average of tuber weight, tuber length, tuber diameter were measured by caliper, specific gravity = weight in air/(weight in air – weight in water) (Dinesh, 2005), dry matter was determined by drying small pieces of tubers at 80°C for 72 hr in oven where tuber dry weight% = (tuber dry weight at 80 °C /tuber fresh weight)*100, tuber starch% = 17.55 + 0.891 * (tuber dry weight% – 24.182) (AOAC, 1980) and ash% in dried tubers was determined after burning in a muffle-furnace at 550°C for 48 hours (AOAC, 2005).

Statistical analysis was carried out according to Steel et al., (1997) where Duncan's Multipl Range Test was used to compare between means. Means has the same letter/s were not significantly different at $p = 0.05$.

RESULTS AND DISCUSSION

Vegetative growth

Potato plants vegetative growth in term of plant length, plant fresh weight, number of main stem splant^{-1} and leaf area are presented in Table (1). Results revealed that plant length significantly increased in cvs Mondial and Spunta respectively than Lady Rosetta and Alaska. Estevez et al., (1982) indicated that number of tubers plant^{-1}, average of tuber weight and plant height were the most closely related to tuber yield. (Wurr et al., 1992 and 1993) the differences among cultivars in plant length and number of stem internodes may be due to genetic differences.

Plant fresh weight showed a significant increase in Mondial and Spunta than Lady Rosetta cultivar only. Plant fresh weight were significantly different among the 4 varieties where Mondial produced the highest significant increase.

Number of main stems plant^{-1} cleared that Mondial had the highest number of main stems, however Spunta, Mondial and Alaska were not significantly different. On the other hand Lady Rosetta cv. showed the lowest number of main stems plant^{-1}.

Leaf area of cv. Alaska significantly increased than those of the other three potato cultivars whereas no significant differences were detected among Spunta, Mondial and Lady Rosetta. Midmor and Prange, (1992) reported that the increase in number of main stems, leaf area will increase the amount of absorbed light. Due to this phenomena, tuber is going forward and crop will premature.

The present study is in harmony with those found by Infenkwe and Alen, (1978) and Wurret et al., (1993) on number of stems, Asle-Gorgani, (2005) number of main stems, stem and leaf dry weight, Alsharari et al., (2007) on plant height, number of branches and leaf area , Ranjbar and Mirzakhan, (2012) on plant height and number of stems and Belhjati et al., (2013) on average number of main stems of differents potato cultivars.

Yield components

Data of yield as number of tubers plant^{-1} and tuber grades are presented in Table (2). Yield (g plant^{-1}) proved that Mondial showed the highest significant yield increase than the other varieties. Spunta and Alaska significantly came to the second position where no significant difference was observed between the two aforementioned cultivars. (Moorby, 1978) indicated that short photoperiod limits giberellic acid levels in the leaves and the light high intensity facilitates both early tuber initiation and tuber bulking. Estevez et al., (1982) indicated that factors affecting tuber yield in potato cultivars as number of tubers per plant, average tuber weight and plant height were the most closely related to tuber yield.

The results from Hassanpanah et al., (2011) and Belhjati et al., (2013) are coincided with this study that the different cultivars are significantly different in yield.

Number of tubers plant^{-1} was significantly higher in Mondial than the other three potato cultivars where no significant differences were noticed among Sounta, Lady Rosetta and Alaska. Lady Rosetta. Arzani, (2001) reported that potato yield is affected by tubers number and tuber weight. Number of potato tubers plant^{-1} is ranging 3-10 where each underground stem produces about three tubers. The number of stems produced has the highest correlation where there is a negative relationship between the number of stems and the number of tubers plant^{-1} there. Subarta and Upadhya, (1997) indicated that number of tubers plot^{-1} will depend mainly on number of stems plot^{-1}, total number of stolons and stolons tuberized. The development and tuberization of stolons is a complex phenomena and is not completely understood as yet. Both genetic and environmental factors play a vital role in stolon development and tuberization process.

The results concerning number of tubers plant^{-1} in this trial were consistent with findings of Infenkowe and Alen, (1978) ,Wurret et al., (1993), Alsharari et al., (2007) and Ranjbar and Mirzakhan, (2012).

Tuber grades in cvs Mondial and Alaska respectively showed a significant higher yield of tubers that having diameter > 60 mm where no significant difference was observed between Alaska and Spunta. In respect to the tubers of diameter 30-60 mm, Mondial produced the highest yield (g plant^{-1}) of this grade. However, no significant differences were noticed among Spunta, Rosseta and Alaska, The cultivar Lady Rosetta produced the lowest yield of 30 - 60 mm tubers. Sadiq et al., (1995) and Bussan, et al., (2007) noticed that plant had higher number of stems produced lesser potato tuber size.

Tuber properties

Results on tuber properties of potato are present in Table (3). The average weight of tuber showed significant increase in Spunta, Alaska and Mondial respectively than Lady Rosetta where no significant differences were observed among the three cultivars. Hanan et al., (1998) observed differences among the varieties in weight of different tubers and positive relationship between number of tubers and weight of tubers plant^{-1}. Similar trend of tuber average weight were reported by Alsharari, et al., (2007) and Ranjbar and Mirzakhan, (2012) on different potato cvs.

Tuber length showed a significant increase in Spunta and Mondial than Lady Rosetta and Alaska respectively, however no significant difference was observed between Mondial and Alaska cultivars.

Tuber diameter was significantly higher in Alaska, Spunta and Mondial cultivars respectively than Lady Rosetta where no significant differences could be detected among the former three cultivars.

Tuber dry weight% showed a significant increase in Lady Rosetta than the remaining 3 cultivars. In addition, Spunta followed by Mondial significantly came to the second position in tuber dry weight% and Alaska had the significant lowest percentage. Burton, (1966) reported that genetic differences among potato varieties play a role in their ability to produce high solids when was grown in the same test plot. Miller et al., (1975) and Tai and Cooleman, (1999) cleared that dry matter content is influenced by both of the environment and genotypes.

The dry weight% of the different screened potato cultivars are in agreement with results of Kabira and Berga, (2003) Damavand and Asle-Gorgani, (2005) Abong et al., (2009 and 2010), Hassanpanah et al., (2011) and Kaur and Aggarwal, (2014).

Specific gravity of Lady Rosetta cultivar showed significant higher value (1.137 g cm^{-1}) than the other three cultivars without significant differences among them. Tekalign and Hammaes (2005) reported that dry matter content of potato tuber was positively and significantly highly correlated with specific gravity ($r = 0.9$) indicating that specific gravity is a true indicator of the amount of dry mater in tubers. The yield recovery of the processed products is directly related to the tuber yield and high specific gravity or dry matter content of tubers (Ali et al., 2003). To make the production cost effective the French fries industry acquire tubers with high dry matter content due to weight losses during frying in form of vapor.

Starch% showed significant differences among the four cultivars where Lady Rosetta had the significant highest starch% than the other three cultivars. In this context, Spunta was significantly ranked the second to have starch content and Mondial was significantly the third. Chung , (2014) noticed that total starch content in dry matter was affected by cultivar or growing location.

These findings were in harmony with results of Dorota et al., (2011), Hassanpanah et al., (2011) and Kaur and Aggarwal, (2014).

Ash% (Table, 3) showed no significant differences among the screened varieties where Mondial followed by Spunta cultivars produced the highest percentage. True et al., (1978) and Woolfe, (1987) attributed that large variations in tuber ash content as the observed in the present study may be due to variety, soil type and fertilizer application.

Investigations of Abong et al., (2009 and 2010), Dorota et al., (2011) and Kaur and Aggarwal, (2014) came to the same trend of the present study, that ash content in tuber is affected by cultivar of potato.

Table 1. Vegetative growth.

Treatments		Plant length (cm)	Plant fresh weight (g)	Plant dry weight (g)	Number of main stems Plant^{-1}	Leaf area (cm^2)
Spunta	T1	33.1 a	214 a	17.9 b	1.4 ab	129 b
Mondial	T2	35.5 a	243 a	22.3 a	1.9 a	117 b
Lady Rosetta	T3	20.5 b	116 b	11.9 c	1.0 b	103 b
Alaska	T4	26.8 b	183 ab	16.9 b	1.7 a	197a

Means followed by the same letter/s in each column are not significantly different at *p*= 0.05 accordind to Duncan's Multiple Range Test.

Table 2. Yield components

Treatments		Yield Plant^{-1} (g)	Number of tubers plant^{-1}	Yield of tubers > 60 mm Diameter plant-1 (g)	Yield of tubers 60-30 mm Diameter plant^{-1} (g)
Spunta	T1	591 b	4.1 b	362 b	227 b
Mondial	T2	797 a	6.8 a	466 a	320 a
Lady Rosetta	T3	310 c	3.5 b	80 c	228 b
Alaska	T4	584 b	4.2 b	411 ab	168 b

Means followed by the same letter/s in each column are not significantly different at *p*= 0.05 accordind to Duncan's Multiple Range Test.

Table 3. Tuber properties.

Treatments		Average of tuber weight (g)	Tuber length (cm)	Tuber diameter (cm)	Tuber dry weight %	Tuber specific gravity (g cm^{-3})	Starch %	Ash%
Spunta	T1	188 a	11.0 a	6.0 a	17.89 b	1.102 b	11.946 b	4.78 a
Mondial	T2	179 a	10.3 ab	5.9 a	16.14 c	1.098 b	10.384 c	5.06 a
LadyRosetta	T3	90 b	6.3 c	5.0 b	23.63 a	1.137 a	17.058 a	4.40 a
Alaska	T4	188 a	9.6 b	6.1 a	15.10 d	1.095 b	9.455 d	4.48 a

Means followed by the same letter/s in each column are not significantly different at *p*= 0.05 accordind to Duncan's Multiple Range Test.

REFERENCES

Abong GO, Okoth MW, Imung JK, Kabira JN. 2010. Evaluation of selected Kenyan potato cultivars for processing into potato crisps. Agriculture and Biology Journal of North America Biol J N Am, 1 (5): 886-893.

Abong GO, Okoth MW, Karuri EG, Kabira JN, Francis M. 2009. Nutrient contents of raw and processed products from Kenyan potato cultivars. Journal of Applied Biosciences 16: 877 - 886.

Akhavan S, Moosavi SF, Mostafazadeh P, Gadami A. 2007. Study of drip and furrow irrigation with regard to yield and WUE in potato cultivation. J Sci Tech Agric Nat Resour, 11 (41): 15-26.

Ali A, Rab A, Hussain AS.2003. Yield and Nutrients Profile of Potato Tubers at Various Stages of Development . *Asian Journal of Plant Sciences*. 2003, 2: 247-250.

Alsharari SF, Alsadon AA, Alharbi AR. 2007. Evaluation of drought tolerance of potato cultivars under greenhouse conditions. Acta Hort (ISHS), 747:67-74.

AOAC. 1980. Official Methods of Analysis. Association of Official Analytical

AOAC. 2005. Official Methods of Analysis. Association of Official Analytical

Arzani A.2001. Breeding crop plants (translated). Esfahan University of Technology press. Second edition. 257 pages.

Belhjati S, Choukan R, Hassanabadi H, Delkhosh B. 2013. The evaluation of yield and effective characteristics on yield of promising potato clones. Annals of Biological Research, 4 (7): 81-84.

Burton WG. 1966. Specific gravity as a guide to the content of dry matter and of starch in potato tubers. In: The potato. Burton, WG (Ed.), pp. 305-308. Veenman H and Zonen BV. Wageningen, The Netherlands.

Bussan AJ, Mitchell PD, Copas ME, Drilias MJ. 2007. Evaluation of the effect of density on potato yield and tuber size distribution. Crop Sci 47: 2462-2472.

Chemists, 13Th ed, Washington, USA.

Chemists, 18Th ed, Gaitherburg, Maryland 20877-2417, USA.

Chung H, Li X, Kalinga D, Lim S, Yada R, Liu Q. 2014. Physicochemical properties of dry matter and isolated starch from potatoes grown in different locations in Canada. Food Research International, 57: 89-94.
Damavandi A, Asle-Gorgani R. 2005. Effect of cultivar and plant density on growth and distribution of dry matter in potatoes. J Agric Sci, 15 (4): 25-39.
Dinesh K, Ezekiel R, Singh B, Ahmed I. 2005. Conversion table for specific gravity dry matter and starch content from under water weight of potatoes grown in North India plains. Potato J, 32 (1-2): 79-84
Dorota D, Rafal Z, Mieczyslaw N, Renata S. 2011 .Characterization of five potato cultivars according to their nutritional and pro-health components. Acta Scientiarum Polonorum. Technologia Alimentaria, 10 (1): 73-80.
Gorgani A, Ali D. 2004. Effect of cultivar and plant density on potato yield components and tuber yield. J Agric Sci, 14 (3):41-50.
Hanan A, Ali N, Inayatullah H. 1998. Cooperative performance of the French cultivars in Peshawar valley. Sarhad J Agric, 3: 460–70.
Hassanpanah D**,** Hassanabadi H, Azizi Chakherchaman SH. 2011. Evaluation of cooking quality characteristics of advanced clones and potato cultivars. American Journal of Food Technology, 6: 72-79.
Ifenkwe OP, Alen EJ. 1978. Effect of row width and planting density on growth and yield of two main potato varieties. I: Plant morphology and dry matter accumulation relationships with above ground stem. J Agric Sci, 91: 256-269.
Kabira J, Berga L. 2003. Potato processing quality evaluation procedure for research and food industry applications in east and central Africa. Kenya Agric Res Insti. Nairobi.
Kaur S, Aggarwal P. 2014. Studies on Indian potato genotypes for their processing and nutritional quality attributes. Int J Curr Microbiol App Sci, 3 (8): 172-177.
Midmore DJ, Prange RK. 1992. Growth responses of two *Solanum* species to contrasting temperatures and irradiance levels: relations to photosynthesis, dark respiration and chlorophyll fluorescence Ann Bot 69 (1): 13-30
Miller RA, Harrington JD, Kuhn GD. 1975. Effect of variety and harvest date on tuber sugars and chip color. Am Potato J, 52: 379-386.
Ministry of Agriculture (MoA).2013. Annual reports of agriculture production. Ministry of Agriculture, Gaza, Palestine.
Moorby J. 1978. The physiology of growth and tuber yield, pp. 153–194. In P.M. Harris, (ed.). The Potato Crop: The Scientific Basis of Improvement. Chapman & Hall. London, UK.
NIVAA. 2002 on the road to potato processing http://www.potato.nl/files/ontheroad_uk.pdf
Ranjbar M, Mirzakhan M. 2012. Response of agronomic and morphologic characteristics of commercial and conventional potato cultivars to greenhouse condition. Intl J Agri Crop Sci, 4 (6): 333-335.
Sadiq M, Tariq AH, Iqbal M, Asghar KA. 1995. Evaluation of red
skinned exotic indigenous potato strains at vegetable Res. Faisalabad. pp: 32–8. Research and Development of Potato Production in Pakistan.
Steel, RGD, Torrie JH, Dickie DA. 1997. Principles and procedures of statistics, A Biometric Approach. 3rd Ed. McGraw-Hill, Co. Singapore p. 204-227.
Subarta M, Upadhya MO. 1997. Potato production in western Bengal. Environ Ecol, 15: 646–9.
Tai GCC, Coleman W. 1999. Genotype environment interaction of potato chip color. Can J Plant Sci 79: 433-438.
Tekalign T, Hammes PS. 2005. Growth and productivity of potato as influenced by cultivar and reproductive growth: II. Growth analysis, tuber yield and quality. Sci Hort, 105: 29-44.
True RH, Hogan JM, Augustin J, Johnson SR, Teitzel C, Toma RB, Shaw RL. 1978. Mineral content of freshly harvested potatoes. Am. Potato J, 55: 511-519.
Woolfe JA. 1987. The potato in the human diet. CIP_Lima. Cambridge University Press, Cambridge, Britain. Pp. 19-54.
Wurr DCE, Fellows JR, Allen ER. 1992. Determination of optimum tuber density in the potato varieties. Journal of Agricultural Science. 119:35-99.
Wurr DCE, Fellows JR, Allen ER. 1993. An approach to determining of optimum tuber planting density for production of tubers in early potato varieties. J Agric Sci, 120: 63-70.