Effect of Cultivars, Nitrogen and Potassium Fertilizer Levels on Potato Yield and Chipping Quality

***El Hakim S. Z., **A. M. El Gamal, **Thanaa. M.Ezz and **Omayma E.Shaltout.**

*Chips for food industries ** Plant production department, and*** food technology department, Fac. of Agric. Saba basha, Alex. Univ.

ABSTRACT

Two field experiments were conducted during the two successive winter seasons of 2008-2009 and 2009-2010 to study the effect of 3 potato cultivar,100, 150 and 200 kg nitrogen (N), and 50, 100 and 150 kg potassium (K) K_2O / fed combinations on the production of potato tubers suitable for processing.

The results of this study indicate that Herms (Her) cultivar overcropped Lady Rossitta (L.R) and Lady Jo (L.J), respectively, and gave lowest in specific gravity (Sp.gr) and the highest in reducing sugars (R. S) and chips defects (Ch.d). L.R was characterized with higher yield than L.J, and similar to the other two in the accepted % of tubers for processing (ATFP), where R.S, exhibited the highest Sp. gr and the lowest Ch. D after processing. Generally, Lady Jo was in a moderate position between the two other cultivars in most of the studied characters.

Increasing either N or K levels resulted in higher tuber potato yield with more ATFP. Specific gravity increased by increasing K level. Reducing sugars and potato defects decreased as a result of increasing K level or by reducing N level. Herms was the highest in yield when fertilized with 200 kg N/ fed and, with either 100 or 150 kg K_2O / fed. Herms at the highest level of N, gave the highest level of R.S and Ch. D. The lowest R.S and Ch. D were obtained from L.R cultivar under 100 kg N or 150 kg K. The highest Sp.gr was obtained when L.R cultivar was fertilized with 100 or 150 kg K at any level of N. On the other hand, L.J cultivar exhibited the lowest levels of R.S and Ch. D when fertilized with 100 kg K and 100 kg N or when L.R cultivar was fertilized with 100 kg N and 150 kg K.

INTRODUCTION

Potato (Solanum tuberosum, L.) is one of the most important vegetable crops in Egypt for local consumption and export. It gained a considerable importance as an export crop to European and Arabian markets, and it is considered to be one of the national income resources (Mahmoud and Hafez, 2010). Moreover, potato is used in many industries, such as French fries, chips, starch and alcohol production (Abdel-Aal, *et al.*, 1977).

The acceptability of potatoes for processing as french fries or chips is largely dependent on the color of the end product. Color is directly related to the quantity of sugars in the tuber. The quantity and composition of sugars in tubers is dependent on cultivar, stage of maturity, occurrence of stress, and handling and storage management practices. These differences might be due to the differences among the cultivars regarding the, maturity, tuber initiation time, vigority of the haulm, light intersection, physiological activity, and the ability to accumulate photosnthitically substances. Saluzzo *et al* (1999), and Tekalign and Hammes (2005), reported that some cultivars produced the highest total tuber yield when compared to some other cultivars.

Total tuber yield was increased by increasing N rates (El Gamal 1985, Jenkins and Nelson, 1992, Maier, et al., 1994, and El Gamal 1996). Potato response to applied K is influenced considerably by the cultivar growing (Trehan, 2007). K fertilizer did not improve potato yield or Sp. gr (Davenport and Bentley 2001). Some other researchers reported that K rate did not improve yield (Chapman, et al, 1992 and El Gamal, *et al*, 1993). Many researchers reported that K has desirable effects on potato crop and quality. The potato tuber yield was increased as K level increased according to El khatib, *et al*, (2004) and Mahmoud and Hafez (2010). It was recorded before, by Khan, *et al*, (2010) that K enhanced potato tuber yield and, also, improved the quality of the produce. Similarly, McDole (1978), and Satyanarayana and Arora (1985) reported that insufficient K resulted in reduced yield and smaller tubers which were rejected for processing.

As a matter of fact, high Sp. gr and tuber dry matter percentages in cultivars resulted in a higher crisp yield and a lower oil consumption percentage, which are advantageous to processing industry (Kumar, *et al*, 2007). Tuber Sp. gr did not follow a constant trend as affected by K application. It was either unaffected (Abd elgadir, *et al*, 2003) or decreased (McDole, 1978 and Westerman *et al* 1994). On the other side Mohmoud and Hafez (2010) and El-Moshileh, *et al*, (2005) noted that Sp. gr was increased by increasing K level. However, Zelalem, et al, (2009) reported that both dry matter and Sp. gr contents, slightly, decreased with increasing N level. On the contrary, Kara (2002) reported positive effects of N fertilization on Sp. gr, dry matter content, crops yield and protein content of potato tuber. Anon, (2005) also indicated that K application decreased R. S, improved Sp. gr and chip color for processing potato. Khan, *et al*, (2010) reported that potatoes with high Sp. gr were preferred for preparation of chips and French fries but potatoes with very high Sp. gr (1.10) might not be suitable for French fries production because they became hard or biscuit like. So purpose of growing potato should be kept in mind. According to

Kabira and Berga (2003), potatoes which had a Sp. gr value above 1.080 were suitable for processing in to crisps and French fries, while, tubers with Sp. gr values less than 1.070 were generally unacceptable for processing. Reust (1987) found that N fertilization rate ranging from 0 to 240 kg N/ha, did not affect tuber taste and processing quality (in particular, reducing sugar content).

Bansal and Trehan (2011) reported that K fertilizer application decreased R. S and improved chips colour during processing. On the contrary, Rajanna, *et al.* (1987) found that potassium fertilizer increased reducing sugar. The primary reason for these sugar concentrations being a concern in industry was due to the reaction of R. S (glucose and fructose) with amino acids in the presence of heat (frying) to form a darkened color of fried products (Millard Reaction) (Nora Olsen et al 2005). R. S and crisp color were found to be positively correlated (Kumar, *et al*, 2007).

Crisp quality was influenced by both genotype and environment, as reported by Stevenson, *et al.* (1964). Irene, *et al.* (1964), also reported that cooking quality of potato is influenced by the genetic factors inherent in a cultivar. Potatoes showed reduced internal, external and discoloration defects with optimal N management (Stark and Westermann, 2003). Low N and high K treatments gave best yield, quality and commodity rate of tuber among treatments (Yang 1993).

Now in Egypt a great part of potato crop is directed to chips production to supply the Egyptian and foreign market throughout the year. The chipping companies complain about the discoloration of the product due to the high R. S even after a considerable storage period after harvesting. Factories in most cases use the available cultivars of potato in the market without a recognition between the suitable and undesirable type for chips production, which leads frequently to bad quality and low quantity of the end product. According by, this study aimed to know the more suitable cultivar for high crop with good quality production, under the most result able conditions of N and K fertilizer levels.

MATERIALS AND METHODS

Two field experiments were conducted at EL-Nubarya Rigion, Chipsy Company farm in Beheira Governrate during the two winter potato growing seasons of 2008/2009 and 2009/2010. Local produced certified potato seed tubers of L.J, L.R and Her cultivars were tested. Planting took place in the first of October of both seasons in a wet soil, using whole seed tubers.

One hundred whole locally produced seed tubers were planted in two rows, 0.90 m wide, 12.5 m long and at 0.25 m apart between hills, making an area of 22. 5 m^2 for each experimental plot. Phosphorus fertilizer was applied at the rate of 46.5 kg P_2O_5/fed, in the form of monocalcium super phosphate 15.5% P_2O_5, added once in the opened row at planting time, to all of the experimental plots to test the effect of 50, 100, and 150 kg K_2O / fed. Three N levels (100, 150 and 200 kg N/fed) were also tested. A factorial experiment in a randomized complete blocks design, with three replicates was used in both seasons. All possible combination of the three potato cultivars x three N levels x three K_2O levels were randomly distributed in the blocks.

All other agricultural practices for potato production were followed as recommended in the area. Harvesting was accomplished after 120 days from planting in both seasons.

Random potato tuber samples were taken from each treatment, washed and cleaned by running water, peeled using carbarundum mechanical potato peeler (model No20 fimar Co., Italy), with size 14 lbs., grit size 1-1.5mm for 1.5 to 2 minutes. Washed peeled potatoes were trimmed by hand using stainless steel knives, mechanically sliced into slices, 1.3 to 1.5 millimeters thickness by Lama 220 slicer (model Shed Co, Italy). The resulted slices were washed to remove the released starch formed during slicing. The slices were immersed in palm oil at 185^{0}C until fried, using pilot fryer, 8 liter capacity, (model Bartlett D11E30, Italy). When the oil in the fryer reached to 185^{0}C, power to the fryer was immediately switched off then the basket containing potato slices was immersed in the oil. The basket was moved out vigorously after 3 minutes from frying in the oil to prevent the sticking of slices together. Samples of chips were inspected for defects according to the standards of Frito Lay Company (1999). A complete randomize design was used in the experiment.

The following measurements were performed to assess physical and chemical parameters: Total tuber yield per plot (weighed and then converted into tons/fed). Potato yield accepted for processing %., the suitable tubers for processing per plot (weighted and related to total yield as a percentage). Specific gravity, it was calculated using the method described by (Dinesh *et al.*, 2005). Reducing sugars content (%), was determined according to the method of Dubois *et al.* (1956) on fresh weight basis. Chips defect evaluation was calculated by showing the size limits (1/2 cm) for sugar browning and defects using chip

– check chart method to determine the internal, external and undesirable color (Frito Lay Company.1999).

Statistical analysis of data: All the collected data from both seasons were tabulated and statistically analyzed using the analysis of variance technique. Duncan's multiple range tests (Steel *et al.*, 1997) was applied to determine the difference between the means at $p \leq 0.05$.

RESULTS AND DISCUSSION

Generally, the data collected from this study in both seasons, were too much similar to each other.

Total potato tuber yield is amended by the used potato cultivar (Table, 1). The highest productive one among them was Her followed by L.R and then L.J. The cultivars defected differences might be due to the inherent differences among the cultivars regarding the, maturity, tuber initiation time, vigority of the haulm, light interception, physiological activity, and ability to accumulate photosynthitically substances. This result seemed to be in agreement with that of Saluzzo *et al* (1999), and Tekaling and Hammes (2005), who stated that some cultivars produced higher total tuber yield when compared with other evaluated cultivars. Total tuber yield was increased with increasing N rates (Table, 1) which agree a with the reported reults of (El Gamal, 1985, Jenkins and Nelson, 1992, Maier et al. 1994 and El Gamal, 1996). Potato response to applied K was influenced considerably by the growing cultivar in the experiment, as found by Trehan (2007). Potassium fertilizer appeared to increase potato yield when 100 or 150 kg K2O / fed were used in both seasons of the study. There was an insignificant difference between the highest ttwo levels (Table, 1). K fertilizer did not improve potato yield or Sp. gr, as reported Davenport and Bentley, 2001. Some other researchers reported that K rate did not improve total potato yield (Chapman, *et al*, 1992, and El Gamal, *et al*, 1993). However, many researchers reported that K has desirable effects on potato crop and quality. The potato tuber yield was increased as K level increased according to El khatib, *et al*, (2004) and Mahmoud and Hafez (2010).

Nitrogen was noticed to interact with K to change potato tuber yield in both seasons (Table, 1). The highest potato yield was obtained when Her cultivar was fertilized by either 100 or 150 kg K_2O / fed in both seasons. Such an interaction N x K resulted in the lowest tuber yield when N was 100 kg / fed and K was 50 kg / fed. The second order interaction (C x N x K) appeared to show a visible effect on potato tuber yield. The highest yield produced in this respect was when Her cultivar was fertilized with 100 kg N / fed and either 100 kg or 150 kg K_2O / fed in both experiments (Table 1). The lowest yield of all was produced when L.J cultivar was fertilized with 100 kg N / fed and 50 kg K_2O / fed.

None of the used cultivars exceeded the other in respect to accepted yield for processing, in both seasons (Table, 2). Applying N to the potato crop in an increasing manner caused a pronounced and significant increase in the accepted yield for processing in the first season only (Table, 2). This result could be related to the effect of N on producing a large number of tubers and in the meantime, increased tuber size. It might also reduced the number of small tubers, which are rejected from processing. Likely, it might also improved the tergedety of the tubers by photosynthates and water that may increase, its tolerance to miss handling. N might also increased the portion of large tubers which was in favor of the ATFP. The percentage of ATFP increased gradually and significantly as K level was increased in both seasons. This result might be accepted on the basis that K resulted in a sturdy plant and, in turn, sturdy tubers, which could tolerate miss handling browses and cracks during harvesting. In addition K might increased the tuber content of solids specially starch. It was previously recorded by Khan, *et al*, (2010) that K enhanced potato tuber yield and, also, improved the quality of the produce. Similarly, McDole (1978), and Satyanarayana and Arora (1985) reported that insufficient K resulted in reduced yield and smaller tubers, which are rejected from processing.

Adding K at the rates of 100 or 150 kg / fed to any of the studied cultivars improved the tuber quality in both seasons of the study (Table 2). The highest accepted percentage of tubers were obtained when 100 or 150 kg N /fed were used combined with 150 kg K_2O / fed.

The behavior of the potato cultivars was completely different when fertilized with different levels of N in both seasons. In the first season, however, Her cultivar responded to 100 and 200 kg N / fed, and L.J cultivar responded to 100 and 150 kg N / fed, whereas, the cultivar L.R did not respond to any N level in the production of acceptable tubers for processing. In the second season, Her and L.R did not respond to N levels, but, L.J when fertilized with 200 kg N / fed produced the least percentage of the ATFP. These results seemed to reflect the effect of the genetic environment enteraction on the behavior of potato crop which appeared to be in accordance with Saluzzo *et al.* (1999), and Tekalign and Hammes (2005).

The combined effect of N and K changed the percentage of the ATFP in both seasons (Table 2). The highest obtained accepted yield was gained when 100 or 150 kg N / fed were combined with 150 kg K_2O / fed in the first season. In the second one the lowest percentage were obtained when 150 or 200 kg N / fed were combined with 50 kg K_2O / fed. The second order interaction between cultivar x N x K levels apparently affected the percentage of the ATFP, in both seasons (Table 2). The highest percentages were gained with any given cultivar by increasing both N and K levels and vise versa.

All the tested cultivars gave the same quality of tubers suitable for processing. The increased percentages of this category of tubers by increasing K levels might be related to the increasing effect of K to the tuber size of the small tubers, which reduced the percentage of small tuber. It might also improved the tolerance of tuber to miss handing by balancing the moisture status. Likely, N caused the same effect on the tergedety of the tubers by photosynthates and water that might increased its tolerance to miss handling. It also increased the percentage of large tubers which was in favour of the accepted tubers for processing. Potato tuber Sp. gr of the three used cultivars was approximately the same in the first season of the study (Table 3). But, in the second season L.R cultivar produced higher tuber Sp. gr than the other two, which was more desired for crisp production. High Sp. gr and tuber dry matter percentage of cultivars, resulted in higher crisp yield and lower oil consumption percentage, which were advantageous to processing industry, as reported by Kumar, *et al*, (2007). Tuber Sp. gr did not follow a constant trend as affected by K application. It was either unaffected (Abd elgadir, *et al*, 2003) or decreased (McDole 1978 and Westerman, *et al*, 1994). On the other hand Mohmoud and Hafez (2010) and El-Moshileh, *et al.* (2005) noted that Sp. gr was increased by increasing K level. Sp. gr of potato tuber was not affected with N level (Table 3). There is general agreement that high level of N reduced Sp. gr and tuber dry matter. However, Zelalem *et al* (2009) reported that recently both dry matter and Sp. gr contents slightly decreased with increasing N level in Ethiopia. On the contrary, Kara (2002) reported that positive effects of N fertilization on Sp. gr, dry matter content, crops yield and protein content of potato tuber. Anon (2005), also, indicated that K application improved Sp. gr and chip color of processed potato.

The highest values of Sp. gr was obtained when L.R cultivar was fertilized with either 100 or 150 kg K_2O / fed, but in the second season only, in the first season tuber Sp. gr was not significantly change (Table, 3). The highest Sp. gr values were resulted from Her when fertilized with 100 or 150 kg N and 150 kg K_2O / fed, or from L.R cultivar when fertilized with 100 kg or 150kg K at any level of N. concerning L.J cultivar, the highest Sp. gr of tubers was obtained when fertilized with 150 kg K and 150 kg N (Table, 3). Khan *et al* (2010) reported that potatoes with high Sp. gr are preferred for preparation of chips and French fries but potatoes with very high Sp. gr (1.10) might not be suitable for French fries production because they became hard or biscuit like. Thus, the purpose of growing potato should be kept in mind. According to Kabira and Berga (2003), potatoes which had a Sp. gr value above 1.080 were suitable for processing in to crisps and French fries, while, tubers with Sp. gr values less than 1.070 were generally unacceptable for processing.

Reducing sugars of potato tubers were found to be affected with the cultivar, N and K levels and their interactions, in both seasons of the study (Table, 4). The highest tuber R. S content was given by Her cultivar and the lowest was that of L.J and L.R without significant difference between them in both seasons. This result might be attributed to the abundance of hydrolyzing enzymes found in the tubers of high level of N. Such enzymes interconvert sucrose to R. S. Increasing N level gradually increased R. S in potato tubers in both season. However, Reust (1987) found that N fertilization rate ranging from 0 to 240 kg N/ha, did not affect tuber taste and processing quality (in particular, reducing sugar content). In contrast, increasing K level resulted in significant decreases in tuber R. S content in both seasons. This reducing effect might be due to the limited available water controlled by K, which inhibits the activities of hydrolyzing enzymes. This result is in accordance with the results reported by Anon (2005), and Bansal and Trehan (2011), who found that K fertilizer application decreased R. S and improved chips colour during processing. On the contrary, Rajanna, *et al.* (1987) reported that potassium fertilizer increased reducing sugar.

The highest R.S content was that of Her cultivar when fertilized with 200 kg N / fed, and the lowest was obtained from any used cultivar with 150 kg K in the first season (Table, 4). In the second season the highest was also that of Her cultivar when fertilized with 200 kg N / fed and the lowest were these of any used cultivar when fertilized with 100 kg N / fed. Generally, the lowest level of tuber R. S content was given when 100 kg from both N and K were used or 150 kg K was used with 100 kg N / fed, in both seasons.

Potato cultivar x N x K levels interaction appeared to affect tuber R. S content in both seasons (Table, 4). The use of low level of N and high K level produced potato tubers having a low level of tuber R. S content, which was in favor of the production of quality crisps. Crisps prepared from potatoes having a higher amount of R. S turned brown and become unacceptable to consumers (Ezekiel, *et al.*, 2003). The primary reason for these sugar concentrations are an important concern was due to the reaction of R. S (glucose and fructose) with amino acids in the presence of heat (frying) to form a darkened color of fried products (Nora Olsen et al 2005). R. S and crisp color were found to be positively correlated (Kumar, *et al*, 2007).

Potato Ch. d appeared to be affected with potato cultivar used, in both seasons (Table, 5). The highest defects were found to be those Her cultivar and the lowest were these of L.J cultivar in both seasons. However, L.J and L.R were not significantly differ from each other in the first season. Crisp quality was reported to be influenced by both genotype and environment (Stevenson *et al.* 1964). Irene, *et al.*, (1964) also reported that cooking quality of potato is influenced by the genetic factors inherent in a cultivar. Flavor of cooked potato was one of the attributes most frequently cited by consumers when evaluating the acceptability of cultivars. From a sensory point of view, it was usually considered as a composite of the aroma and taste of the tubers, both of which are dependent upon its constituents and the changes occurring to them during cooking.

Nitrogen level increased the tuber defects in both seasons (Table 5). Potatoes showed reduced internal, external and discoloration defects with optimal N management (Stark and Westermann, 2003). Reust (1987) found that N fertilization rate, ranging from 0 to 240 kg N/ha, did not affect tuber taste and processing quality. On the contrary increasing K level reduced tuber Ch. d in both seasons, although in the second season there was an insignificant difference between the effects of 100 and 150 kg K_2O / fed. Anon. (2005), also, indicated that K application improved chip color score. Bansal and Trehan (2011) reported that K fertilizer improved quality parameters of tuber processing, with translocated more photosynthates from the leaves and stems to the tuber.

Her cultivar when fertilized with the highest level of N, 200 kg N / fed, it showed the highest Ch. d in both seasons, and the lowest defects were remarked in L.J or L.R cultivars when fertilized with 100 kg N / fed, in the first season (Table, 5). In the second one the lowest defects were these of L.J cultivar when fertilized with 100 kg N / fed. The Ch. d appeared to be affected with potato cultivar x K level interaction in both seasons. The abundant defects were found when Her was fertilized with 50 kg K_2O / fed only, in both seasons. The lowest percentage was also obtained when L.R was fertilized with any of the tested levels of K, or when L.J or L.R cultivars were fertilized with 150 kg K_2O / fed. In the second season the lowest defects were found when the potato cultivar L.J was fertilized with either 100 or 150 kg K_2O / fed, or when the cultivar L.R cultivar was fertilized with 150 kg K_2O / fed. The highest level of Ch. d was defected when 200 kg N / fed and 50 kg K_2O / fed were applied to the potato crop, and the lowest was found when 100 or 150 kg K_2O / fed were used with 100 kg N / fed in the first season. In the second season the highest Ch. d were found when the potato crop received 200 kg N / fed and 100 or 150 kg K_2O / fed levels, and the lowest was noticed when 100 kg N / fed was used with 100 or 150kg K_2O / fed.

Potato Ch. d were significantly affected by the interaction effects among cultivars x N x K levels in both seasons (Table, 5). Low N+ high K treatment gave best yield, quality and commodity rate of tuber among various treatments (Yang, 1993). The highest defects were found when Her cultivar was fertilized with 50 or 100 kg K_2O / fed, in the first season or when it was fertilized with 100 kg K_2O / fed in the second season. The lowest Ch. d were found also when L.J was fertilized with 100 or 150 kg K_2O / fed, and when the cultivar L.R was fertilized with 100 kg of both N and K.

CONCLUSION AND RECOMMENDATION

From the above mentioned results it could be concluded that potato cultivars are different in their genetic make-up and behavior. Each cultivar, if it is necessary, could be used as a chips product at certain conditions of fertilization. Generally, using moderate levels of N and K, 150 and 100, respectively is recommended to produce high quality tubers which produce good quality chips with the lowest level of defects after frying, and low oil and energy consumption. The cultivar L.R is recommend to be the most suitable cultivar chosen among the tested ones at moderate levels of N and K to be planted, for using its crop in potato chips production with the minimal crisp defects.

REFERENCES

Abdel- Aal, Z. S.; A. M. Khalf-Allah, M. A. Al-Shal, and M. M. Abd-al-Qader 1977. Vegetables production Part 2., Dar. Al-Madboat. Al-Jadida, (Publsher) Alexandria, A.R.E. pp.15-57.

Abdeldagir, A. H., M. A. Errebhi, H. M. Al Sarhan and M. Ibrahim. 2003. The effect of different levels of additional potassium on yield and industrial qualities of potato (Solanum tuberosum L.) in an irrigated arid region. Amer J. Potato Res. 80:219-222.

Al-Moshileh1, A. M., M. A. Errebhi and M. I. Motawei 2005. Effect of various potassium and nitrogen rates and splitting methods on potato under sandy soil and arid environmental conditions. Emir. J. Agric. Sci. 2005. 17 (1): 01-09.

Anon ymous, 2005, Annu. Rep. Project on Effect of Potassium Sulphate and Murriate of Potash on Potato Cultivars used for Chip Processing Institute

Bansal. S. K. and S.P. Trehan (2011). Effect of potassium on yield and processing quality attributes of potato. India Karnataka J. Agric. Sci., 24 (1): (48-54) 2011.

Chapman K. S. R, L.A. Sparrow, P. R. Hardman, D. N. Wright, and J. R. A. Thorp. 1992. Potassium nutrition of Kennebec and Russet Burbank potatoes in Tasmania: Effect of soil and fertilizer potassium on yield, petiole and tuber potassium concentrations, and tuber quality. Australian J. Exp. Agric. 32:521-527.

Davenport, J. R., and E. M. Bentley. 2001. Does potassium fertilizer form, source, and time of application influence potato yield and quality in Columbia basin. Amer. J. Potato Res. 78:311-318.

Dinesh, K., R. Ezekiel, B. Singh and I. Ahmed. 2005. Conversion Table for Sp. gr dry matter and starch content from under water weight of potatoes grown in North India plains. Potato J., 32 (1-2) 79-84

Dubbois, M.,K.A. Gilles, J.K. Hamilton, P.A. Rebers and F. Smith 1956. Calorimetric method for determination of sugars and related substances. Analytical chem.28:250-356.

El Gamal A. M (1985). Effect of potassium level on potato yield and quality. J. gric. Sci. Mansoura Univ. 10 (4): 1478 – 1476.

El Gamal, A. M, A. N. Fayed and A. M. Daoud 1993. Effect of potassium and zinc applications of leaf analysis, potato yield and seed quality. Minia. J. Agric. Res. And deve. Special issue. Mania first conference for horticulture crops, 19 – 21. Oct. 1993.

El Gamal, A. M. (1996). Response of potato in the newly reclaimed area to mineral nitrogen fertilizer levels and nitrogen fixing bio fertilizer HALEX2. Increasing number of stems resulted in an increase in the number of potato tuber.

Elkhatib. H. A, E. A. Elkhatib, A. M. Khalaf Allah and A. M. El-Sharkawy (2004). Yield Response of Salt-Stressed Potato to Potassium Fertilization: A Preliminary Mathematical Model. JOURNAL OF PLANT NUTRITION. (1), pp. 111–122.

Frito Lay Company. 1999. Potato sending Manual. Operations quality system department. Leicester, United kingdom.

Irene H, R. Stuckey, Tucker E, and Sheehan J.E. 1964. Cooking qualities of Rhode Island potatoes. Am Potato J 41(1):1–13.

Jenkins, P.D. and D.G. Nelson. 1992. Aspects of nitrogen fertilizer rate on tuber dry-matter content of potato cv. Record. Potato Res. 35: 127-132.

Kabira J, and Berga L. 2003. Potato processing quality evaluation procedures for research and food industry applications in East and Central Africa. Kenya Agricultural Research Institute, Nairobi, Kenya.

Kara K (2002) The effects of nitrogen and phosphorus applications in various planting time and at different doses on quality. 3th National Potato Congress, 23–27 September 2002, İzmir, Turkey, pp 347–363.

Khan .M. Z, M. E. Akhtar, M. N. Safdar, M. M. Mahmood, S. Ahmad and N. Ahmad.2010. Effect of source and level of potash on yield and quality of potato tubers. Pak. J. Bot., 42(5): 3137-3145.

Kumar. P, S. K. Pandey, B. P. Singh, S. V. Singh, D. Kumar. 2007. Influence of Source and Time of Potassium Application on Potato Growth, Yield, Economics and Crisp Quality. Potato Research (Indian). 50:1–13.

Mahmoud, A. R., and M. M. Hafez. 2010. Increasing productivity of potato plants (Slanum tuberosum, L.) by using potassium fertilizer and humic acid application . International journal of academic research vol.2. No. 2. March 2010.

Maier N.A., A.P. Dahlenburg and C.M. Williams. 1994. Effects of n trogen, phosphorus and potassium on yield, Sp. gr, crisp colour and tuber-chemical composition of potato (Solanum tuberosum L.) cv. Kennebec. Aust. J. Exptal. Agric. 34: 813-824.

McDole R. E. 1978. Potassium fertilizer trials with potatoes on coarsetextured soils in southern-eastern Idaho. Am Potato J 55: 161-170.

Nora, O, G. Kleinkopf, L. Woodell and T. Brandt.2005. Processing quality: cultivars, vine kill and storage. Presented at the Idaho Potato Conference on January 18, 2005.

Rajanna, K. M., K. T. Shivasankar and K.S. Krishnappa. 1987. Effect of different levels of nitrogen, phosphorus and potassium on growth, yield and quality of potato. South Indian Horticulture 35:347- 355.

Reust W. 1987. Effect of nitrogen fertilizer application on cooking and processing quality of recent potato cultivars. Revue Suisse d, 19 (6): 281-287.

Saluzzo J.A., H.E. Echeverria, F.H. Andrade and M. Huarte. 1999. Nitrogen nutrition of potato cultivars differing in maturity. J Agron. Crop Sci.183:157-165.

Satyanarayana, V, and P. N Arora. 1985. Effect of nitrogen and potassium on yield and yield attributes of potato (var. Kufri Bahar). Indian J. Agron. 30:292-295.

Stark, J.C. and D.T. Westermann. 2003. Nutrient Management. In J.C. Stark and S.L. Love (eds) Potato Production Systems. University of Idaho Agricultural Communications, Moscow, Idaho. p. 115-135.

Steel, R.G.D., J.H. Torrie and D.A. Dickie. 1997. Principles and procedures of statistics, A Biometric Approach.3rd Ed. McGraw-Hill, Co. Singapore p. 204-227.

Stevenson F. J, R. V. Akeley and C.E. Cunningham. 1964. The potato—its genetic and environmental variability. Amer Potato J 41(2):46–53.

Tekalign T. and P.S. Hammes. 2005. Growth and productivity of potato as influenced by cultivar and reproductive growth. II. Growth analysis, tuber yield and quality. Scientia Hort. 105: 29-44.

Trehan,S.P. 2007, Efficiency of potassium utilization from soil as influenced by different potato cultivars in the absence and presence of green manure (Sesbania aculeata). Advances Hort. Sci., 21(3) : 156-164.

Westermann D.T, T.A. Tindall, D.W. James, and R.L. Hurst. 1994 Nitrogen and potassium fertilization of potatoes: Yield and Sp. gr. Am Potato J. 71:417-431.

Yang Xian Guan Peicong Li Baoqing 1993. The effects of NK interaction on yield, quality and uptake of nitrogen, phosphorus and potassium in potato (Solanum tuberosum L.). Journal of South China Agricultural Universty.

Zelalem A, Tekalign T and Nigussie, D. 2009. Response of potato (Solanum tuberosum L.) to different rates of nitrogen and phosphorus fertilization on vertisols at Debre Berhan, in the central highlands of Ethiopia. Afr. J. Plant Sci. 3:16–24.

Table (1) Effect of cultivar, levels of N, K and their interactions on potato total tuber yield (ton / fed) during the winter season of 2008-2009 and 2009-2010.

		2008-2009				2009-2010			
varieties	**N / K**	**50 kg K**	**100 kg K**	**150 kg K**	**Mean**	**50 kg K**	**100 kg K**	**150 kg K**	**Mean**
Hermes	100 kg N	10.65e-h*	12.42bc	12.57bc	**11.88bc**	11.37def	11.80cde	11.69cdef	**11.62c**
	150 kg N	11.30b-h	12.30bcd	12.10b-f	**11.90bc**	11.78cde	12.43cd	11.95cd	**12.06bc**
	200 kg N	11.89b-g	15.15a	14.37a	**13.80a**	12.75c	14.03a	13.90ab	**13.56a**
		11.28c	**13.29a**	**13.01a**	**12.53a**	**11.97bc**	**12.76a**	**12.51ab**	**12.41a**
Lady Jo	100 kg N	9.10i	10.25hi	10.48f-i	**9.94e**	9.15h	9.64gh	9.86gh	**9.55e**
	150 kg N	10.53e-i	10.71d-h	10.53e-i	**10.59de**	9.96gh	10.05gh	10.67efg	**10.23d**
	200 kg N	10.70d-h	11.24c-h	11.44b-h	**11.13cd**	12.07cd	12.49cd	11.82cde	**12.13bc**
		10.11d	**10.73cd**	**10.82cd**	**10.55c**	**10.39f**	**10.73ef**	**10.78ef**	**10.63c**
Lady Rosita	100 kg N	10.43ghi	11.63b-h	12.13b-e	**11.40cd**	10.04gh	10.54fg	10.55fg	**10.38d**
	150 kg N	11.21c-h	12.69bc	12.91b	**12.27b**	11.47def	12.01cd	12.14cd	**11.87c**
	200 kg N	11.13c-h	12.08b-f	11.18c-h	**11.47bc**	12.12cd	12.87bc	12.73c	**12.57b**
		10.92cd	**12.13b**	**12.07b**	**11.71b**	**11.21de**	**11.81cd**	**11.81cd**	**11.61b**

Table (1 cont.)

100 kg N	10.06e	11.44cd	11.73bcd	**11.07c**	10.19e	10.66de	10.70de	**10.52c**
150 kg N	11.01d	11.90bc	11.85bcd	**11.59b**	11.07cd	11.50c	11.59c	**11.39b**
200 kg N	11.24cd	12.83a	12.33ab	**12.13a**	12.31b	13.13a	12.82ab	**12.75a**
Mean	**10.77b**	**12.05a**	**11.97a**		**11.19b**	**11.76a**	**11.70a**	

* Values with an alphabetical letter in a comparable group of means don't differ significantly from one another using Duncan's Multiple Range Test at 0.05 level of significance.

Table (2) Effect of cultivar, levels of N, K and their interactions on potato accepted yield for processing % during the winter season of 2008-2009 and 2009-2010.

		2008-2009				2009-2010			
varieties	N / K	50 kg K	100 kg K	150 kg K	Mean	50 kg K	100 kg K	150 kg K	Mean
Hermes	100 kg N	95.84d-g*	96.70a-d	97.51a	**96.69a**	96.30a-d	96.97ab	95.53c-e	**96.27ab**
	150 kg N	94.77i	96.92abc	96.78abc	**96.16bc**	96.00a-d	96.13a-d	96.23a-d	**96.12ab**
	200 kg N	95.20ghi	96.58b-e	96.94abc	**96.24abc**	95.53c-e	96.80ab	97.07a	**96.47ab**
		95.27c	**96.73ab**	**97.08a**	**96.36a**	**95.94bc**	**96.63a**	**96.28ab**	**96.29a**
Lady Jo	100 kg N	95.57f-i	96.48b-e	97.13ab	**96.39ab**	96.07a-d	96.63a-c	96.90ab	**96.53a**
	150 kg N	95.24ghi	96.38b-f	96.75abc	**96.12bc**	95.83b-d	96.40a-c	96.30a-d	**96.18ab**
	200 kg N	94.90hi	96.42b-f	96.17c-f	**95.83c**	94.60e	96.03a-d	95.97a-d	**95.53c**
		95.24c	**96.43b**	**96.68ab**	**96.12a**	**95.50c**	**96.36ab**	**96.39ab**	**96.08a**
Lady Rosita	100 kg N	95.73e-h	96.55b-e	96.96abc	**96.41ab**	96.13a-d	96.37a-d	96.07a-d	**96.19ab**
	150 kg N	95.09ghi	96.54b-e	96.93abc	**96.19bc**	95.23de	95.87b-d	96.53a-c	**95.88bc**
	200 kg N	95.26ghi	96.92abc	97.03abc	**96.40ab**	95.97a-d	96.63a-c	96.10a-d	**96.23ab**
		95.36c	**96.67ab**	**96.97a**	**96.34a**	**95.78bc**	**96.29ab**	**96.23ab**	**96.10a**

Table (2 cont.)

100 kg N	95.71c	96.58b	97.20a	**96.50a**	96.17ab	96.66a	96.17ab	**96.33a**
150 kg N	95.05d	96.61b	96.82ab	**96.16b**	95.69bc	96.13ab	96.36a	**96.06a**
200 kg N	95.12d	96.64b	96.71b	**96.16b**	95.37c	96.49a	96.38a	**96.08a**
Mean	**95.29c**	**96.61b**	**96.91a**		**95.74b**	**96.43a**	**96.30a**	

* Values with an alphabetical letter in a comparable group of means don't differ significantly from one another using Duncan's Multiple Range Test at 0.05 level of significance.

Table (3) Effect of cultivar, levels of N, K and their interactions on potato tuber specific gravity during the winter season of 2008-2009 and 2009-2010.

		2008-2009				2009-2010			
varieties	**N / K**	**50 kg K**	**100 kg K**	**150 kg K**	**Mean**	**50 kg K**	**100 kg K**	**150 kg K**	**Mean**
	100 kg N	1.076a*	1.090a	1.081a	**1.082a**	1.074g	1.087a-e	1.089a-d	**1.083abc**
Hermes	**150 kg N**	1.070a	1.077a	1.084a	**1.077a**	1.073g	1.082c-g	1.087a-e	**1.081bc**
	200 kg N	1.066a	1.075a	1.079a	**1.073a**	1.077fg	1.079d-g	1.079d-g	**1.078c**
		1.071a	**1.081a**	**1.081a**	**1.078a**	**1.075e**	**1.083cd**	**1.085c**	**1.081b**
Lady Jo	**100 kg N**	1.077a	1.085a	1.082a	**1.081a**	1.077fg	1.081c-g	1.082c-g	**1.080bc**
	150 kg N	1.076a	1.081a	1.084a	**1.080a**	1.079d-g	1.085b-f	1.091abc	**1.085ab**
	200 kg N	1.076a	1.078a	1.081a	**1.078a**	1.079d-g	1.079d-g	1.086b-f	**1.081bc**
		1.076a	**1.081a**	**1.082a**	**1.080a**	**1.078de**	**1.082cd**	**1.086bc**	**1.082b**
	100 kg N	1.084a	1.095a	1.089a	**1.089a**	1.082c-g	1.089a-d	1.090abc	**1.087a**
Lady Rosita	**150 kg N**	0.753b	1.088a	1.091a	**0.977a**	1.075g	1.090abc	1.090abc	**1.085ab**
	200 kg N	1.076a	1.082a	1.084a	**1.081a**	1.077fg	1.092ab	1.096a	**1.088a**
		0.971a	**1.088a**	**1.088a**	**1.049a**	**1.078de**	**1.090ab**	**1.092a**	**1.087a**

Table (3 cont.)

100 kg N	1.079a	1.090a	1.084a	**1.084a**	1.078c	1.086ab	1.087ab	**1.084a**
150 kg N	0.966b	1.082a	1.086a	**1.045a**	1.075c	1.086ab	1.089a	**1.084a**
200 kg N	1.073a	1.079a	1.081a	**1.078a**	1.078c	1.083b	1.087ab	**1.083a**
Mean	**1.039a**	**1.084a**	**1.084a**		**1.077c**	**1.085b**	**1.088a**	

* Values with an alphabetical letter in a comparable group of means don't differ significantly from one another using Duncan's Multiple Range Test at 0.05 level of significance.

Table (4) Effect of cultivar, levels of N, K and their interactions on potato tuber reducing sugars content (%) during the winter season of 2008-2009 and 2009-2010.

		2008-2009				2009-2010			
varieties	**N ⁄ K**	**50 kg K**	**100 kg K**	**150 kg K**	**Mean**	**50 kg K**	**100 kg K**	**150 kg K**	**Mean**
	100 kg N	0.160d-g*	0.147e-h	0.147e-h	**0.151def**	0.145g-k	0.146g-k	0.145h-k	**0.145d**
Hermes	**150 kg N**	0.178a-d	0.167c-f	0.148e-h	**0.164bcd**	0.163cde	0.167cd	0.147f-k	**0.159c**
	200 kg N	0.200a	0.188abc	0.173b-e	**0.187a**	0.202a	0.189ab	0.176bc	**0.189a**
		0.179a	**0.167ab**	**0.156bc**	**0.167a**	**0.170a**	**0.167a**	**0.156b**	**0.164a**
Lady Jo	**100 kg N**	0.153d-h	0.134gh	0.143fgh	**0.143ef**	0.148e-j	0.138ijk	0.132k	**0.139d**
	150 kg N	0.177a-d	0.146e-h	0.142fgh	**0.155c-f**	0.174cd	0.149e-j	0.141ijk	**0.154c**
	200 kg N	0.197ab	0.165c-f	0.157d-h	**0.173b**	0.196a	0.162c-f	0.160d-h	**0.173b**
		0.176a	**0.148c**	**0.147c**	**0.157b**	**0.173a**	**0.150bc**	**0.144c**	**0.156b**
	100 kg N	0.153d-h	0.132h	0.143c	**0.142f**	0.147e-k	0.134jk	0.138ijk	**0.140d**
Lady Rosita	**150 kg N**	0.175a-d	0.153d-h	0.144fgh	**0.157cde**	0.171cd	0.151e-i	0.145h-k	**0.156c**
	200 kg N	0.189abc	0.164c-f	0.154d-h	**0.169bc**	0.196a	0.161c-g	0.158d-h	**0.172b**
		0.172a	**0.149c**	**0.147c**	**0.156b**	**0.171a**	**0.149bc**	**0.147c**	**0.156b**

Table (4 cont.)

100 kg N	0.155de	0.137f	0.144ef	**0.146c**	0.147d	0.139de	0.138e	**0.141c**
150 kg N	0.177b	0.155de	0.145ef	**0.159b**	0.169b	0.156c	0.144de	**0.156b**
200 kg N	0.196a	0.172bc	0.161cd	**0.176a**	0.198a	0.171b	0.165b	**0.178a**
Mean	**0.176a**	**0.155b**	**0.150b**		**0.171a**	**0.155b**	**0.149c**	

* Values with an alphabetical letter in a comparable group of means don't differ significantly from one another using Duncan's Multiple Range Test at 0.05 level of significance.

Table (5) Effect of cultivar, levels of N, K and their interactions on potato chips defect % during the winter season of 2008-2009 and 2009-2010.

		2008-2009				2009-2010			
varieties	N / K	50 kg K	100 kg K	150 kg K	Mean	50 kg K	100 kg K	150 kg K	Mean
Hermes	100 kg N	8.33d-g*	4.67g-l	4.67g-l	**5.89c**	6.67e-j	5.00ij	4.67ij	**5.45d**
	150 kg N	13.67bc	9.67def	5.67f-j	**9.67b**	9.33cde	8.00c-h	5.00ij	**7.44bc**
	200 kg N	20.33a	15.33b	14.67b	**16.78a**	15.00a	13.00ab	10.67bc	**12.89a**
		14.11a	**9.89b**	**8.34bc**	**10.78a**	**10.33a**	**8.67b**	**6.78c**	**8.59a**
Lady Jo	100 kg N	3.33i-l	1.00l	1.33kl	**1.89d**	5.00ij	2.00k	2.00k	**3.00e**
	150 kg N	7.00e-i	6.00e-j	4.00g-l	**5.67c**	6.33f-j	5.00ij	5.67g-j	**5.67d**
	200 kg N	10.00cde	8.00e-h	7.33e-i	**8.44b**	9.33cde	8.33c-g	8.00c-h	**8.55b**
		6.78cd	**5.00de**	**4.22e**	**5.33b**	**6.89c**	**5.11d**	**5.22d**	**5.74c**
Lady Rosita	100 kg N	3.67h-l	2.00jkl	1.33kl	**2.33d**	5.67g-j	5.33hij	5.00ij	**5.33d**
	150 kg N	7.67e-i	5.33g-k	5.00g-l	**6.00c**	8.00c-h	6.00g-j	6.33f-j	**6.78cd**
	200 kg N	12.33bcd	8.33defg	7.33e-i	**9.33b**	9.67cd	9.00c-f	7.67d-i	**8.78b**
		7.89bc	**5.22de**	**4.55de**	**5.89b**	**7.78bc**	**6.78c**	**6.33cd**	**6.96b**

Table (5 cont.)

100 kg N	5.11c	2.56d	2.44d	**3.37c**	5.78d	4.11e	3.89e	**4.59c**
150 kg N	9.44b	7.00c	4.89c	**7.11b**	7.89c	6.33d	5.67d	**6.63b**
200 kg N	14.22a	10.56b	9.78b	**11.52a**	11.33a	10.11ab	8.78bc	**10.07a**
Mean	**9.59a**	**6.70b**	**5.70b**		**8.33a**	**6.85b**	**6.11b**	

* Values with an alphabetical letter in a comparable group of means don't differ significantly from one another using Duncan's Multiple Range Test at 0.05 level of significance.

الملخص العربي

تاثير الاصناف ومستويات التسميد النيتروجيني والبوتاسي علي انتاجية البطاطس وجودتها لصناعة الشيبسي

*سعيد احمد زكي الحكيم** احمد محمود عبدالحليم الجمل** ثناء مصطفي درويش عز***
اميمة السيد شلتوت

*شركة شيبسي للصناعات الغذائية **قسم الانتاج النباتي ***قسم علوم الاغذية كلية الزراعة سابا باشا- جامعة الاسكندرية

اجريت تجربتان حقليتان في منطقة النوبارية خلال الموسمين الشتويين 2009/2008 و2010/2009 لدراسة تاثير ثلاثة اصناف من البطاطس (الهيرمس, الليدي روزيتا والليدي جو) 100، 150 و200 كجم نيتروجين و 50، 100 و150 كجم بوتاسيوم للفدان. وذلك لتحديد انسب الاصناف ومستويات التسميد من النيتروجين والبوتاسيوم للحصول علي اعلي جودة باعلي انتاجية لصناعة الشيبسي.

واوضحت النتائج ان اي صنف من اصناف البطاطس تحت الدراسة يمكن ان يستخدم في انتاج الشيبسي، ولكن تحت ظروف معينة من التسميد النيتروجيني والبوتاسي. واعطي صنف الهيرمس اعلي انتاجية يلية صنف الليدي روزيتا ثم صنف الليدي جو وكان الهيرمس الاقل في الكثافة النوعية والمحصول القابل للتصنع والاعلي في السكريات المختزلة وعيوب التصنيع. في حين تساوا الصنفان الليدي روزيتا والليدي جو في المحصول القابل للتصنيع وكانا اقل في عيوب التصنيع والاعلي في الكثافة النوعية.

زيادة التسميد النيتروجيني والبوتاسي حسنا الانتاجية، ومع زيادة مستويات التسميد البوتاسي وقلة مستويات التسميد النيتروجيني زادت الكثافة النوعية وقلت السكريات المختزلة والعيوب التصنيعية وزادت نسبة المحصول القابل للتصنيع.

اعطي صنف الهيرمس عند 200 كجم نيتروجين وعند 100 او 150 كجم بوتاسيوم / ف أعلي انتاجية.

صنف البلدي روزيتا اعطي اعلي كثافة نوعية عند التسميد ب 100 او 150 كجم بوتاسيوم عند اي مستوي من النيتروجين وكانت اقل نسبة سكريات مختزلة عند التسميد ب 100 كجم نيتروجين / ف او 150 كجم بوتاسيوم / ف.

في حين ان صنف البلدي جو قد اعطي اقل مستوي من السكريات المختزلة والعيوب التصـنيعية عند التسميد ب 100 كجم نيتروجين / ف و100 كجم بوتاسيوم / ف.

ومن كل ما تقدم يتضح ان الصنف البلدي روزيتا هو انسب الاصناف للانتاج للتصنيع عندما يسمد بالمستويين المتوسطين من كل من النيتروجين والبوتاسيوم (150 كجم نيتروجين و100 كجم بوتاسيوم) ، وذلك للحصول عل شرائح بطاطس جيدة وباقل نسبة من العيوب التصنيعية مع التوفير في كل من الوقت والزيت والطاقة المستهلكين في التصنيع.