J. Agric. Sci. Mansoura Univ., 29 (6): 3481 - 3494, 2004

RESPONSE OF SUGAR PEAS TO PRE-HARVEST FOLIAR SPRAY WITH POTASSIUM, PASSIVELY MODIFIED ATMOSPHERE PACKAGING, AND PERIOD OF STORAGE UNDER COLD CONDITIONS

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ABSTRACT

This study was carried out in two growing seasons, 1999 and 2000, to investigate the effect of foliar application of potassium (0, 200, 400 and 600 ppm) and size of package (polystyrene trays of 250 and 500 capacities, over – wrapped with transparent pliofilm sheets) on the quality of Sugar peas (cv. Toledo), during cold storage for different periods of time (At harvest, 8 and 16 days). The obtained results indicated that spraying peas plants with potassium yielded peas pods that suffered high losses in both fresh weight and moisture content during storage, compared to control, though the differences among treatments appeared insignificant. However, the detected losses were in proportion to the used concentration of potassium. Chlorophyll contents increased also as a result of potassium foliar application, especially at 600 ppm. Peas pods of better quality during storage, as perceived from the low percentages of culls, were obtained due to potassium-sprayings, regardless of the insignificant differences among potassium treatments. The scores of consumer preference were enhanced due to the application of potassium. Reducing sugars were the highest in peas pods as a result of spraying with potassium at 200 ppm; while 600 ppm increased significantly non – reducing and total sugars. The storage resulted in slight losses in both fresh weight and moisture content of pods. However, the magnitudes of such losses fell within the accepted range that did not seriously affect the pods' quality, a result that was supported by the obtained scores of consumer preference, along with elapsing time of storage. In addition, losses in chlorophylls were slight, but significant in the second season after 16 days of storage. The great deal of the total losses was incident in the first period in both seasons, i.e., 81.8% and 67.12%, respectively. Reducing and non - reducing sugars decreased with storage and most of the reductions were incident in the first term of storage as well. Packaging the peas pods in trays, generally, conserved both losses in fresh weight and moisture content at minimal, especially in the small-sized trays. Both types of packages did not significantly differ from one another in conserving the pods' chlorophyll contents as well as the consumer preference. The small – sized package enhanced retaining the reducing and total sugars better than in the large – sized ones; but both packages did not affect pods' total sugars content.

INTRODUCTION

Edible pods of Sugar peas; also known as Snow peas, are flat type pods, harvested when the seeds are very small and immature. High quality – edible pods should be uniformly green, clean, free from damage, and the stem and calyx should be green and fresh. Storage of Sugar peas should be conducted under the optimum conditions (0°C and 95% - 98% relative humidity) because edible pod peas are highly perishable and will not maintain good quality for more than two weeks. Wilting, yellowing of pods, loss of tenderness, development of starchiness and decay are likely to increase following storage beyond 14 days as reported by Suslow and Cantwell (1998); who also added that pod – peas respired at a low rate (14-15 mg CO_2. $kg^{-1}.hr^{-1}$) when stored at O°C, but the rate of respiration increased (123-128 mg CO_2. $kg^{-1}.hr^{-1}$) if stored at 20°C. Moreover, peas produced a very low level of C_2H_4 (less than 0.1 µl. Kg^{-1}.hr-1) at 20°C; but they were moderately sensitive to C_2H_2 after harvest, which resulted in yellowing and increased decay, where, calyx was more sensitive to C_2H_4 than pod.

The biomass and dry matter accumulation of peas plants increased with increasing rates of potassium and nitrogen up to 27 and 34 days of growth, respectively, but the application of potassium at 57 days without nitrogen reduced progressively the biomass and dry matter as the potassium rate increased (Rao and Rao, 1983). In addition; the application of nitrogen, with or without potassium, increased plant chlorophyll up to flowering. On the other hand, transpiration was low in potassium-deficient plants and increased with increasing the potassium supply. Packing the freshly shelled peas in high density polyethylene bags of gauge 100, resulted in minimum changes in the size, bulk density, physiological weight, crude protein and total soluble sugars, hence, extended the shelf - life of the produce up to 40 and 10 days under refrigerated and ambient conditions, respectively; as reported by Minar and Zehnalek (1989).

The aim of the study reported herein was to investigate the influence of spraying the sugar peas plants with potassium and the size of package on the behavior of some quality attributes, at different periods of cold storage.

MATERIALS AND METHODS

This study was carried out in the two successive seasons, 1999 and 2000, at Sabahia Hort. Res. Stat., Alexandria, to investigate the effects of the pre-harvest foliar fertilization of Sugar Peas plants (cv. Toledo) with potassium solutions; the size of package and storage period, on quality of pods. The following procedures were applied:

A. Foliar spraying with potassium:

Spraying of potassium on peas plants was applied after the onset of flowering, where, three applications were executed at 15 days – intervals. Potassium solutions were prepared at 200; 400; and 600 ppm; whereas, spraying with clean tap water was applied to the control plants.

B. Pre – packaging in consumer's sized - packages:

Peas pods were packaged in polystyrene trays; over - wrapped with a transparent sheets of pliofilm to provide protection for pods; and to help in a passively created modified atmosphere inside packages, as a result of the ongoing respiration of pods during storage under cold conditions (0°C and 95% relative humidity). Two sizes of trays were used that fulfill packing of 250 g or 500 g of pods.

C. Period of storage:

The whole time of storage was 16 days covering two periods each of which was 8 days – factor, in addition to the at harvest time, which was considered as a base for the time factor, at which the comparisons were made.

All the conventional practices were followed during the growing seasons. Harvesting of peas pods was manually accomplished and those harvested at the peak of season were targeted for this study. After harvest, the pods were sorted out, graded for a uniform size, washed with tap water and dried up before packing and packaging. The trays were placed in storage in a CRD experiment. At the end of each period, random samples (trays) were driven out of storage; representing two types of packages, four potassium treatments and three replications; and the pods were subjected to the following measurements:

1 - Percentage of fresh weight loss.
2 - Percentage of culls: unmarketable pods: Peas pods that showed extreme shriveling, yellowing, loss of turgidity and crispiness, and decay were collectively referred to as unmarketable; so, culls, after being weighed.
3 - Percentage of moisture content: A hundred – gram sample was dried up under vacuum in a hot air oven at 60°C until a constant weight, then, the percentage of moisture was calculated.
4 – Consumer's preference: The peas pods that showed a uniform green – bright color, fully turgid, free from damage, and green stem and calyx were collectively considered at their utmost quality condition and given the highest score, on a scale ranging from 1 to 5.
5 - Chlorophylls (mg/ 100g fresh weight): A Five – gram sample of fresh pods was extracted in *N*, *N*-Dimethylformamide and measured on a spectrophotometer at 663 and 644 for chlorophylls a and b, respectively; as described by Moran (1982).
6 - Sugars (mg/ g dry matter): The reducing -, non- reducing - and total - sugars were determined by the method that was described in the A.O.A.C. (2000).

Statistical analyses and analysis of variance were calculated according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Weight loss (%):

Weight loss in peas pods during storage was not affected by the pre - harvest foliar spraying of peas plants with potassium (Table, 1). Generally, the lowest weight loss, in the first season, was recorded for control pods (0.63 %); while, the highest value (0.66%) was resulted from spraying with potassium, either at 200 or 400 ppm. Spraying potassium at 600 ppm, in the second season, resulted in the highest weight loss (2.13 %).

Holding the peas pods in storage, for different periods of time, increased losses in fresh weight, significantly, in both seasons. Storing pods for 8 days resulted in 0.88% and 2.19% of fresh weight losses in first and second seasons, respectively. Also, more significant losses were evident when the time of storage was extended to 16 days, i.e., 1.07 % and 3.83 %, were obtained in corresponding seasons. The importance of keeping water loss from vegetables at the lowest rate is to lower the losses in fresh weights and avoid the development of poor texture that would lead to a degraded quality (Ezell and Wilcox, 1959). Haruschka (1977) reported that moisture losses ranging from 3 – 6 % could be enough to cause losses in quality.

Table (1): Weight loss (%) Of sugar peas, as influenced by pre-harvest foliar spray with potassium, size of package, and period of storage under cold conditions, in 1999 and 2000 seasons.

		(Season 1999)					(Season 2000)				
Pack size	K^+ (ppm)	Period of storage			K^+ x Pack	Mean pack	Period of storage			K^+ x Pack	Mean pack
		At harvest	8 days	16 days			At harvest	8 days	16 days		
250 g	Control	0.0	0.95	0.95	0.63		0.0	1.97	3.64	1.87	
	200	0.0	0.86	0.91	0.59		0.0	2.64	3.26	1.97	
	400	0.0	0.81	0.97	0.59	0.61	0.0	2.16	4.12	2.09	2.01
	600	0.0	086	1.03	0.63		0.0	2.15	4.11	2.09	
Period x Pack.		0.0	0.87	0.97			0.0	2.23	3.78		
500 g	Control	0.0	0.93	0.97	0.63		0.0	2.34	4.04	2.13	
	200	0.0	0.81	1.39	0.73		0.0	2.06	3.64	1.90	
	400	0.0	0.96	1.10	.69	0.69	0.0	1.99	3.50	1.83	2.01
	600	0.0	0.86	1.20	0.69		0.0	2.16	4.34	2.17	
Period x Pack.		0.0	0.89	1.17			0.0	2.14	3.88		
Mean (Period)		0.0	0.88	1.07			0.0	2.19	3.83		
Mean (K^+)		Control = 0.63 400 ppm = 0.64		200 ppm = 0.66 600 ppm = .66			Control = 2.00 400 ppm= 1.96		200 ppm = 1.94 600 ppm = 2.13		

L.S.D. $_{0.05}$ (1999)		L.S.D. $_{0.05}$ (2000)	
K^+ = ns	Pack. x K^+ = ns	K^+ = ns	Pack. x K^+ = ns
Period = 0.06	Pack. x Period = 0.08	Period = 0.21	Pack. x Period = ns
Package = 0.05	Pack. x K^+ x Period = 0.17	Package=ns	Pack. x K^+ x period = ns

Period of storage x Potassium - interaction

Period / K^+[ppm]	(Season 1999) At harvest	8 days	16 days	(Season 2000) At harvest	8 days	16 days
Control	0.00	0.94	0.96	0.00	2.16	3.84
200	0.00	0.84	1.15	0.00	2.35	3.45
400	0.00	0.89	1.04	0.00	2.08	3.81
600	0.00	0.86	1.12	0.00	2.16	4.23

L.S.D. $_{0.05}$ = 0.12 (Season 1999); L.S.D. $_{0.05}$ = ns (Season 2000)

The obtained results indicated that small – sized trays resulted significantly in lower losses in fresh weight than the larger ones, in the first season; while no differences between packages were detected in the second season. Both sizes of trays (250 and 500 gram) kept the incidence of losses in fresh weight at low levels, a result that might be referred to that storage of pods at a low temperature reduced the rates of respiration and transpiration due to the applied protective over - wrapping to trays (Comin and Junilla, 1946; and Kumar and Singh, 2003). It was found that the edible quality of peas pods was better when held in a modified atmosphere at a low temperature than in air for 20 days. Packaging in polyethylene films, as consumer's - size packaging, can restrict the exchange of CO_2, O_2 and water loss; thus, accumulate the evolved CO_2 and lower O_2 level, inside the packages, that could reach a harmful level (Sainsbury, 1961). However, Ryall and Lipton (1972) found that the more ambient O_2, available around packages during storage, the more the gas exchanged between the internal and external package's atmosphere. Significant interactions between packages and periods of storage, as well as the three – ways interaction were detected, but only in the first season.

Moisture content (%):

Spraying peas plants with potassium yielded peas pods that, significantly, contained a higher moisture content than those produced from the control treatment, in both seasons (Table, 2). Significant differences, among concentrations of potassium, were detected in the two seasons as well.

Table (2): Moisture content (%) of sugar peas, as influenced by pre-harvest foliar spray with potassium, size of package, and period of storage under cold conditions, in 1999 and 2000 seasons.

Pack size	K^+ (ppm)	(Season 1999) Period of storage: At harvest	8 days	16 days	K^+ x Pack	Mean (pack)	(Season 2000) Period of storage: At harvest	8 days	16 days	K^+ x Pack	Mean (pack)
250 g	Control	90.52	89.14	87.67	89.11		90.19	88.93	88.91	89.34	
	200	90.96	99.95	88.36	89.42		90.49	89.56	89.47	89.84	
	400	90.13	89.12	88.72	89.32		90.59	89.41	89.91	89.96	
	600	90.48	88.93	89.39	89.60	89.36	90.14	89.32	89.73	89.73	89.72
Period x Package		90.52	89.04	88.54			90.34	89.31	89.51		
500 g	Control	90.15	89.53	88.14	89.27		90.14	88.61	89.74	89.50	
	200	90.79	89.76	88.06	89.54		90.27	89.08	89.78	89.71	
	400	90.81	89.73	88.97	89.84		90.43	89.58	89.78	89.93	
	600	91.18	89.30	88.99	89.82	89.62	90.44	89.53	89.61	89.86	89.75
Period x Pack		90.73	89.58	88.54			90.32	89.20	89.73		
Mean (Period)		90.63	89.31	88.54			90.33	89.26	89.62		
Mean (K^+)		Control = 89.19		200 ppm = 89.48			Control = 89.42		200 ppm = 89.78		
		400 ppm = 89.58		600 ppm = 89.71			400 ppm= 89.95		600 ppm = 89.80		

L.S.D. $_{0.05}$ (Season 1999)		L.S.D. $_{0.05}$ (Season 2000)	
K^+ = 0.33	Pack. x K^+ = ns	K^+ = 0.25	Pack. x K^+ = ns
Period = 0.29	Pack. x Period = ns	Period = 0.22	Pack. x Period = ns
Package = 0.23	Pack. x K^+ x Period=ns	Package = ns	Pack. x K^+ x period = ns

Period of storage x K^+ - interaction

Period / K^+[ppm]	(Season 1999) At harvest	8 days	16 days	(Season 2000) At harvest	8 days	16 days
Control	90.34	89.34	87.91	90.17	88.77	89.33
200	90.88	89.36	88.21	90.38	89.32	89.63
400	90.47	89.43	88.85	90.49	89.50	89.85
600	90.83	89.12	89.19	90.29	89.43	89.67
L.S.D. $_{0.05}$ = 0.57				L.S.D. $_{0.05}$ = ns		

Generally, the higher concentrations of potassium resulted slightly in higher moisture contents in pods, as noticed in the first season. Rao and Rao (1983) found that transpiration was low in potassium – deficient peas plants and increased with the increased potassium nutrition.

As for periods of storage, peas pods contained the highest moisture content at the time of harvesting, i.e., 90.63% and 90.83%, in the respective two seasons; thus, reflecting the highest degree of freshness, crispiness and overall quality; but holding these pods in storage resulted in significant losses in moisture content for each period of storage, a trend that was noticed in both seasons. The calculated losses in moisture were, fortunately, still within the accepted range that could conserve quality of peas pods. Losses in the first season were 1.32% and 2.09% at the end of 8 and 16 days, from the initial content in first season, while the corresponding values in the second season were 1.07% and 0.71%, respectively. As regard to packages, the large – sized packages resulted in retaining higher moisture content in pods than those packed in the small sized trays; significant difference between packages was only evident in the first season. The interaction between period of storage and potassium was the only significant one detected, in first season.

Chlorophyll content (mg/ 100 g fresh pods):

The obtained results (Table, 3) showed that spraying peas plants with potassium raised the chlorophyll content of pods in both seasons. Such detected increments were proportional to the applied potassium concentrations. However, significant differences among concentrations were only detected in the second season; where, the lowest chlorophyll content was in control pods and the highest resulted from spraying with potassium at 600 ppm, in both seasons. The differences among the overall means of chlorophyll contents were found insignificant at the end of periods of storage in the first season. On the other hand, keeping the pods in storage for 16 days resulted in a significant loss in chlorophyll, in the second season; but, generally, there was a slight decrease in chlorophyll as a result of the extended storage. These findings were relevant to those obtained by Soliman (1999), who found that sugar - peas pods lost significant amounts of chlorophyll during the extended storage. Packaging peas pods in small – sized trays, enhanced retaining a significantly higher chlorophyll content in pods than in the large – sized ones, in the second season. Generally, both packages resulted in very close values of chlorophyll contents in each respective season, a result that might be referred to modified – gas composition, developed during storage; thereby, the concentration of CO_2 was elevated, which was necessary to prevent loss of chlorophyll (Groeschell *et al.*, 1966).

Table (3): Chlorophyll content (mg/ 100 g fresh weight) of sugar peas, as influenced by pre-harvest foliar spray with potassium, size of package, and period of storage under cold conditions, in 1999 and 2000 seasons.

		(Season 1999)					(Season 2000)				
Pack size	K^+ (ppm)	Period of storage			K^+ x Pack	Mean (pack)	Period of storage			K^+ x Pack	Mean (pack)
		At harvest	8 days	16 days			At harvest	8 days	16 days		
250 g	Control	5.25	5.63	4.48	5.12	5.70	4.94	5.07	4.18	4.73	6.95
	200	6.42	6.93	4.97	6.11		6.97	7.13	6.99	7.03	
	400	6.15	5.47	5.64	5.75		7.74	7.36	7.50	7.53	
	600	5.76	6.48	5.26	5.83		8.27	8.45	8.84	8.52	
Period x Package		5.90	6.13	5.09			6.98	7.00	6.88		
500 g	Control	4.91	5.85	5.05	5.27	5.76	4.96	4.18	4.28	4.47	6.26
	200	5.91	4.58	5.09	5.19		8.26	6.92	6.79	6.66	
	400	6.64	6.25	5.85	6.25		6.86	6.97	6.75	6.86	
	600	6.51	6.35	6.12	6.33		7.69	6.92	6.50	7.04	
Period x Pack		5.99	5.76	5.53			6.45	6.25	6.08		
Mean (Period)		5.95	5.95	5.31			6.72	6.63	6.48		
Mean (K^+)		Control = 5.20 400 ppm = 6.00		200 ppm = 5.65 600 ppm = 6.08			Control = 4.60 400 ppm= 7.20		200 ppm = 6.85 600 ppm = 7.78		

L.S.D. $_{0.05}$		L.S.D. $_{0.05}$	
K^+ = ns	Package x Period = ns	K^+ = 0.43	Package x Period = ns
Package = ns	Package x K^+ = ns	Package =0.31	Package x K^+ = ns
Period = 0.61	Package x K^+ x Period = ns	Period = ns	Package x K^+x period=ns

Period of storage x K^+ - interaction

Period / K^+[ppm]	(Season 1999) At harvest	8 days	16 days	(Season 2000) At harvest	8 days	16 days
Control	5.08	5.74	4.77	4.95	4.63	4.23
200	6.17	5.76	5.03	8.13	7.03	6.89
400	6.40	5.86	5.75	7.30	7.17	7.13
600	6.14	6.42	5.69	7.98	7.69	7.67

L.S.D. $_{0.05}$ = ns   L.S.D. $_{0.05}$ = ns

Culls (%):

Spraying peas plants with potassium solutions did not reflect significant differences among culls % during storage (Table, 4); though, potassium treatments, generally, lowered the cull % than the control treatment, in both seasons. The obtained result agreed with that obtained by Kuile (1994), who found that spraying of snap bean plants with potassium resulted in pods of high keeping quality, that sustained well in storage.

The Period of storage increased significantly the percentages of culled pods in both seasons, either after 8 or 16 days of storage. Although culls % were the highest after 16 days in both respective seasons, i.e., 8.09 % and 5.14 %, respectively, a substantial proportion of total losses took place during the first period of storage, i.e., 81.8 % and 67.12 %, in the first and second seasons, respectively. This result might be referred to the fact that the peas pods were still biologically active due to the availability of an enough and high concentration of oxygen inside packages that, probably, kept the pods respiring at a high rate, but, as the time of storage was elapsing, an equilibrium in gas composition inside packages might have developed and, consequently, lowered respiration and culling rates (Kader, 1986). The small – sized trays resulted in lower culls % (4.76% and 2.78%) than the larger ones (5.05% and 2.95%) in the first and second seasons, respectively; whereas, significant difference were only detected in the first season.

Table (4): Culls (%) of sugar – peas pods, as influenced by pre-harvest foliar spray with potassium, size of package, and period of storage under cold conditions, in 1999 and 2000 seasons.

		(Season 1999)					(Season 2000)				
Pack size	K^+ (ppm)	Period of storage: At harvest	8 days	16 days	K^+ x Pack	Mean (pack)	Period of storage: At harvest	8 days	16 days	K^+ x Pack	Mean (pack)
250 g	Control	0.0	5.68	9.04	4.91		0.0	3.63	6.23	3.29	
	200	0.0	7.65	7.54	5.06		0.0	3.31	3.90	2.40	
	400	0.0	6.44	7.94	4.79		0.0	3.64	4.44	2.69	2.78
	600	0.0	5.36	7.44	4.27	4.76	0.0	2.78	5.37	2.72	
Period x Pack.		0.0	6.28	7.99			0.0	3.34	4.99		
500 g	Control	0.0	6.96	8.46	5.14		0.0	4.47	6.47	3.65	
	200	0.0	5.31	6.72	4.01		0.0	4.49	4.51	3.00	
	400	0.0	8.21	8.52	5.58		0.0	2.51	4.08	2.20	
	600	0.0	7.30	9.04	5.45		0.0	2.76	6.06	2.94	2.95
Period x Pack		0.0	6.95	8.19		5.05	0.0	3.56	5.28		
Mean (Period)		0.0	6.62	8.09			0.0	3.45	5.14		
Mean (K^+)		Control = 5.03; 400 ppm = 5.19		200 ppm = 4.54; 600 ppm = 4.86			Control = 3.47; 400 ppm= 2.45		200 ppm = 2.70; 600 ppm = 2.83		

L.S.D. $_{0.05}$ (Season 1999)		L.S.D. $_{0.05}$ (Season 2000)	
K^+ = ns	Package x K = 0.94	K^+ = ns	Package x K = ns
Period = 0.57	Package x Period = ns	Period = 0.58	Package x Period = ns
Package = ns	Package x K^+ x Period = ns	Package = ns	Package x K^+ x period = ns

Period of storage x K^+ - interaction

Period / K^+[ppm]	(Season 1999) At harvest	8 days	16 days	(Season 2000) At harvest	8 days	16 days
Control	0.0	6.32	8.75	0.0	4.05	6.35
200	0.0	6.48	7.13	0.0	3.90	4.21
400	0.0	7.33	8.23	0.0	3.08	4.26
600	0.0	6.33	8.24	0.0	2.77	5.72
	L.S.D. $_{0.05}$ = ns			L.S.D. $_{0.05}$ = ns		

Consumer's preference:

Spraying the peas plants with potassium enhanced significantly the consumer's preference of stored pods. Such a positive result was proportional to the applied concentrations of potassium, in the second season (Table, 5). Though, the quality condition of pods was maximal at the time of harvest and the overall mean values of consumer's preference decreased along with time of storage in both seasons, the pods were still in a good salable condition, after 16 days in storage. Insignificant effect was detected in the first season for the size of packages in this respect; whereas, the small – sized trays performed slightly better than the larger trays, and scored higher values for consumer's preference in the second season. Both sizes of trays seemed to contain a passively developed modified atmosphere that resulted in a good - quality produce. Insignificant interactions effects were detected in the first season, while, a significant package x period – interaction effect was the only one detected in the second season, showing that the effect of size of package as an intrinsic factor in respect to quality conservation varied with the time – length of storage.

Table (5): Consumer Preference of sugar peas, as influenced by pre-harvest foliar spray with potassium, size of package, and period of storage under cold conditions, in 1999 and 2000 seasons.

Pack size	K^+ (ppm)	(Season 1999) Period of storage At harvest	8 days	16 days	K^+ x Pack	Mean (pack)	(Season 2000) Period of storage At harvest	8 days	16 days	K^+ x Pack	Mean (pack)
250 g	Control	5.00	4.17	4.33	4.50	4.49	5.00	4.00	3.17	4.06	4.50
	200	5.00	4.33	4.17	4.50		5.00	4.50	4.33	4.61	
	400	5.00	4.17	4.50	4.56		5.00	4.50	4.33	4.61	
	600	5.00	3.67	4.50	4.39		5.00	4.67	4.50	4.72	
Period x Pack.		5.00	4.09	4.38			5.00	4.42	4.08		
500 g	Control	5.00	4.33	4.50	4.61	4.49	5.00	4.00	3.00	4.00	4.26
	200	5.00	4.33	4.83	4.39		5.00	4.33	3.67	4.33	
	400	5.00	4.17	4.50	4.56		5.00	4.50	3.67	4.39	
	600	5.00	4.00	4.17	4.39		5.00	4.17	3.83	4.33	
Period x Pack.		5.00	4.21	4.25			5.00	4.25	3.54		
Mean (Period)		5.00	4.15	4.32			5.00	4.23	3.81		
Mean (K^+)		Control = 4.56 400 ppm = 4.56		200 ppm = 4.45 600 ppm = 4.39			Control = 4.03 400 ppm= 4.50		200 ppm = 4.47 600 ppm = 4.53		

K^+ = ns	Package x K+ = ns	K^+ = 0.14	Package x K+ = ns
Period = 0.21	Package x Period = ns	Period = 0.12	Package x Period = 0.17
Package = ns	Package x K^+ x Period = ns	Package = 0.10	Package x K^+ x period = ns

LSD 0.05 LSD 0.05

Period of storage x K^+ - interaction

Period / K^+[ppm]	(Season 1999) At harvest	8 days	16 days	(Season 2000) At harvest	8 days	16 days
Control	5.00	4.25	4.42	5.00	4.00	3.09
200	5.00	4.33	4.00	5.00	4.42	4.00
400	5.00	4.17	4.50	5.00	4.50	4.00
600	5.00	3.83	4.34	5.00	4.42	4.17

L.S.D. $_{0.05}$ = ns L.S.D. $_{0.05}$ = 0.24

Reducing sugars (mg /g dry matter):

All treatments of potassium sprayings, significantly, increased reducing sugars content of peas pods in the second season (Table, 6), compared to control treatment. Moreover, spraying at 200 ppm was the most effective in this respect; while, spraying at 400 ppm resulted in the lowest content (89.39

mg), in the first season. Such increments in reducing sugars are desirable for the better quality in sugar peas. It was reported that potassium activates the enzymes, which are responsible for sugar biosynthesis and encourage the translocation of sugars from leaves to fruits (Yagodin, 1984). Storage reduced the reducing sugars content in peas pods and the detected reductions were found significant at the end of each consecutive period, in both seasons. Similar results were obtained on snap bean (EL-Sheikh and Saleh, 1998). Peas pods packaged in small – sized trays retained a higher reducing sugars content than those packaged in the lager trays, in both seasons; but a significant difference was only detected in the first season, in favor of small trays.

Table (6): Reducing sugars content 9mg/ g dry matter) of sugar peas, as influenced by pre-harvest foliar spray with potassium, size of package, and period of storage under cold conditions, in 1999 and 2000 seasons.

		(Sason1999)					(Season 2000)				
Pack size	K^+ (ppm)	Period of storage			K^+ x Pack	Mean (pack)	Period of storage			K^+ x Pack	Mean (pack)
		At harvest	8 days	16 days			At harvest	8 days	16 days		
250 g	Control	131.33	104.14	104.73	113.40		116.20	101.01	103.14	106.78	
	200	138.52	107.48	104.73	116.91		140.17	112.46	110.22	120.95	
	400	84.81	103.71	83.35	90.62	108.15	115.39	116.06	116.85	116.10	115.61
	600	124.04	106.48	104.09	111.66		126.72	116.29	112.83	118.61	
Period xPackage		119.68	105.54	99.23			124.62	111.46	110.76		
500 g	Control	118.52	108.96	90.24	105.91		118.50	103.77	99.79	107.35	
	200	124.73	106.83	89.55	107.04		129.83	118.15	104.12	117.37	
	400	85.17	104.13	76.45	88.15	100.68	121.94	119.41	108.66	116.76	114.37
	600	121.96	107.16	75.76	101.63		119.74	115.99	112.48	116.07	
Period x Pack		112.60	106.77	83.00			122.50	114.33	106.26		
Mean (Period)		116.14	106.16	91.12			123.56	112.90	108.51		
Mean (K^+)		Control = 109.66		200 ppm = 111.98			Control = 107.07		200 ppm = 119.16		
		400 ppm = 89.39		600 ppm = 106.65			400 ppm= 116.39		600 ppm = 117.34		

L.S.D. $_{0.05}$ (1999)		L.S.D. $_{0.05}$ (2000)	
K^+ = 5.20	Package x K^+ = ns	K^+ = 4.56	Package x K^+ = ns
Period = 4.50	Package x Period = 6.38	Period =3.95	Package x Period = ns
Package = 3.67	Package x K^+ x Period = ns	Package = ns	Package x K^+ x period = ns

Period of storage x K^+ - interaction

Period / K^+[ppm]	(Season 1999) At harvest	8 days	16 days	(Season 2000) At harvest	8 days	16 days
Control	124.93	106.55	97.49	117.35	102.39	101.47
200	131.63	107.16	97.14	135.00	115.31	107.17
400	84.99	103.92	79.90	118.67	117.74	112.76
600	123.00	107.00	89.93	123.23	116.14	112.66
	L.S.D. $_{0.05}$ = 9.02			L.S.D. $_{0.05}$ = 7.92		

Non – reducing sugars:

The Non – reducing sugars increased in peas the pods of the plants that received potassium spraying at all applied concentrations, in the second season, in comparison to the control treatment (Table, 7). In addition, spraying at 200 ppm and 600 ppm, in first season, resulted in slightly higher retained non-reducing sugars contents. On the other hand, spraying at 400 ppm gave the lowest – retained non – reducing sugars content. At the time of harvest, non – reducing sugars were at the highest level in pods, but some significant reductions took place at the end of each consecutive period of storage in both seasons, Most of the reductions occurred in the first term of storage; i.e , 16.43% and 25 32% from the initial contents in the first and second seasons, respectively. In addition, extending the time of storage to 16 days resulted in losses of 6 01% and 5.56%, from what retained at the end of the first period, indicating that the respiration rate might be higher in the first period than in the second, in both seasons. The packages showed an insignificant difference from one another, in this respect.

Table (7): Non- reducing sugars content (mg/ g dry matter) of sugar peas, as influenced by pre-harvest foliar spray with potassium, size of package, and period of storage under cold conditions, in 1999 and 2000 seasons.

		(Season 1999)					(Season 2000)				
Pack size	K^+ (ppm)	Period of storage: At harvest	8 days	16 days	K^+ x Pack	Mean (pack)	Period of storage: At harvest	8 days	16 days	K^+ x Pack	Mean (pack)
250 g	Control	97.14	71.51	84.73	84.46	74.30	94.48	70.82	59.16	74.82	77.28
	200	91.10	66.97	60.59	72.89		95.70	70.69	64.20	76.84	
	400	56.47	64.89	57.83	59.73		83.81	70.84	61.12	71.92	
	600	91.87	64.94	83.52	80.11		107.77	85.63	63.09	85.50	
Period x Pack		84.15	67.08	71.67			95.44	74.50	61.89		
500 g	Control	58.28	57.19	59.90	58.46	69.85	59.79	61.86	56.88	59.51	78.27
	200	90.74	70.29	66.80	75.94		96.07	67.12	70.15	77.78	
	400	52.79	72.20	55.70	60.23		85.81	65.82	75.81	75.81	
	600	78.52	83.48	49.26	70.42		93.76	75.63	86.49	85.29	
Period x Pack		80.83	70.79	57.92			94.86	67.61	72.33		
Mean (Period)		82.49	68.94	64.80			95.15	71.06	67.11		
Mean (K^+)		Control = 71.46; 400 ppm = 59.98		200 ppm = 74.42; 600 ppm = 75.27			Control = 62.67; 400 ppm= 73.78		200 ppm =77.31; 600 ppm = 85.40		

L.S.D. $_{0.05}$ (Season 1999)		L.S.D. $_{0.05}$ (Season 2000)	
K^+ = 8.34	Package x K^+ = ns	K^+ = 5.08	Package x K^+ = ns
Period = 7.22	Package x Period = ns	Period = 4.40	Package x Period = 6.24
Package = ns	Package x K^+ x Period = ns	Package = ns	Package x K^+ x period = 12.49

Period of storage x K^+ - interaction

Period / K^+[ppm]	(Season 1999) At harvest	8 days	16 days	(Season 2000) At harvest	8 days	16 days
Control	77.71	64.35	72.32	77.14	66.34	58.02
200	90.92	68.63	63.70	95.89	68.91	67.18
400	54.63	68.55	56.77	84.81	68.33	68.47
600	85.20	74.21	66.39	100.77	80.63	74.79

L.S.D. $_{0.05}$ = 14.50 L.S.D. $_{0.05}$ = 12.49

Total sugars (mg/ g dry matter):

The stored pods showed that spraying the peas plants with potassium solutions significantly increased the total sugars content over the control pods, in the second season (Table, 8). On the other hand, spraying with potassium at 400 ppm, in the first season, resulted in the significantly lowest total sugars content in peas pods (149.44 mg); while, the remainder potassium treatments, in addition to the control, did not significantly differ from each other. Storage of pods resulted in reducing the total sugars, compared to the contained amount at the time of harvest. A substantial portion of the total losses in sugars occurred in the first term of storage; but the rate of losses was suppressed during the second period of storage. The total sugars content of peas pods, packaged in the large – sized trays, was significantly lower by 6% than those packaged in the smaller trays and the difference was found significant, in first season. However, a slight difference (0.28%) was detected in the second season that did not reach the level of significance. Similar results were obtained by Soliman (1999).

Table (8): Total sugars content (mg/ g dry matter) of sugar peas, as influenced by pre-harvest foliar spray with potassium, size of package, and period of storage under cold conditions, in 1999 and 2000 seasons.

Pack size	K^+ (ppm)	Season 1999: Period of storage: At harvest	8 days	16 days	K^+ x Pack	Mean Pack.	Season 2000: Period of storage: At harvest	8 days	16 days	K^+ x Pack	Mea pack.
250 g	Control	228.48	175.65	189.46	197.86	181.48	211.69	160.18	173.95	181.95	192.12
	200	229.46	174.46	165.32	189.75		235.87	176.67	180.92	197.82	
	400	141.29	168.61	141.18	150.36		199.20	17.18	187.69	188.02	
	600	215.67	173.84	174.34	187.95		234.49	179.23	188.32	200.68	
Period x Pack		203.73	173.14	167.58			220.31	173.32	182.72		
500 g	Control	219.80	166.15	150.14	178.70	170.59	222.28	160.65	161.65	181.53	191.59
	200	215.47	177.12	156.35	182.98		225.90	199.30	171.24	195.15	
	400	137.96	176.33	131.53	148.61		207.75	195.21	174.48	192.48	
	600	200.48	190.65	125.02	172.05		213.50	202.47	175.63	197.20	
Period x Pack		193.43	177.56	140.76			217.36	186.66	170.75		
Mean (Period)		198.58	175.35	154.17			218.84	179.99	176.74		
Mean (K^+)		Control =188.28; 200 ppm = 186.37; 400 ppm = 149.49; 600 ppm = 180.00					Control=181.74; 200 ppm =196.49; 400 ppm=190.25; 600 ppm=198.94				

L.S.D. $_{0.05}$ (Season 1999)		L.S.D. $_{0.05}$ (Season 2000)	
K^+ = 9.4	Package x K = ns	K^+ = 8.25	Package x K = ns
Period=8.61	Package x Period = 12.22	Period = 7.14	Package x Period = 10.14
Package=7.03	Package x K^+ x Period = ns	Package = ns	Package x K^+ x period = ns

Period of storage x K^+ - interaction

K^+ [ppm] \ Period	(Season 1999) At harvest	8 days	16 days	(Season 2000) At harvest	8 days	16 days
Control	224.14	170.90	169.80	216.99	160.42	167.80
200	222.47	175.79	160.84	230.89	182.49	176.08
400	139.63	172.47	136.36	203.48	186.20	181.09
600	208.08	182.25	149.68	224.00	190.85	181.98

L.S.D. $_{0.05}$ = 17.28 **L.S.D. $_{0.05}$ = 14.34**

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تأثيراستجابه نباتات البسله السكرية للتسميد الورقي بالبوتاسيوم قبل الحصاد، وحجم العبوه، وفترة التخزين المبرد في جو معدل علي جودة القرون

خليل علي سليمان
محطة الصبحيه، معهد بحوث البساتين، مركز البحوث الزراعية

أجريت هذه الدراسة في محطة بحوث البساتين بالصبحيه، بالأسكندريه، في موسمي 1999 و 2000، وذلك لمعرفة تأثير رش نباتات البسله السكريه (صفر-200-400 و 600 جزء في المليون)، و حجم العبوه(صواني من البوليستيرين سعات 250جم و 500جم، والمغلفه برقائق البلايوفيلم الشفاف) و ذلك علي جوده القرون أثناء التخزين المبرد (صفر و 95% رطوبة نسبيه)، لفترات مختلفة(عند الحصاد-8 و 16 يوما). و كانت النتائج كالأتي :-

تأثير الرش بالبوتاسيوم:

رش نباتات البسلة السكرية بالبوتاسيوم أدى إلى زياده الفقد في كل من الوزن الرطب و المحتوى الرطوبي للقرون أثناء التخزين، رغم عدم معنوية هذا الفقد، مقارنه بالكنترول. وقد تناسب ذلك طرديا مع تركيز البوتاسيوم المستخدم في كلي الموسمين. وارتفع مستوى الكلوروفيل في القرون في كلي الموسمين أيضا، خاصة عند استخدامه بتركيز 600 جزء في المليون. لم تتأثر النسب المئوية من القرون الصالحة للتسويق في كلي الموسمين، ومع ذلك أوضحت النتائج أن الرش بالبوتاسيوم كان أفضل من الكنترول في هذا الخصوص. و قد تأكد ذلك بارتفاع قيم تفضيل المستهلك للقرون الناتجة من معاملات البوتاسيوم، و خصوصا عند الرش بتركيز 600 جزء في المليون، في الموسم الثاني. أما بالنسبة للسكريات، فقد أزداد محتوى القرون من السكريات المختزلة باستخدام البوتاسيوم بتركيز 200 جزء في المليون، في كلي الموسمين.أما الرش بتركيز 600 جزء في المليون فقد أدي إلى زياده معنوية في كل من السكريات الغير مختزله و الكلية، مقارنه بباقي التركيزات المستخدمة، اضافه إلى الكنترول.

تأثير التخزين:

أدى التخزين إلى فقد في كل من الوزن الرطب و المحتوى الرطوبي لقرون البسله، ولكن كمياتهما كانتا في الحدود التي لم تؤثر علي جوده القرون أثناء الخزين، حيث لم تتأثر قيم تفضيل المستهلك بالتخزين. وكذلك كان الفقد في محتوى القرون من الكلوروفيل طفيفا، مع أنه كان معنويا في الموسم الثاني. وبلغت نسبه القرون الغير صالحة للتسويق 8.56% في الموسم الأول و 5.14% في الموسم الثاني، و ذلك بعد 16 يوما من بدء التخزين. و لوحظ أن معظم هذا الفقد كان في الفترة الأولي من التخزين حيث شكل 81.8% و 67.12% من جمله الفقد في الموسمين، علي الترتيب. أما بالنسبة للسكريات، فقد تبين أن محتوى القرون من السكريات المختزلة والغير مختزله والسكريات الكلية قد نقص مع فتره الخزين، كما أن معظم الفقد في هذه السكريات قد حدث في الفتره الأولي من التخزين.

تأثير حجم العبوه:

لوحظ، وبوجه عام، أن تعبئه قرون البسله في الصواني المغلفة قد أوضحت أن حدوث الفقد في كل من الوزن الطازج ومحتوى القرون من الرطوبة كان عند الحدود الدنيا، والمقبولة تجاريا، حيث لم تؤثر علي جوده القرون أثناء التخزين. وقد تفوقت الصواني الصغيرة (250 جم) علي الصواني الكبيرة (500 جم) في ذلك. ولوحظ أن العبوات بحجميها حافظت علي نسب متقاربة من المحتوى الرطوبي لقرون البسله. ولم تختلف هذه العبوات فيما بينها في قيم تفضيل المستهلك وفي الحفاظ علي تركيزات متقاربة من الكلوروفيل في القرون في كلي الموسمين. غير أن العبوات الصغيرة كانت في ذلك أفضل من العبوات الكبيرة. أما بالنسبة للسكريات، فقد ساعدت العبوات الصغيرة الحجم في احتفاظ قرون البسله علي محتوى عال من السكريات المختزلة والكلية في كلي الموسمين، ولكن لم يكن هناك فرق جوهري بين العبوات بالنسبة لمحتوى قرون البسله من السكريات الغير مختزله.