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Potato Response to Potassium and Nitrogen Fertilization Under Gaza Strip Conditions

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Abstract: *Two Spring trials were carried out on potato cv. Spunta to investigate the effect of O(K0), 15(K1) and 25(K2) kg K_2O/donum and 0(N0), 10(N1), 20(N2) and 30(N3) kg N/donum and their interactions on the crop growth and productivity. Plant height was significantly increased with nitrogen increase, where N3 had the longest plants. K insignificantly increased the height, where K1×N3 and K2×N3 respectively produced the significantly longest plants. Shoot fresh weight was significantly increased with N increment, and K2×N3, where K1 and K2 insignificantly increased it. Yield as g/plant, ton/donum and tubers number/plant was significantly increased by N increase, where N3 and N2 produced the significantly highest yield. K1×N2 and K2×N3 were the highest g/plant or ton/donum, whereas K1×N2 and K1×N3 were the highest tubers number. Tuber >60mm was significantly increased by N, where K was insignificantly effective, and K1×N2 and K2×N3 were the highest. Tuber 35-60mm insignificantly was increased by N, K, K1×N3 and K1×N2. Tuber weight was insignificantly increased by N and K increase, K1×N2, and K2×N3. Tuber specific gravity showed insignificantly changes. Nitrogen increment significantly increased tuber dry matter percentage, where K0×N3 and K2×N3 had the highest percentage. Leaf total chlorophyll was significantly increased with N increase, where N3 and N2 produced the highest pigment. Potassium had no effect, where K1×N3 and K2×N3 were the highest chlorophyll. Leaf petiole N was significantly increased by nitrogen increment, where K was insignificantly effective. K2×N3, K0×N3, and K1×N3 were the significant highest N content. Petiole K significantly increased as K increased, where K2 was the highest significant content. Nitrogen was of insignificant effect on K, where K2×N1, K2×N2, and K2×N3 were the highest leaf petiol K content.*

Key words: *Leaf; Nitrogen; Potassium; Potato; Tuber; Growth; Yield.*

الملخص: أُجريت تجرُبتان ربيعيتان على البطــاطس صــنف Spunta لدراســة تــأثير 0(K0), 15(K1) 25(K2) كجم K20/دونم، 0(N0), 10(N1), 20(N2) و30(N3) كجم نيتروجين/دونم والتفاعــل بينهــا

على نمو وإنتاجية محصول البطاطس، وقد ازداد معنوياً طول النبـــات بزيـــادة النيتـــروجين، وكانـــت N3 الأطول نباتاً ، وزاد البوتاسيوم غير معنوياً ارتفاع النبات وكانت معنوياًN3×K1 وN3×K2 تباعاً أطولهم، وأزاد معنوياً وزن النبات الأخضر بزيادة النتروجين والتفاعل N3×K2 و زيادةٍ غير معنويةٍ بفعل K1، و K2، وازداد معنوياً وزن المحصول جراماً لكل نبات أوطناً لكل دونم وكذلك عدد الدرنات لكل نبات بزيادة إضافة النتروجين وكانت معنوياً N3، N2 الأعلى والتفاعل N2×K1 وN3×K2 الأعلى محصولاً جرامـــاً لكل نبات أو طناً لكل دونم، وكانت N2×K1 وN3×K1 الأكثر درنات عدداً لكل نبـــات، وزادت معنويـــاً الدرنات بحجم > 60 مليمتراً بزيادة النتروجين، وزيادةً غير معنويةً بفعـــل البوتاســـيوم وكانـــت N2×K1 وN3×K2 الأعلى، وزادت غير معنوياً الدرنات بحجم 35- 60 مليمتراً بفعل النتـــروجين، والبوتاســـيوم، وN3×K1، وN2×K1، وازداد غير معنوياً وزن الدرنة بزيـــادتي النتـــروجين و البوتاســـيوم والتفـــاعلين N2×K1 وN3×K2، ولم يؤثر معنوياً العنصران على الوزن النوعي للدرنة، وازدادت معنوياً نسبة المادة الجافة في الدرنة بزيادة النتروجين وكانت N3×K0 وN3×K2 الأعلى، وازداد معنوياً الكلوروفيل الكلـــي بزيادة إضافة النتروجين وكانت N3 و N2 الأكثر اخضراراً، ولم يكن للبوتاسيوم تأثيرٌ وكانـــت N3×K1 وN3×K2 الأكثر كلوروفيل كلي، وازداد معنوياً محتوى عنق الورقة من النتروجين بزيادة المضاف منـــه ولم يكن للبوتاسيوم تأثيرٌ معنويٌ، وكانت معنوياً N3×K2، وN3×K0، وN3×K1 الأعلى محتـــوى مـــن النتروجين،و ازداد معنوياً البوتاسيوم في عنق الورقة بزيادة إضافته وكانت معنوياً K2 الأعلى، ولـــم يكـــن للبوتاسيوم المضاف تأثيرٌ معنوي على محتواه في الورقـــة، وكانـــت N1×K2 ، وN2×K2، وN3×K2 الأكثر تركيزاً للبوتاسيوم في عنق الورقة.

Introduction

Potato is one of the major vegetable crops in Palestine. It is widely grown for local consumption and exportation, where the yield increase could be achieved by the appropriate horticultural practices. Fertilization in general and with K and N in particular is a controllable factor that affects tuber yield and quality. The farmers used to apply excess of fertilizers that resulted in a higher nitrate status in the underground water and increasing the crop running coast.

Barakat *et al.*(1991) noticed that, potato shoots fresh weight and chlorophyll content were increased with each N dose increment (0, 40, 80, 120 kg N/feddan). The first two doses successively increased total tuber yield, average tuber weight, and tubers number/plant. Tuber specific gravity was higher with the highest two N doses, where no advantage in tuber dry matter was detected due to nitrogen application greater than the first N increment. Locascio *et al.*(1992) reported that yield was not affected with K rate, but specific gravities of tubers were lower in two of three seasons with increasing K rate from 225 to

450 kg/ha. Anabausi *et al*.(1997) application of N increment (0, 125, 250, or 350 kg N/ha) on potato resulted in a significantly increase in plant height, leaf chlorophyll, and leaf N and K content. In addition, application rate increase of all N-sources up to 250 N/ha significantly increased large and medium tubers yield, tuber average weight, and total yield. On the other hand, a reduction was noticed in tuber dry matter and specific gravity due to N rate increasing. Ribeiro *et al.*(1997) observed a significantly increase in potato production and leaves NPK content due to fertilization with the aforementioned elements. Gaber and Sarg (1998) mentioned that the greatest plant fresh weight, yield, and tuber quality was measured in potato cv. Andera. after receiving 150 kg N/feddan. Allison *et al*.(2001) noticed that potassium is rarely applied on potato at rate >210 kg/ha. The element optimum rate application showed insignificantly effect on tuber dry matter, whereas exceeding the K level was occasionally reducing the dry matter. Tawfik (2001) reported that 120 kg K/feddan showed 25-30 % increase in fresh weight of tubers and lowered foliage fresh weight of cv. Spunta in sandy soil and drp-irrigation. In addition, the aforementioned dose gave 10-20% more tuber yield and large tubers than those receiving 60 kg k/ feddan. Belanger *et al.*(2002) reported an increasing in the average of fresh tuber weight with N level (0-25 kg/h) increase and a decreasing in tuber specific gravity. Al-Moshileh *et al*.(2005) indicated that increasing potassium sulfate application rates significantly increased plant height, leaf area, chlorophyll, specific gravity, and marketable tubers yield of potato. In addition, 300 kg N/ha gave the highest marketable tuber yield. Karam *et al*.(2005) observed that K treatments (0, 96, 192, and 288 kg K/ha) significantly increased four potato varieties yield, but contrast responses were reported in dry matter % due to K applications on the different cultivars. Sharmila *et al*.(2006) obtained maximum potato yield (50.3 ton/ha) with N, P_2O_5, K_2O, and Mg application at 240, 240, 240, and 48 kg/ha respectively. Yield was significantly higher (22.4 ton/ha) by the aforementioned formula than that of 120, 240, 120, and 6 kg/ha.

This study aimed to investigate the effect of different potassium and nitrogen levels on growth and productivity of potato crop under Gaza Strip conditions.

Materials and Methods

This investigation was carried out on a certified and cutted tubers of potato (Solanum tuberosum L.) cv. Spunta. Tubers were grown in February of 2001 & 2002 seasons on sandy soil (Table 1) at the Agricultural Experimental Station Farm, Faculty of Agriculture & Environment, Al-Azhar University, Beit-Hanoun, Gaza Strip-Palestine.

The experiment layout was a split-plot in a randomized complete block design with three replications. Potassium were allocated to the main plots, which were splitted for nitrogen levels. The sub-plot replicate contained three lines that each contained 15 plants. Drip-irrigation system of 4 l/h was used, where plants were grown at inter-row spacing 25 cm and the intra-row spacing was 70 cm. The general horticultural practices were applied as recommended for the commercial potato production. Fertilization treatments were as follows : Potassium at 0 (K0), 15 (K1), and 25 (K2) kg of K_2O/donum (1000 m^2) as potassium sulphate (48 % K_2O), where nitrogen was applied at 0 (N0), 10 (N1), 20 (N2), and 30 (N3) kg of N/donum as ammonium sulphate (21% N). The fertilization treatments were splitted into three equal doses, which were applied at 30, 45, and 60 days post-sowing. In addition, basic dressing of 11 kg of P_2O_5 as an ordinary super phosphate (25 % P_2O_5) and 8 m^3/donum of cattle manure had been added before tuber sowing.

Vegetative growth as plant height and plant shoot fresh weight were determined after 90 days of planting. Yield as g/plant, ton/donum, tubers number/plant, tubers size-grades >60, 35-60, and < 35mm (g/plant) were measured at harvesting time after 100 days of sowing. Tuber properties as an average tuber weight, specific gravity (SG) was determined at harvesting time according to the equation that SG = (weight of tuber in air)/[(weight in air) – (weight in water)], and tuber dry matter % was measured by tuber drying at 70 ^{0}C to a constant weight. Leaf analysis (4th mature leaf from the top) was carried out after 75 days of planting as total chlorophyll content according to Holden (1965), leave petiole were dried at 70 ^{0}C for 48 h, then digested by the concentrate H_2SO_4, the wet-digest was devoted for total nitrogen determination by micro-Kjeldahl and potassium was measured by flam–photometer.

Data were statistically analyzed according to Steel and Torrie (1980), where means comparison was carried out using Duncan's multiple range test. Means followed by the same letter/s within columns and rows are insignificantly different at $p = 0.05$.

Results and Discussion

Vegetative growth:

The effect of potassium and nitrogen fertilization on potato plant height is presented in Table (3). It was clear that plant height significantly increased with nitrogen levels increasing in both seasons ,whereas N3 was the highest. The same was also noticed due to potassium applications, however the changes among the treatments were insignificantly. The interactions showed that K1×N3 and K2×N3 respectively were of the significant longest plants. Potato shoot fresh weight (Table 4) also increased in the same aforesaid trend, where the differences between the two higher nitrogen levels were insignificant in the first season. Also, insignificantly differences was observed among the three higher N levels in the second experiment, where the two higher potassium levels insignificantly increased shoot fresh weight. However, the K2×N3 was the significantly heaviest plants shoot, insignificantly changes were observed among the aforementioned interaction and some of the other interactions. Nitrogen plays a significant role in the production of stem and axillary branches (Moorby and Morris 1967). In addition, nitrogen fertilizer increased potato leaf area, which increases the amount of solar radiation intercepted and consequently increases plant height and dry matter production of different plant parts (Krishnippa, 1989). The obtained results were in agreement with those reported by Barkat *et al*.(1991), Gaber and Sarg (1998), and Al-Moshileh *et al*.(2005).

Yield:

Data presented in Tables (5, 6 and 7) showed that yield as g/plant, ton/donum and tubers number/plant increased significantly with nitrogen increasing in the two seasons. However, insignificantly changes were noticed between N1, N2 and N3, the two higher N levels gave the significantly highest yield. The two higher potassium levels were of the slight highest yield. However, most interactions were insignificantly different, the K1×N2 followed by K2×N3 were the highest yield as g/plant and ton/donum. Also, most interactions in term of tubers number/plant were of insignificant changes, where K1×N2 and K1×N3 respectively were of the highest tuber number. Nitrogen affects potato stolons formation by influencing the biosynthesis and activity of phytohormons balance especially the level of gibberellic, abscissic acid and cytokinins (Kumar and Wareing 1972, and Amzallag *et al.*1992).

Tubers size-grade > 60mm as g/plant (Table 8) increased significantly by nitrogen applications in both seasons, where the differences among the three higher N levels were insignificantly. Potassium treatments insignificantly increased the aforementioned grade-size, whereas K1×N2 and K2×N3 respectively were of the highest. Tubers size-grade 35-60mm (Table 9) produced insignificantly a slight increase with nitrogen dose increasing, where K1 insignificantly was of the slight highest increase. Moreover, K1×N3 and K1×N2 respectively were the highest tuber size without significant differences among all the interactions. The size-grade <35mm (Table 10) produced insignificantly a slight decease with K or N levels increasing. The opposite was true for K0×N0 and K0×N2 respectively that had the insignificant highest small size-grade < 35mm as g/plant. These findings found support in the work of Barakat *et al*.(1991), Anabausi *et al.*(1997), Tawfik (2001), Al-Moshileh (2005), Sharmila and Santhu (2006), however Locascio *et al*.(1992) did not find an effect on the crop yield with K rate increasing.

Tuber properties:

Results in Tables (11) showed insignificantly increase in average of tuber weight with nitrogen and potassium increasing in both seasons. The interactions cleared that K1×N2 and K2×N3 respectively were of the heaviest tubers, and this was clearly significant in the second season. Potassium has a crucial role in the energy status of the plant, translocation, assimilates storage and maintenance of tissue water relation (Maschner, 1995). Moreover, potassium influences on the crop quality can also be indirect as a result of its positive interaction with other nutrients especially with N and production practices (Usherwood, 1985). Tuber specific gravity (Table 12) generally was not affected significantly in both seasons by the two elements or their interactions. Tuber dry matter % (Table 13) produced a significantly increasing with N level increment, however potassium treatments showed insignificantly changes. The two elements interactions generally were insignificantly in favor of K0×N3 in the first season and for K2×N3 and K0×N3 in the second one. The increase in average of tuber weight in response to the fertilizer supply increase could be attributed to more luxuriant growth, more foliage and leaf area and higher supply of photosynthates, which may have induced formation of bigger tubers thereby resulting in higher yield (Patricia and Bansal, 1999). The current results agreed with those of Alison *et al*.(2001) who noticed insignificantly effect on tuber dry matter % was due to optimal K level. Contrary results were reported by Al-Moshileh *et al.*(2005) that specific gravity increased by K rate increasing. In addition, the results agreed with Barakat *et al*. (1991), Gaber and Sarg (1998) and Balenger *et al*.(2002) who observed that potato average tuber weight and tuber dry matter % increased with N increasing. Contrary results were reported by Anabausi *et al.*(1997) who noticed a decreasing in potato tuber dry matter % and specific gravity with increasing N application up to 250kg N/ha, where Belanger *et al*.(2002) reported a decrease in tuber specific gravity with N increasing.

Leaf chemical content:

The effect of nitrogen, potassium applications and their interactions on leaf total chlorophyll contents is illustrated in Table (14). The pigment increased significantly with nitrogen level increasing, whereas N3 followed by N2 were the highest content in both seasons. Potassium showed insignificantly effect on the total chlorophyll content, where the interactions produced the highest pigment content by K1×N3 and K2×N3 respectively. Potato leaf petiole N content in the two seasons (Table 15) significantly increased with N fertilization level increasing, however the differences were insignificant between the element two higher doses. Potassium applications were of insignificant effect on petiole N content, where the interactions K2×N3 in the first season and K0×N3 and K1×N3 respectively in the second one were of the significant highest nitrogen content. Insignificantly differences were observed between the two aforementioned interactions and also among some of the other interactions. Leaf petiole K_2O content (Table 16) increased significantly with potassium fertilization dose increasing, whereas K2 treatment was of the significant highest content. Nitrogen treatments were of insignificant effect on petiole potassium content. The interactions were in favor of K2×N2 and K2×N1 respectively in the first season and this was also true for K2×N1, K2×N3 and K2×N2 respectively in the second experiment. The aforementioned results were in agreement with Anabausi *et al.*(1997), Ribeiro *et al.*(1997) and Barakat *et al*.(1991) on potato.

Conclusion and Recommendation

This study aimed at decreasing the running cost of potato production and pollution with chemical fertilizers. However, the difference between three higher N rates were insignificantly; the higher significantly yield and other parameter were achieved by 30 and 20 kg N/donum respectively. Potassium fertilizations significantly increased leaf petiole K content. However, 15 and 25 kg K_2O/donum generally were insignificantly different, application 25 kg K_2O/donum slightly increased yield and the other parameters were insignificantly and positively achieved.

It could be recommended under similar conditions to use nitrogen and potassium at 20 and 25 kg/donum respectively. No benefits could be achieved with nitrogen applications higher than 20 kg N/donum. More studies should be focused on potassium levels, nitrogen sources, application time and other nutrients.

Table (1): Physical & chemical properties of soil

Sample	$CaCO_3$ %		Sand %		Clay %		Silt %		Texture
depth	18.26		97		1		2		Sandy
0-30 cm	S.P. %	EC mmho/cm	Ca + Mg meq/l	Cl meq/l	pH	Na meq/l	S.A.R.	K meq/l	NO3 mg/l
	21.0	0.77	16.53	2.9	8.38	2.32	0.81	0.51	97.0

Table(2): Well irrigation water chemical analysis.

NO3 Mg/l	K meq/l	S.A.R.	Na meq/l	PH	Cl meq/l	Ca+Mg meq/l	EC mmho/cm	S.P.%
319.5	3.52	3.91	11.48	8.39	16	17.29	2.88	22.2

Table (3): Effect of K and N on potato plant height (cm).

	First season					**Second season**				
Treatment	N0	N1	N2	N3	**Mean**	N0	N1	N2	N3	**Mean**
	d	abcd	abc	abc	a	c	c	bc	abc	a
K0	28.2	35.0	37.3	36.7	34.3	25.0	26.1	27.0	30.8	27.2
	cd	ab	a	a	a	bc	abc	abc	a	a
K1	29	38.4	40.9	42.2	37.8	27.0	30.0	29.6	35.3	30.5
	bcd	abcd	ab	a	a	bc	abc	abc	ab	a
K2	31.5	34.4	39.5	42.5	37	26.6	31.5	31.3	33.0	30.6
	c	b	ab	a		c	b	b	a	
Mean	29.7	35.9	39.2	40.5		26.2	29.2	29.3	33.0	

Table (4): Effect of K and N on potato plant shoot fresh weight (g/plant).

	First season					**Second season**				
Treatment	N0	N1	N2	N3	**Mean**	N0	N1	N2	N3	**Mean**
	cd	abcd	abcd	abcd	a	b	ab	ab	ab	a
K0	193	213	232	231	217	146	165	190	196	174
	d	abcd	abc	ab	a	ab	ab	ab	a	a
K1	166	220	268	282	234	176	195	208	221	200
	cd	bcd	abc	a	a	ab	ab	a	a	a
K2	182	201	261	288	233	169	207	218	231	206
	b	b	a	a		b	ab	a	a	
Mean	180	212	253	267		163	189	205	216	

Table (5):Effect of K and N on potato yield (g/plant).

	First season					Second season				
Treatment	N0	N1	N2	N3	**Mean**	N0	N1	N2	N3	**Mean**
K0	ab 814	ab 874	ab 882	ab 976	a 887	b 735	ab 851	ab 840	ab 931	a 839
K1	b 697	ab 804	a 1067	ab 966	a 884	ab 765	ab 812	a 1018	ab 921	a 879
K2	ab 839	ab 927	ab 837	a 988	a 898	ab 806	ab 878	ab 838	ab 942	a 866
Mean	b 783	ab 868	a 929	a 977		b 769	ab 847	a 899	a 931	

Table(6): Effect of K and N on yield (ton/donum).

	First season					Second season				
Treatment	N0	N1	N2	N3	**Mean**	N0	N1	N2	N3	**Mean**
K0	ab 4.649	ab 4.991	ab 5.037	ab 5.577	A 5.064	b 4.199	ab 4.863	ab 4.802	ab 5.319	a 4.796
K1	b 3.984	ab 4.592	a 6.099	ab 5.517	A 5.048	ab 4.374	ab 4.639	a 5.819	ab 5.262	a 5.024
K2	ab 4.794	ab 5.296	ab 4.782	a 5.647	A 5.13	ab 4.607	ab 5.019	ab 4.787	ab 5.385	a 4.950
Mean	b 4.476	ab 4.96	a 5.306	a 5.58		b 4.393	ab 4.840	a 5.136	a 5.322	

Table (7): Effect of K and N on potato tubers number/plant.

	First season					Second season				
Treatment	N0	N1	N2	N3	**Mean**	N0	N1	N2	N3	**Mean**
K0	abc 5.29	abc 5.63	abc 5.63	abc 5.88	a 5.61	c 4.42	abc 5.44	abc 5.35	abc 5.60	a 5.20
K1	c 4.63	abc 5.11	a 6.41	ab 6.17	a 5.58	abc 4.93	abc 5.12	a 6.1	ab 5.83	a 5.50
K2	bc 4.96	abc 5.57	abc 5.71	abc 5.84	a 5.52	bc 4.67	abc 5.25	abc 5.65	abc 5.55	a 5.28
Mean	b 4.96	ab 5.44	a 5.92	a 5.96		b 4.67	a 5.27	a 5.70	a 5.66	

Table (8): Efect of K and N on potato tubers size-grade >60 (g/plant).

	First season					Second season				
Treatment	N0	N1	N2	N3	**Mean**	N0	N1	N2	N3	**Mean**
K0	bc 349	ab 497	abc 444	ab 544	A 459	b 316	ab 471	ab 424	ab 519	a 433
K1	c 263	abc 416	a 605	ab 523	A 452	b 345	ab 411	a 578	ab 499	a 458
K2	abc 452	ab 514	abc 429	ab 559	A 489	ab 449	ab 488	ab 439	ab 533	a 477
Mean	b 355	a 476	a 493	a 542		b 370	a 457	a 480	a 517	

Table (9): Effect of K and N on potato tubers size-grade 35-60mm (g/plant).

	First season					Second season				
Treatment	N0	N1	N2	N3	**Mean**	N0	N1	N2	N3	**Mean**
K0	a 289	a 292	a 275	a 280	a 284	a 261	a 277	a 262	a 267	a 267
K1	a 279	a 263	a 310	a 322	a 294	a 277	a 284	a 296	a 307	a 291
K2	a 262	a 286	a 284	a 275	a 277	a 242	a 271	a 275	a 262	a 262
Mean	a 277	a 280	a 290	a 292		a 260	a 277	a 277	a 279	

Table (10): Effect of K and N on potato tubers size-grade <35mm (g/plant).

	First season					Second season				
Treatment	N0	N1	N2	N3	**Mean**	N0	N1	N2	N3	**Mean**
K0	a 175	a 185	a 162	a 152	a 144	a 158	a 104	a 155	a 145	a 140
K1	a 156	a 124	a 152	a 121	a 138	a 144	a 118	a 145	a 115	a 130
K2	a 126	a 127	a 124	a 155	a 133	a 116	a 120	a 124	a 148	a 127
Mean	a 152	a 112	a 146	a 143		a 139	a 114	a 141	a 136	

Table (11): Effect of K and N on average weight of potato tuber (g/tuber).

	First season					**Second season**				
Treatment	N0	N1	N2	N3	**Mean**	N0	N1	N2	N3	**Mean**
K0	a 121.3	a 141.0	a 130.5	a 142.5	a 133.8	b 109.4	a 136.6	ab 128.5	a 136.3	a 127.7
K1	b 120.0	a 136.0	a 148.3	a 138.0	a 135.6	ab 128.5	a 136.6	a 141.8	ab 132.3	a 134.8
K2	a 145.8	a 145.8	a 130.5	a 144.8	a 141.7	a 140.6	ab 135.8	ab 130.9	a 138.8	a 136.5
Mean	a 129	a 140.9	a 136.4	a 141.8		a 126.2	a 136.3	a 133.7	a 135.8	

Table(12):Effect of K and N on potato tuber specific gravity (g/cm^3).

	First season					**Second season**				
Treatment	N0	N1	N2	N3	**Mean**	N0	N1	N2	N3	**Mean**
K0	a 1.059	a 1.064	a 1.055	a 1.062	a 1.060	a 1.054	a 1.055	a 1.055	a 1.057	a 1.055
K1	b 1.062	a 1.057	a 1.063	a 1.061	a 1.061	a 1.052	a 1.056	a 1.051	a 1.055	a 1.054
K2	a 1.063	a 1.062	a 1.062	a 1.063	a 1.063	a 1.054	a 1.053	a 1.056	a 1.051	a 1.053
Mean	a 1.062	a 1.061	a 1.060	a 1.062		a 1.053	a 1.055	a 1.054	a 1.054	

Table (13): Effect of K and N on potato tuber dry matter %.

	First season					**Second season**				
Treatment	N0	N1	N2	N3	**Mean**	N0	N1	N2	N3	**Mean**
K0	abc 18.59	abc 18.85	abc 18.8	a 19.36	a 18.90	a 17.69	a 17.78	a 18.24	a 18.27	a 18.00
K1	abc 18.49	ab 18.94	ab 18.91	bc 18.23	a 18.64	a 17.86	a 17.97	a 17.92	a 18.01	a 17.94
K2	c 17.86	abc 18.53	abc 18.86	abc 18.85	a 18.53	a 17.33	a 17.57	a 17.84	a 18.28	a 17.76
Mean	B 18.31	a 18.77	a 18.86	a 18.81		b 17.63	ab 17.77	ab 18.00	a 18.19	

Table (14): Effect of K and N on potato leaf chlorophyll content (mg/100 g fresh wt).

	First season					Second season				
Treatment	N0	N1	N2	N3	**Mean**	N0	N1	N2	N3	**Mean**
K0	Ab 105	ab 112	ab 108	ab 109	a 109	ab 88	a 96	a 96	a 98	a 95
K1	B 101	b 100	ab 105	a 117	a 106	ab 95	ab 88	a 97	a 100	a 95
K2	B 103	ab 107	ab 112	ab 112	a 109	b 82	a 97	a 95	a 99	a 93
Mean	B 103	b 106	ab 108	a 113		b 88	a 94	a 97	a 98	

Table (15):Effect of K and N on potato leaf petiol total nitrogen %.

	First season					Second season				
Treatment	N0	N1	N2	N3	**Mean**	N0	N1	N2	N3	**Mean**
K0	c 0.86	b 2.48	ab 2.77	ab 2.92	a 2.26	c 0.104	ab 2.31	ab 2.55	a 2.71	a 2.15
K1	c 1.01	ab 2.54	ab 2.92	ab 3.06	a 2.38	c 0.90	b 2.16	ab 2.53	a 2.69	a 2.07
K2	c 1.29	ab 2.71	ab 2.89	a 3.18	a 2.52	c 1.01	b 2.09	b 2.15	ab 2.51	a 1.94
Mean	c 1.05	b 2.58	ab 2.86	a 3.05		c 0.98	b 2.19	ab 2.41	a 2.64	

Table (16):Effect of K and N on potato potassium %.

	First season					Second season				
Treatment	N0	N1	N2	N3	**Mean**	N0	N1	N2	N3	**Mean**
K0	c 3.55	b 3.23	ab 3.43	ab 3.62	b 3.46	d 2.83	d 3.02	d 2.63	d 2.8	c 2.82
K1	c 4.54	ab 4.8	ab 4.71	ab 4.64	a 4.67	c 3.89	abc 4.10	bc 4.02	abc 4.15	b 4.04
K2	c 4.91	ab 5.11	ab 5.3	a 4.83	a 5.04	abc 4.43	a 4.81	abc 4.50	ab 4.74	a 4.62
Mean	a 4.33	a 4.38	a 4.48	a 4.36		a 3.72	a 3.98	a 3.72	a 3.90	

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