Effects of Cytokinin Types and Concentrations on Potato Growth, Yield, and Quality under Field Conditions

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ABSTRACT

Several authors have used Cytokinins (CKs) to boost the production of potato, but data on the varying effects of CK types on potato yield and tuber traits are scarce. In the current study, two field experiments were conducted in sandy loam soil to investigate the effects of different types of CK and concentrations [6-Benzylaminopurine-BAP (20 and 40 ppm), N-(2-chloro-4-pyridyl)-N'-phenylurea-CPPU (10 and 20 ppm) and kinetin-KN (2 and 4 ppm)] on the yield and quality of potato. The collected data, generally, indicates that the treatment with BAP had a remarkable effect on plant fresh weight and chlorophyll content. Moreover, adding BAP increased the N content of potato leaves, while adding CKs did not affect K content in both seasons. In potato tubers, 40 ppm BAP maintained the highest N content, whereas the different types of CK raised P and K levels in both seasons. However, the application of CKs did not have a significant effect on the number of tubers. Except for 20 ppm BAP, the applied CKs increased, often by similar levels, the average tuber weight, total tuber weight per plant, and total yield. In addition, CKs treatment did not impact potato tuber specific gravity or dry matter, in both seasons. However, the application of CPPU and KN lead to produce more tuber starch and reduced sugar. Plants treated with 40 ppm BAP had the greatest total protein content and ascorbic acid in tubers. These results highlight the importance of different CK types on the growth, yield, and quality of potato plants.

Keywords: Potato; *Solanum tuberosum*; Cytokinins; Yield; Quality; Specific gravity; Reducing sugar.

INTRODUCTION

Potato (*Solanum tuberosum* L.) is a crop with various uses that is produced in approximately 368 million tons worldwide. Egypt produces 5 million tons from 0.175 million hectares, with an average yield of 29 tons per hectare (FAO, 2019). In addition to their significance in the fresh market, potatoes are crucial to many foods business; including those that use them in frozen forms, chips, dried goods, and potato starch (Brengi et al., 2021). Potato has a significant part in the Egyptian economy. Therefore, improving the quantity and quality of potatoes is critical for this major crop (Abouelsaad et al., 2022).

Cytokinins (CKs) are a kind of plant growth regulator (PGR) that can influence the plant's life cycle from embryogenesis through senescence (Brengi et al., 2022). In 1950s, Skoog and Miller discovered that DNA from autoclaved herring sperm was an effective stimulant of tobacco pith cell growth in culture (Miller & Skoog, 1953). They determined that the active component was 6-furfurylaminopurine, an adenine derivative, and gave it the name kinetin (Haberer and Kieber, 2002). Zeatin was later shown to be the first spontaneously produced CK in immature corn endosperm and to be the most common CK in coconut milk (Haberer & Kieber, 2002; Kieber & Schaller, 2014). Cytokinins found in nature are adenine derivatives with different replacements at the N6 location of the adenine ring. The list of substances that fit the criteria of CKs has increased to encompass a wide range of natural and synthetic substances, including adenine and phenylurea derivatives. The phenylureas are a class of synthetic CKs, some of which are very active, such as N-(2-chloro-4-pyridyl)-N'-phenylurea (CPPU) (Haberer & Kieber, 2002; Kieber & Schaller, 2014; Werner & Schmülling, 2009). Although the functions of the different forms are unknown, structural changes are expected to alter CK function (Haberer & Kieber, 2002; Kieber& Schaller, 2014).

Cytokinins play several physiological roles in plant development, such as seed germination, growth and proliferation of shoot, flowering, ripening and seed set development of fruit, and senescence (Aremu et al., 2020; Lomin et al., 2020). Their performance as agrochemicals in field experiments, where they improve the growth and yields of a wide range of plants, including horticultural crops, is especially notable (Haberer & Kieber, 2002; Werner & Schmülling, 2009). Cytokinins have been postulated to have an important function in tuberization for a long time (Aremu et al., 2020; Lomin et al., 2020). Cytokinins were used to induce microtubers *in vitro* and to enhance tuberization when given directly to isolated stolons cultivated *in vitro* (Kieber & Schaller, 2018; Aremu et al., 2020; Lomin et al., 2020). Caldiz (1996) discovered in early

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research that foliar application of benzylaminopurine (BAP) at 50 ppm may result in increased tuber production in both field and glasshouse environments. In another study, El-Areiny et al. (2019) showed that foliar application treatments of cytokinin as CPPU improve both yield and quality compared with untreated plants. Overall, several authors have employed Cks to enhance potato field production; however, evidence on the varied impacts of CK types on potato production and tuber characteristics is limited. So, the goal of the study was to find out how different types of CK with different concentrations affect the yield and quality of potato.

MATERIALS AND METHODS

1. Field experiment conditions and treatments

Two field trials were conducted in a private field in the Wady El-Natron region of Beheira Governorate, Egypt, on a potato plant CV. Santana, during seasons of 2019 and 2020. A month before beginning the field experiment, 30 cm-deep soil samples were taken for physical and chemical analysis. According to Jackson (1973) and Gupta et al. (2007), physical and chemical characteristics, respectively, were obtained. Table 1 displays the soil's physicochemical characteristics.

The experiment consisted of seven treatments, each with three replicates, laid out in a randomized complete blocks design. Each experimental unit (12 m^2) consisted of four ridges (4 meters long and 0.75 meters wide), and potato tubers were sown at 30 cm apart. The tubers were sowed during the first and second seasons on 21 and 24 January 2019 and 2020, respectively. The foliar spraying treatments of CKs included the application of 6-Benzylaminopurine-BAP (20 and 40 ppm), N-(2-chloro-4-pyridyl)-N'-phenylurea- CPPU (10 and 20 ppm), and kinetin- KN (2 and 4 ppm) as well as the control treatment (distilled water), were applied at 40 and 60 days after planting. Where, the plant foliage was covered with the spraying solutions until it started to drip.

Pest management and agricultural practices were carried out in accordance with the Ministry of Agriculture's instructions for commercial potato cultivation under Egyptian circumstances. The applied NPK fertilizer rates were 86 kg N feddan^{-1} (ammonium nitrate; 33% N), 35 kg P_2O_5 feddan^{-1} (calcium superphosphate; 16% P_2O_5), and 55 kg K_2O feddan^{-1} (potassium sulfate; 48% K_2O). Irrigation was carried out using a sprinkler irrigation system.

Table 1. Soil physical and chemical properties throughout the two growth seasons.

Soil properties	First season	Second season
Sand (%)	69.2	70.1
Clay (%)	4.3	3.2
Silt (%)	26.5	26.7
Soil texture	Sandy loam	Sandy loam
PH	8.01	7.94
Ec (ms/cm)	0.84	0.82
Organic matter (%)	0.13	0.09
N (%)	0.1	0.94
P (ppm)	11	13
Ca (meq/100g)	17	15.3
Mg (meq/100g)	6.1	6.4
K (meq/100g)	0.18	0.16
Na (meq/100g)	0.31	0.28
CEC (meq/100g)	20.2	19.4

2. Plant parameters

Potato plant growth parameters were assessed 90 days after planting. Samples of five plants were selected from each experimental unit to measure the fresh weight (g) per plant. The relative chlorophyll content of potato leaves was evaluated using the SPAD-502 chlorophyll meter (Konica Minolta Sensing, Japan) (Brengi et al., 2022; Gabr et al., 2022). For each treatment, dry samples of tubers and potato leaves were used to determine nitrogen (N), phosphorus (P), and potassium (K) contents (%) using the techniques previously reported by Page et al. (1982), John (1970), and Cottenie et al. (1982), respectively. Total protein (%) was calculated by multiplying nitrogen % by 6.25 (Mariotti et al., 2008; Brengi & Abouelsaad, 2019). After 120 days of planting, the number of tubers per plant, the average tuber weight (g), total tuber weight (g) and the total yield (ton feddan^{-1}) were also recorded. Starch was measured in dried tuber samples using the Luff-Schoorl technique, which employs acid hydrolysis of starch and titration with sodium thiosulfate as described in the A.O.A.C. procedures (Tobaruela et al., 2018). Tuber dry matter (%) was determined by randomly selecting 100 g of fresh tuber samples and drying them in an electrical oven at 70 C until they reached a consistent weight. The resulting value of tuber dry matter was then expressed as a percentage. Vitamin C content of the potato tubers was determined by titration with iodide potassium using Ranganna (1986) technique and expressed as mg vitamin C per 100 gm fresh weight (Brengi et al., 2018). The method outlined by Kumar et al. (2005) was used to calculate the specific gravity in potato tubers. Reducing sugar content was determined for tuber samples according to the method reported by Ehlenfeldt et al. (1990).

3. Statistical Analysis

All data were statistically analyzed using one-way ANOVA. The Duncan's multiple range test ($p \leq 0.05$) was used to compare means using COSTAT software.

RESULTS AND DISCUSSION

1. Potato vegetative growth and chlorophyll content

Table 2 clearly shows that various types of CKs had distinct effects on the vegetative growth and chlorophyll content of potato plants. In comparison with the control treatment, the highest values of plant fresh weight were found on potato plants treated with BAP, followed by the foliar application of CPPU, in both seasons. On the other hand, the effect of KN treatment did not show a significant increase in the plant weight, in the first season. Instead, in the second season, KN treatment did show significant differences (Table 2). Also, plants given 20 and 40 ppm BAP had the highest chlorophyll content, while other forms of CKs didn't have much of an effect compared to the foliar control (Table 2).

Aremu et al. (2020) highlighted the importance of CKs as agrochemicals to improve shoot proliferation and the growth dynamics of a wide range of horticultural plants. The positive impact of CKs on potato growth undoubtedly takes advantage of their propensity to stimulate cell divisions (Abouelsaad, 2016; Lomin et al., 2020). Also, the apical dominance blocks the formation of lateral shoots, allowing the plant to grow upwards. When apical dominance is lost by CKs, elongation and lateral development are encouraged, and the lateral buds develop into new shoots. El-Anany (2020) demonstrated a considerable improvement in vegetative growth parameters (plant height, number of stems, and plant fresh weight) in response to 50 ppm BAP. In another study, El-Shraiy and Hegazi (2010) observed enhanced vegetative growth parameters at 20 ppm CPPU relative to the control potato plants. Also, CKs application may enhance chlorophyll content in leaf tissues by slowing down chlorophyll degradation and delaying the aging process (Brengi & Abouelsaad , 2019; Aremu et al., 2020). El-Anany (2020) found that potato plants sprayed with BAP had much greater levels of photosynthetic pigments (chlorophyll a, b, and carotenoids) than control plants.

2. Chemical Composition of Potato Leaves and Tubers

The effect of foliar CKs on the minerals in potato plants was not always the same (Tables 3 and 4). The results showed that BAP (both seasons) and 10 ppm CPPU (second season) increased the N content of potato leaves compared with the foliar control (Table 3). Also, BAP increased the P content in the first season only, but the various types of CKs increased the P content of potato leaves in the second season. However, the addition of CKs exhibited similar K content to control plants in both seasons. In potato tubers, the greatest N content was maintained in the 40 ppm BAP treatment, while the various types of CKs increased the contents of P and K, but at comparable levels in both seasons (Table 4).

Cytokinin controls the ability of plants to absorb numerous nutrients from their environment, including N, P, and K; therefore, the nutritional status of the plant may influence the plant's growth and development (Argueso et al., 2009). Perhaps the most well-understood of these is the function of CK in nitrogen absorption (Kiba et al., 2011). Genome-wide microarray studies showed that either CK or nitrate treatments stimulate the expression of a variety of genes involved in primary metabolism, with considerable overlap between the groups of genes activated by either treatment. This link between nitrate and CK led Haberer & Kieber (2002) to think that CK may act as a signal from the roots to the leaves that control how nitrogen is used in each tissue.

Table 2. Effect of CKs on the growth and chlorophyll content of potato plants during the two growing seasons.

	Plant fresh weight (g)		Relative chlorophyll content (SPAD value)	
Foliar Spraying	**1st Season**	**2nd Season**	**1st Season**	**2nd Season**
Control	475.21 d	401.71c	39.93 b	39.51 b
BAP (20 ppm)	563.13 ab	497.22 a	43.17 a	42. 62 a
BAP (40 ppm)	580.60 a	505.12 a	42.17 ab	42. 34 a
CPPU (10 ppm)	525.53 bc	461.55 b	40.00 b	39.42 b
CPPU (20 ppm)	525.42 bc	470.74 b	39.50 b	39.31 b
KN (2 ppm)	503.33 cd	462.32 b	39.33 b	39.66 b
KN (4 ppm)	514.71 cd	470.16 b	39.67 b	39.47 b

Values followed by the same letter imply that there are no significant differences ($p \leq 0.05$) among the foliar spraying treatments.

Table 3. Effect of CKs on the minerals content of potato leaves during the two growing seasons (the results are given in dry weight).

	N (%)		P (%)		K (%)	
Foliar Spraying	**1st Season**	**2nd Season**	**1st Season**	**2nd Season**	**1st Season**	**2nd Season**
Control	1.60 b	1.51 b	0.12 c	0.13 b	1.95 a	1.88 a
BAP (20 ppm)	1.78 a	1.70 a	0.15 ab	0.14 a	1.90 a	1.91 a
BAP (40 ppm)	1.79 a	1.70 a	0.16 a	0.14 a	1.88 a	1.97 a
CPPU (10 ppm)	1.71 ab	1.71 a	0.13 abc	0.14 a	1.97 a	1.85 a
CPPU (20 ppm)	1.67 ab	1.59 ab	0.13 abc	0.14a	1.90 a	1.93 a
KN (2 ppm)	1.63 ab	1.52 ab	0.13 bc	0.14 a	1.94 a	1.90 a
KN (4 ppm)	1.63 ab	1.54 ab	0.14 abc	0.14 a	1.86 a	1.89 a

Values followed by the same letter imply that there are no significant differences ($p \leq 0.05$) among the foliar spraying treatments.

Table 4. Effect of CKs on the minerals content of potato tubers during the two growing seasons (the results are given in dry weight).

	N (%)		P (%)		K (%)	
Foliar Spraying	**1st Season**	**2nd Season**	**1st Season**	**2nd Season**	**1st Season**	**2nd Season**
Control	2.09 b	2.05 b	0.24 b	0.22 b	1.80 b	1.73 b
BAP (20 ppm)	2.15 ab	2.18 a	0.27 a	0.26 a	1.97 a	1.91 a
BAP (40 ppm)	2.17 a	2.17 a	0.28 a	0.27 a	1.99 a	1.94 a
CPPU (10 ppm)	2.11 ab	2.05 b	0.27 a	0.25 a	1.98 a	1.95 a
CPPU (20 ppm)	2.09 b	2.06 b	0.26 a	0.25 a	1.96 a	1.91 a
KN (2 ppm)	2.09 b	2.05 b	0.26 a	0.26 a	1.96 a	1.93 a
KN (4 ppm)	2.11 ab	2.06 b	0.27 a	0.26 a	1.98 a	1.94 a

Values followed by the same letter imply that there are no significant differences ($p \leq 0.05$) among the foliar spraying treatments.

3. Potato yield

A global concern for commercial potato producers is to increase the total yield with appropriate quality characteristics for manufacturing purposes (Rodriguez-Saona & Wrolstad, 1997; Kumar et al., 2005; Ali et al., 2021). In the current study, foliar application of various CKs has been evaluated, offering the potential to achieve those goals. The results showed that except for 20 ppm BAP, the applied CKs increased, often by similar levels, the average tuber weight, total tuber weight per plant, and total yield, compared with the control plants. For example, the 4 ppm KN treatment in the first and second seasons, increased the average tuber weight by 11.55 and 15.73 %, total tuber weight by 16.50 and 15.61%, as well as total yield by 16.83 and 15.56 %, respectively. However, the effect of CK types on tuber numbers was not discernible in any season.

The current findings support the claims made by a number of authors (Roumeliotis et al., 2012; Kolachevskaya et al., 2015) that CKs may enhance potato yield. El-Shraiy and Hegazi (2010) demonstrated that CPPU achieved the highest mean tuber fresh and fresh weights at a treatment concentration of 20 ppm, which increased yield values. Also, according to Njogu et al. (2015) when the quantity of cytokinin as BAP increased, the number of tubers per plant and yield significantly increased. Dwelle & Hurley (1984) discovered that foliar spraying of a commercial seaweed extract called "Cytex" containing CKs at 100ppm resulted in a significant boost in potato yields. In addition, Liu & Xie (2001) showed that the size and weight of mini-tuber potatoes rose with varying CK concentrations. In another study, adding BAP to in vitro cultures increased plant fresh weight and tuber yield in potato plants (Roosta & Rashidi, 2015).

4. Potato tubers quality

The quality of potato tubers is a complex trait that is affected by their intended usage. Santana cultivar is mostly used in the processing industry for frying and chip manufacture (El-Shraiy and Hegazi, 2010; Lomin et al., 2020). A low percentage of reducing sugar leads in less browning of the fries, which is desirable. Texture is enhanced by a high dry matter and starch concentration. A high dry matter percentage allows for less oil absorption while frying, resulting in less oil used per unit output. To endure mechanical pressures experienced during tuber harvesting, transit, and storage, tubers must be solid. The quantity of starch and dry matter in the product, as well as the specific gravity, determine crunchiness and hardness (Ehlenfeldt et al., 1990; Rodriguez-Saona &Wrolstad, 1997; Kumar et al., 2005).

The results showed that treatment with CKs did not affect the specific gravity and the percentage of dry matter of potato tubers in either season (Table 6). However, significantly higher tuber starch and reducing sugar contents were recorded with CPPU and KN as compared with the foliar spray control in both seasons (Table 6 and 7). The highest ascorbic acid (vitamin C) in potato tubers was observed in plants treated with 40 ppm BAP and 20 ppm CPPU (both seasons) as well as 20 ppm BAP (first season), without a significant difference from the values that were obtained with 10 ppm CPPU and KN. Also, the highest total protein content in tubers was observed in plants treated with 40 ppm BAP, with no significant difference with 20 ppm BAP, 10 ppm CPPU, and 4 ppm KN treated plants.

These results agree with El-Shraiy and Hegazi (2010), who found that cytokinin at 10 ppm treatment considerably enhanced the total soluble sugars of potato tubers. Also, Chen et al. (2003) showed that rising cytokinin concentrations caused by antisense repression of the potato box gene resulted in enhanced starch production. In addition, Mousawinejad et al. (2014) found that foliar application of CPPU as cytokinin at 10 and 20 mg l^{-1} on tomato fruit impacted biochemical features such as sugar, treatable acids, and vitamin C content considerably.

Table 5. Effect of CKs on the yield parameters of potato tubers during the two growing seasons.

	Tuber number plant^{-1}		Average tuber weight		Total tubers weight plant^{-1}		Total tuber yield ton feddan^{-1}	
Foliar Spraying	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Control	5.67 a	6. 33a	176.45 bc	150.33 c	1000.98 c	951.58 b	22.788 c	21.750 b
BAP (20 ppm)	6.33 a	6.00 a	171.45 c	155.41 c	1084.28 bc	932.46 b	24.783 bc	21.313 b
BAP (40 ppm)	6.33 a	6.33 a	182.48 b	171.22 b	1152.95 a	1083.82 a	26.352 ab	24.772 a
CPPU (10 ppm)	6.00 a	6.00 a	192.98 a	177.56 a	1150.51 ab	1065.36 a	26.297 ab	24.350 a
CPPU (20 ppm)	5.67 a	6.33 a	196.88 a	178.11 a	1114.87 ab	1127.43 a	25.482 ab	25.769 a
KN (2 ppm)	6.00 a	5.67 a	198.92 a	185.69 a	1184.80 ab	1052.86 a	27.080 ab	24.65 a
KN (4 ppm)	6.00 a	6.33 a	199.82 a	178.05 a	1198.92 a	1127.05 a	27.403 a	25.760 a

Values followed by the same letter imply that there are no significant differences ($p \leq 0.05$) among the foliar spraying treatments.

Table 6. Effect of CKs on the specific gravity, dry matter, and starch content of potato tubers during the two growing seasons.

	Specific gravity		Dry matter (%)		Starch (%)	
Foliar Spraying	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Control	1.10 a	1.11 a	23.56 a	23.66 a	15.84 b	15.81 b
BAP (20 ppm)	1.10 a	1.10 a	23.65 a	23.75 a	15.95 b	15.97 b
BAP (40 ppm)	1.10 a	1.10 a	23.76 a	23.63 a	16.51 b	15.88 b
CPPU (10 ppm)	1.10 a	1.10 a	23.68 a	23.71 a	17.57 a	18.12 a
CPPU (20 ppm)	1.11 a	1.11 a	23.74 a	23.62 a	18.01 a	18.03 a
KN (2 ppm)	1.10 a	1.11 a	23.65 a	23.67 a	18.12 a	17.96 a
KN (4 ppm)	1.11 a	1.10 a	23.85a	23.81 a	18.05 a	17.99 a

Values followed by the same letter imply that there are no significant differences ($p \leq 0.05$) among the foliar spraying treatments.

Table 7. Effect of CKs on the specific gravity, dry matter, and starch content of potato tubers during the two growing seasons.

	Reducing sugars (%)		Ascorbic acid mg/100 gm		Total protein (%)	
Foliar Spraying	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Control	0.12 b	0.11 b	14.40 b	14.37 b	6.83 b	6.80 b
BAP (20 ppm)	0.12 b	0.11 b	14.95 a	14.87 ab	7.16 ab	7.11 ab
BAP (40 ppm)	0.11 b	0.11 b	15.04 a	15.07 a	7.30 a	7.45 a
CPPU (10 ppm)	0.15 a	0.15 a	14.88 ab	14.85 ab	6.95 ab	6.75 ab
CPPU (20 ppm)	0.15 a	0.15 a	14.96 a	14.99 a	6.82 b	6.62 b
KN (2 ppm)	0.16 a	0.15 a	14.87 ab	14.82 ab	6.82 b	6.50 b
KN (4 ppm)	0.16 a	0.15 a	14.86 ab	14.83 ab	6.92 ab	6.80 ab

Values followed by the same letter imply that there are no significant differences ($p \leq 0.05$) among the foliar spraying treatments.

CONCLUSION

Increasing the overall production of potato while maintaining or improving their quality for manufacturing is a major challenge for commercial potato farmers. The obtained data shows that BAP treatment increased plant fresh weight and chlorophyll content. BAP enhanced the N content of potato leaves, while CKs had no effect on K content. 40 ppm BAP maintained the maximum N concentration in potato tubers, whereas CK boosted P and K in both seasons. Except for 20 ppm BAP, CKs enhanced average tuber weight, total tuber weight per plant, and total yield. In both seasons, CKs did not affect potato tuber specific gravity or dry matter. However, CPPU and KN increased tuber starch and reducing sugar. BAP increased tuber protein and ascorbic acid. Finally, it can be assumed that the various forms of CK have distinct effects on the growth, production, and quality of potato.

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الملخص العربي

تأثيرات أنواع السيتوكينين وتركيزاته على نمو البطاطس وإنتاجيتها وجودتها في ظل الظروف الحقلية

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استخدم العديد من الباحثين السيتوكينين لتعزيز إنتاج البطاطس، لكن البيانات المتعلقة بالتأثيرات المختلفة لأنواع السيتوكينين على محصول البطاطس وصفات الدرنات قليلة. في الدراسة الحالية، أجريت تجربتان فى الحقل (٢٠١٩/٢٠٢٠) في تربة رملية سلتية لبحث تأثير الأنواع المختلفة من السيتوكينين والتركيزات[6-Benzylaminopurine-BAP(20 and 40 ppm) و N-(2-chloro-4-pyridyl)-N'-phenylurea-CPPU (10 and 20 ppm) وkinetin-KN (2 and 4 ppm)] على محصول وجودة البطاطس. تشير البيانات بصفة عامة إلى أن المعاملة باستخدام BAP كان لها تأثير ملحوظ على الوزن الطازج للنبات ومحتوى الكلوروفيل. وقد أدت إضافة BAP إلى زيادة محتوى النيتروجين في أوراق البطاطس بينما إضافة الأنواع المختلفة من السيتوكينين لم تؤثر على محتوى البوتاسيوم في كلا الموسمين. ولقد حافظت المعاملة BAP (40 ppm) على أعلى محتوى من النيتروجين، في حين أدت الأنواع المختلفة من السيتوكينين إلى زيادة مستويات الفسفور والبوتاسيوم في كلا الموسمين فى الدرنات. لم يكن لاضافة الأنواع المختلفة من السيتوكينين تأثير معنوي على عدد الدرنات. بينما ادت اضافة الأنواع المختلفة من السيتوكينين المستخدمة (غالبًا بمستويات مماثلة) الى زيادة متوسط وزن الدرنات، إجمالي وزن الدرنات لكل نبات، والمحصول الكلي. بالإضافة إلى ذلك، لم تؤثر الأنواع المختلفة من السيتوكينين على الوزن النوعي لدرنات البطاطس أو المادة الجافة في كلا الموسمين. ومع ذلك، انتجت المعاملة بـ CPPU وKN زيادة فى نشا الدرنات والسكر المختزل.

النباتات المعاملة بـ BAP (40 ppm) اظهرت أعلى محتوى إجمالي من البروتين وحمض الأسكوربيك في الدرنات. وتسلط هذه النتائج الضوء على أهمية أنواع CK المختلفة في نمو وإنتاج وجودة نباتات البطاطس.