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RESPONSE OF SOME SWEET PEPPER HYBRIDS TO NITROGEN AND POTASSIUM FERTILIZER RATES UNDER LOW PLASTIC TUNNELS IN NORTH SINAI

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ABSTRACT

This study was carried out during the two early summer seasons of 2002/2003 and 2003/2004 at The Experimental Farm of The Faculty of Environmental Agricultural Sciences at El- Arish, Suez Canal University, to study the response of three sweet pepper hybrids(Sonar, Gedion and Lamoyo) to three rates of nitrogen(80, 100, 120 kg. N/feddan) and three rates of potassium(50, 100, 150 kg. K_2O/feddan) under sandy soil conditions using drip irrigation system and cultivated under low plastic tunnels. Sonar hybrid had the highest significant values for all studied traits. The high N rate (120 kg N/fed.) had the highest significant effect on all traits of vegetative growth, fruit yield and fruit quality in both seasons without significant differences with the medium N rate for plant height and number of leaves per plant. Also the high K rate had significant effects on all the abovementioned characters. The Sonar hybrid fertilized with 120 kg N+ 150 K_2O/fed. gave the highest significant interaction effects on all vegetative growth parameters, dry matter %, early and total fruit yield, fruit length, in both seasons, and the content of V.C in the second season . The interaction among Lamoyo hybrid and the high rates of N and K had a significant effect on fruit diameter in both seasons. Sonar hybrid had the highest records for fruit content of N and K when fertilized by high N and K rates.

INTRODUCTION

Sweet pepper (*Capsicum annuum* L.) is one of the most important vegetable crops in Egypt. Its cultivation succeeded under protected cultivation in the newly reclaimed soils especially in plastic greenhouses. For minimizing the costs of greenhouses, low plastic tunnels are used for producing sweet pepper in early summer season in North Sinai. The soil in this area is infertile and needs special fertilizing programs.

Little is Known about nutrient requirements of sweet pepper cultivation under low plastic tunnels in this area. Nitrogen and potassium are important nutrients for sweet pepper crop. Nitrogen is the major constituent of the main components of the plant for building up protoplasm, amino acids and proteins which induce cell division and initiate merestimatic activity (Mengel and Kirkby,1978). Potassium is an essential element in carbohydrate, peptide bound formation, protein synthesis and cell division. It plays an important role in the activation of many enzyme systems in the plant. Marschner (1995)decided that the increment in nitrogen supply not only delays senescence and stimulates growth but also changes plant morphology in a typical manner, particularly if the nitrogen availability is high in the rooting medium during the early growth. Increasing rates of N increased plant height and leaf area (Manchanda *et al.*, 1988).

It was reported that K fertilization significantly enhanced plant growth (Medhi *et al.*, 1993). Johanson and Decoteau (1996) observed that leaf and total biomass/pepper plant curvilinearly responded to K rate, but stem biomass linearly increased with increasing K rate. Many researchers reported that increasing K fertilizer rate increased yield of pepper (El-Mansy, 1968; Medhi *et al.*, 1993; Hassan *et al.*, 1994).

Differences among pepper cultivars were detected for dry weight (Swamy and Rao, 1992; Midan, 1995; Pundir and Parwal, 1999), for early yield (Gad 1974; Cebula 1995) and for total yield (Kawarkhe *et al.*, 1989; Swamy and Rao, 1992; Hellemans, 1998; Baudino *et al.*,1999; Pundir and Porwal, 1999). Mishriky and Alphonse (1994) found that increasing N rate significantly increased plant height, fresh and dry weight per plant, number and weight of fruits /plant and total fruit yield.

Therefore, the objective of the present work was to study the response of three sweet pepper hybrids to three rates of both N and K fertilizers under low plastic tunnels in North Sinai.

MATERIALS AND METHODS

This study was carried out during the two early summer seasons of 2002/2003 and 2003/2004 at The Experimental Farm of the Faculty of Environmental Agricultural Sciences at El- Arish, Suez Canal University, to study the response of three sweet pepper hybrids(Sonar, Gedion and Lamoyo) to three rates of nitrogen(80, 100, 120kg. N/feddan) and three rates of potassium(50, 100, 150 kg. K_2O/feddan) under sandy soil conditions, with drip irrigation system and low plastic tunnels. So, this study concluded 27 treatments which were the combinations of three hybrids, three nitrogen rates and three potassium rates. The analyses of the experimental soil and irrigation water are presented in Table 1(a&b).

The nitrogen source was ammonium sulphate (20.5% N), while potassium source was potassium sulphate (52% K_2O). Treatments were arranged in a split- split plot in a randomized complete block design with three replications. The three hybrids were randomly allocated in the main plots. The three nitrogen rates were randomly arranged in the sub plots, while, the potassium rates were randomly arranged in the sub-sub plots. The sub- sub plot area was 10.8 m^2(6m long x 180 cm) .Distance between plants in the same row was 50cm. Pepper seeds were sown in a nursery under a plastic green house on 10th December and transplanted on 15th January in both seasons.

Ammonium sulphate $(NH_4)_2SO_4$ (20.5%N) was divided into four partitions: 10, 30, 40 and 20% of the total amount for each N rate. Potassium sulphate K_2SO_4(52%K_2O) was divided into four partitions: 10, 20, 30 and 40% of the total amount for each K rate. Each of these partitions was divided into four equal parts. The resulted 16 parts of N and K rates were mixed and added together via irrigation water as fertigation (four times per week) beginning at 7 days after transplanting. All plots received the other fertilizers

as fertigation, as recommended for drip irrigation. The other agriculture practices for growing sweet pepper in the district were practiced.

Table 1 a: physical and chemical analyses of the experimental soil .

Soil properties	Seasons 2002/2003 Depth(cm.) 0-30	2003/2004 0-30
Mechanical analysis		
Coarse sand %	68.00	67.99
Fine sand %	20.60	20.55
Silt %	3.50	3.52
Clay %	7.90	7.94
Soil texture	Sand	Sand
Bulk density ($g.cm^{-3}$)	1.53	1.53
Particle density ($g.cm^{-3}$)	2.49	2.49
Chemical analysis (soluble ions in (1:5) extract)		
Ca^{++} ($meq.l^{-1}$)	3.03	2.10
Mg^{++} ($meq.l^{-1}$)	2.11	2.20
Na^{+} ($meq.l^{-1}$)	1.18	4.49
K^{+} ($meq.l^{-1}$)	0.48	0.31
CO_3^{-} ($meq.l^{-1}$)	-	-
HCO_3^{-} ($meq.l^{-1}$)	2.00	2.40
Cl^{-} ($meq.l^{-1}$)	1.02	2.30
SO_4^{-} ($meq.l^{-1}$)	3.78	4.40
EC($dS\ m^{-1}$)	0.68	0.91
pH in (1:2.5 extract)	8.10	8.20
Organic matter % in air dry soil	0.16	0.21
$CaCO_3$ % in air dry soil	3.95	3.95

Table 1 b: Chemical analyses of irrigation water.

pH	EEC	Soluble ions ($meq.l^{-1}$)							
	dSm^{-1}	Cations				Anions			
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	HCO_3^{-}	CO_3^{-}	SO_4^{-}
6.7	5.65	18.12	20.20	17.72	0.25	38.40	6.25	-	11.64

Data Recorded:

1. Vegetative growth:

Three plants of every sub-sub plot were randomly taken at 90 days after transplanting, plant height, number of leaves and plant dry weight were calculated. Plant dry weight was achieved by drying at 70^0C till constant weight.

2. Yield and its components:

Fruits at proper maturity stage (green mature) were picked, counted and weighed for every picking and the following traits were recorded:

1. Number of fruits/m^2 for early and total yield, and
2. Fruit yield/m^2 for early and total yield .The first three pickings were considered as early yield.

3. Fruit quality:

Five fruits were randomly taken from the third picking from each sub sub plot and the following traits were recorded:

1. Fruit length,
2. fruit diameter,
3. fruit flesh thickness,
4. Ascorbic acid content: It was determined using 2,6- dichlorophenol-indophenol method, as described in A.O.A.C.(1990),and
5. fruit dry matter(%).

4. Fruit content of N, P and K:

4.1 Nitrogen (%):

It was determined colorimetrically according to the methods described by Bremner and Mulvaney (1982).

4.2 Phosphorus (%):

It was estimated colorimetrically according to Olsen and Sommers (1982)

4.3 Potassium (%):

It was determined using flame photometrically due to the method described by Jackson (1970).

Statistical analysis:

Data were subjected to the statistical analysis of variance according to Snedecor and Cochran (1967), and the means separation were done according to Duncan (1955).

RESULTS AND DISCUSSION

1. Vegetative growth:

1.1 Effect of sweet pepper hybrids:

Data in Table(2) show that Sonar hybrid had the highest significant values for all studied traits in both seasons. However, there were no significant differences among the three hybrids for plant height and number of leaves per plant in the first season. Since the hybrids had varied genotypes, the differences among sweet pepper hybrids were reported by many researches(Midan, 1995; Hellemans, 1998; Baudino *et al*, 1999; pundir and Porwal, 1999; Chaurasia *et al*, 2002) .

1.2 Effect of nitrogen rates:

Data in Table (2) show that the high N rate had the highest significant effect on all studied vegetative growth traits in both seasons, with no significant differences than the medium N rate for plant height and number of leaves per plant in both seasons.

The satisfactory effects of nitrogen supplementation on the number of leaves of pepper plant could be attributed to the fact that nitrogen encourages the meristematic activity for building more tissues and organs. These findings are in agreement with those reported by Crespo *et al.* (1988), Olsen *et al.* (1993) and Mishriky and Alphonse (1994) who found that nitrogen application led to significant positive effect upon the number of leaves produced on pepper plants.

Table 2: Effect of sweet pepper hybrids , nitrogen and potassium rates on plant height, number of leaves and dry weight of sweet pepper plants in 2002/2003 and 2003/2004 seasons

Characters / Variables	Plant height (cm)	No. of leaves/ plant	Plant dry weight (gm)	Plant height (cm)	No. of leaves/ plant	Plant dry weight (gm)
	First season(2002/2003)			Second season(2003/2004)		
Effect of hybrids						
Sonar	36.83 a	101.70 a	67.27 a	67.97 a	35.87 a	101.20 a
Gedion	35.27 a	99.06 a	64.21 b	64.98 b	34.35 b	97.89 b
Lamoyo	35.84 a	98.86 a	64.33 b	65.01 b	34.67 ab	96.89 b
Effect of nitrogen (Kg N/Fed.)						
80	34.31 b	96.88 b	63.72 b	33.40 b	96.25 b	62.94 b
100	36.59 a	100.42ab	65.65 b	35.43 a	99.11 a	64.89 ab
120	37.04 a	102.31 a	68.58 a	36.06 a	100.62 a	65.65 a
Effect of potassium (Kg K_2O/Fed.)						
50	32.24 c	94.77 c	60.10 b	31.49 c	94.36 c	59.26 b
100	36 20 b	100.11 b	67.52 a	35.07 b	98.93 b	66.77 a
150	39.51 a	104.73 a	70.33 a	38.53 a	102.70 a	69.78 a

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of significance, according to Duncan's multiple range test.

1.3 Effect of potassium rates:

Data in Table (2) show high significant effect for the high K rate on all studied traits in both seasons. There were no significant differences between the medium and high K rates for plant dry weight in both seasons.. The increment in plant growth due to potassium application may be owe to the vital role of K^+ in higher plants, wherein, stimulate large number of enzymes required for protein synthesis in higher concentration, stimulate Co_2 fixation, osmoregulation and cell extention (Marschner, 1995). These results are in agreement with the results obtained by Everett and Subramanya (1984).

1.4 Effect of interaction between hybrids and nitrogen rates:

Data in Table (3) show significant effect for the interaction between sweet pepper hybrids and N rates on all studied traits. The highest value was recorded with the interaction treatment of the hybrid Sonar fertilized with the high N rate (120 kg N/feddan) which did not differ significantly than the treatments of Sonar with the medium N rate (100 kg N/feddan) and Lamoyo hybrid with the high N rate in both seasons. Such different responses of pepper hybrids to N rates were reported by Midan (1995) and Chaurasia *et al.*(2002) who found that the best interaction treatment for increasing plant height was ARCH-235 x 150 kg N/ha.

1.5 Effect of interaction between hybrids and potassium rates:

Data in Table (3) show significant interaction effect between sweet pepper hybrids with potassium rates on all studied traits in both seasons except number of leaves/ plant. The hybrids Sonar and Lamoyo fertilized with the high K rate (150 kg K_2O /feddan) had the highest value of plant height and dry weight / plant .

Table 3: Effect of interaction between sweet pepper hybrids X nitrogen rates, sweet pepper hybrids X potassium rates and nitrogen X potassium rates on plant height, number of leaves and dry weight of sweet pepper plants in 2002/2003 and 2003/2004 seasons

Characters / Variables		Plant height (cm)	No. of leaves/ plant	Plant dry weight (gm)	Plant height (cm)	No. of leaves/ plant	Plant dry weight (gm)
		First season(2002/2003)			Second season(2003/2004)		
Sweet pepper hybrids X N rates (Kg.N/fed.)							
Sonar	80	35.03 de	98.07 bcd	65.47 bc	34.13 de	98.67 bcd	65.00 bc
	100	37.45 ab	102.41 ab	68.62 a	36.42 ab	101.27 ab	68.27 ab
	120	38.01 a	104.61 a	69.81 a	37.06 a	103.66 a	68.53 a
Gedion	80	33.67 f	96.95 cd	63.21 cd	32.84 f	96.04 de	62.22 d
	100	36.06 cd	99.61 bcd	63.57 cd	35.23 bcd	98.61 bcd	62.58 cd
	120	36.08 de	100.62abc	68.16 a	34.97 cd	99.03 bc	67.84 a
Lamoyo	80	34.24 ef	95.63 d	62.48 d	33.54 ef	94.03 e	61.22 d
	100	36.25 bcd	99.24 bcd	64.76 cd	35.23 d	97.46 cd	63.82 cd
	120	37.04 abc	101.71 ab	67.77 ab	36.14 abc	99.17 bc	67.56 a
Sweet pepper hybrids X K rates (Kg K_2O/Fed.)							
Sonar	50	33.99 e	95.86 d	63.88 c	32.26 e	96.65 cd	63.06 c
	100	36.61 cd	101.93 bc	68.80 ab	35.67 cd	101.61 ab	68.20 abc
	150	40.88 a	107.30 a	71.22 a	39.67 a	105.35 a	70.54 a
Gedion	50	31.91 e	94.28 d	58.33 d	31.13 e	93.61 de	57.48 d
	100	35.70 d	99.25 c	66.57 bc	34.61 d	97.85 c	65.68 bc
	150	38.22 bc	103.64 b	70.04 ab	37.31 bc	102.22 ab	69.47 ab
Lamoyo	50	31.81 e	94.17 d	58.10 d	31.07 e	92.82 e	57.24 d
	100	36.30 cd	99.16 c	67.18 bc	35.23 d	97.33 cd	66.42 abc
	150	39.43 ab	103.24 b	69.74 ab	38.61 ab	100.52 bc	69.34 ab
N rates (Kg.N/fed.) X K rates (Kg K_2O/Fed.)							
80	50	31.44 d	92.51 e	59.15 ef	30.96 c	92.02 d	57.95 e
	100	34.16 c	96.82 d	64.07 d	33.25 c	96.15 c	63.54 cd
	150	37.34 b	101.33 c	67.94 bc	36.30 b	100.57 ab	67.34 bc
100	50	32.82 cd	95.82 d	58.82 f	31.93 c	95.46 cd	58.10 e
	100	36.61 b	100.32 c	67.42 c	35.50 b	98.83 bc	66.42 cd
	150	40.34 a	105.12 ab	70.72 abc	39.45 a	103.05 a	70.16 ab
120	50	32.45 cd	96.00 d	62.34 de	31.57 c	95.60 cd	61.74 de
	100	37.83 b	103.21 bc	71.06 ab	36.76 b	101.81 ab	70.34 ab
	150	40.85 a	107.73 a	72.34 a	39.84 a	104.46 a	71.85 a

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of significance, according to Duncan's multiple range test.

1.6 Effect of interaction between nitrogen and potassium rates:

Data in Table (3) show significant effects for the interaction of nitrogen and potassium rates on all studied traits. The highest effects recorded by the medium and high N rates with the high K rate (150 kg K_2O/feddan). As for the positive effect of both N and K rates on plant growth, Mengel and Kirkby (1978) and Gardener *et al.*(1995) concluded that nitrogen is an indispensable elementary constituent of numerous organic compounds as amino acids, protein and nucleic acids and it is needed in formation of protoplasm and new cells, as well as encouragement cell elongation. They also added that K is the prevalent cation in the plant and may be involved in maintenance of ionic balance in the cell and stimulate the enzymes which are

essential in respiration and carbohydrates metabolism. So, K is very important in over all metabolism of plant.

1.7 Effect of interaction among sweet pepper hybrids, nitrogen and potassium rates:

Data in Table (4) show that the hybrid Sonar fertilized with the medium or high N rates and received the high K rate gave the highest significant interaction effects on all vegetative growth traits in both seasons. Whereas, hybrid Lamoyo fertilized with low N rate (80 kg / fed.) and low K rate (50 kg / fed.) recorded the lowest values in this respect.

Table 4: Effect of interaction among sweet pepper hybrids X nitrogen rates X potassium rates on plant height, number of leaves and dry weight of sweet pepper plants in 2002/2003 and 003/2004 seasons

Characters / Variables			Plant height (cm)	No. of leaves/ plant	Plant dry weight (gm)	Plant height (cm)	No. of leaves/ plant	Plant dry weight (gm)
Sweet pepper hybrids	N rates (Kg. N/ fed.)	K rates (Kg K_2O/ Fed.)	First season(2002/2003)			Second season(2003/2004)		
Sonar	80	50	32.40 klm	92.96 no	62.56 fgh	31.73 hi	93.80 j-m	61.70 ij
		100	34.36 ijk	98.00 j-m	65.80 def	33.23 fgh	99.16 d-h	65.63 d-i
		150	38.33defg	103.26d-g	68.06 cde	37.43 cd	103.06a-d	67.66 b-f
	100	50	33.60 jkl	96.90 klm	64.46 e-h	32.86 ghi	96.53 f-k	64.50 f-j
		100	37.13 fgh	101.90 f-l	69.36 bcd	36.36 de	100.76 c-f	68.76 e-j
		150	41.63 ab	108.43 ab	72.03 ab	40.03 ab	106.53 a	71.56 ab
	120	50	33.00 f-m	97.73 j-m	64.63 efg	32.20 hi	99.63 d-h	63.00 g-j
		100	38.33 d-g	105.90b-e	71.23 abc	37.43 cd	104.90 ab	70.20 abc
		150	42.70 a	110.20 a	73.56 a	41.56 a	106.46 a	72.40 a
Gedion	80	50	31.23 m	93.13 no	58.73 ij	30.60 l	91.90 lm	56.96 k
		100	33.53 jkl	96.96 lmn	63.03 fjh	32.66 hi	95.53 i-l	62.30 hij
		150	36.26 ghi	100.76 f-j	67.86 cde	35.26 df	100.70 c-f	67.40 b-f
	100	50	32.50 klm	95.30 mn	55.40 j	31.63 hi	96.20 g-k	54.43 k
		100	36.26 ghi	99.63 h-l	65.33 ef	34.96 efg	97.53 f-j	64.03 f-j
		150	39.43 cde	103.90 cf	70.00 abc	39.10 bc	102.10b-e	69.30 a-e
	120	50	32.00 lm	94.43mno	60.86 hi	31.16 hi	92.73kl m	61.06 j
		100	37.30 hij	101.16 f-j	71.36 abc	36.20 de	100.50 c-f	70.73 abc
		150	38.96 c-f	106.26bcd	72.26 ab	37.56 cd	103.86abc	71.73 ab
Lamoyo	80	50	30.70 m	91.43 o	56.16 j	30.56 l	90.36 m	55.20 k
		100	34.60 ijk	95.50 mn	63.40 fgh	33.86 ghi	93.76 j-m	62.70 g-j
		150	37.43 c-h	99.96 g-k	67.90 cde	36.20 de	97.96 e-l	66.96 c-j
	100	50	32.36 klm	95.26 nm	56.60 j	31.30 hi	93.66 j-m	55.36 k
		100	36.43 ghi	99.43 l-l	67.56 cde	35.16 def	98.20 e-l	66.46 c-h
		150	39.96 bcd	103.03d-h	70.13 abc	39.23 cd	100.53 c-f	69.63 a-d
	120	50	32.36 klm	95.83 mn	61.53 ghi	31.36 hi	94.43 l-m	61.16 j
		100	37.86 d-g	102.56 e-l	70.60 abc	36.66 de	100.03c-g	70.10 abc
		150	40.90 abc	106.73 bc	71.20 abc	40.40 ab	103.06a-d	71.43 ab

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of significance, according to Duncan's multiple range test.

2. Fruit yield:

2.1 Effect of sweet pepper hybrids:

Data in Table (5) show that the Sonar hybrid had the highest significant effect on number of fruits and fruit weight of both early and total yield in both seasons .The increase in fruit yield may be owe directly to the increment in vegetative growth and dry weight, consequently, the increase in fruit yield. In this respect, Chaurasia *et al.* (2002) found that ARCH-226 hybrid significantly increased the total yield / ha. compared with the other hybrids. The variability among the pepper hybrids yield traits were also reported by Arisha *et al.*(2003).

Table 5: Effect of sweet pepper hybrids , nitrogen and potassium rates on yield of sweet pepper hybrids in 2002/2003 and 2003/2004 seasons

Characters / Variables	Early yield		Total Yield		Early yield		Total Yield	
	No. of fruits/ m^2	Fruit weight (kg/m^2)	No. of fruits/ m^2	Fruit weight (kg/m^2)	No. of fruits/ m^2	Fruit weight (kg/m^2)	No. of fruits/ m^2	Fruit weight (kg/m^2)
	First season(2002/2003)				Second season(2003/2004)			
Effect of hybrids								
Sonar	6.62 a	0.73 a	19.59 a	2.16 a	7.02 a	0.76 a	19.23 a	2.13 a
Gedion	6.02 b	0.61 b	17.73 b	1.83 b	6.08 b	0.62 b	17.79 b	1.80 b
Lamoyo	5.53 c	0.53 c	16.54 c	1.60 c	5.34 c	0.49 b	17.14 b	1.59 c
Effect of nitrogen (Kg/Fed.)								
80	5.70 c	0.56 b	16.69 c	1.66 b	5.51 c	0.54 b	16.93 c	1.66 b
100	6.06 b	0.63 a	18.03 b	1.94 a	6.36 b	0.66 a	18.14 b	1.91 a
120	6.41 a	0.67 a	19.14 a	1.98 a	6.57 a	0.68 a	19.09 a	1.95 a
Effect of potassium (Kg/Fed.)								
50	5.03 b	0.47 b	15.23 c	1.43 c	4.67 c	0.44 c	15.20 c	1.42 c
100	6.36 a	0.68 a	18.75 b	2.02 b	6.56 b	0.67 b	18.93 b	1.97 b
150	6.78 a	0.72 a	19.88 a	2.15 a	7.21 a	0.76 a	20.02 a	2.13 a

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of significance, according to Duncan's multiple range test.

2.2 Effect of nitrogen rate:

Data in Table (5) show that high N rate (120 kg N/feddan) had the highest significant effects on number of fruits and fruit weight for both early and total yield in both seasons. However, there were no significant differences among the medium and the high nitrogen rates for fruit weight of

The increase in yield at high N rate may be owe to increases in vegetative growth parameters(Singh *et al.*, 1996). As well as nitrogen increased dry matter production through higher LAI and CGR, wherein, plants were able to partition a greater proportion of their dry matter into fruits, resulting in a higher harvest index and fruit yield (Hegde, 1987). The results are in agreement with those reported by Mishriky and Alphonse (1994), who found that that total yield was increased with increasing N rates. Also, Manchanda *et al.*, (1988) found that increasing rates of N increased number of fruits per plant and fruit yields. In addition, Gonzales and Beale (1987), Shukla *et al.*(1987) and Prince *et al.*(1988) came to similar conclusion.

2.3 Effect of potassium rates:

Data in Table (5) show that the high potassium rate (150 kg K_2O/feddan) had the highest significant effects on early and total yield in both seasons. However, there were no significant differences among K rates on number of fruits and fruit weight for early and total yield in the first season only. The increase in yield and its components due to K application my be owe to the vital role of K in stimulating the plant growth and hence increase fruit yield. Shukla *et al.*(1987) found that fruit yield of bell pepper was not significantly affected by K application up to 80 kg K_2O/ ha. On the other hand, Singh and Verma (1991) found that application of K at 120 kg / ha. resulted in the highest yield of tomato.

2.4 Effect of interaction between sweet pepper hybrids and nitrogen rates:

Data in Table (6) show that there were significant interaction effects between sweet pepper hybrids and N rates on both early and total fruit yield in both seasons. Sonar hybrid gave the highest records for number of fruits per plant and fruit yield when fertilized by the high N rate in both seasons. In this connection , Chaurasia *et al.*, (2002) studied the effect of interaction between four Chilli hybrids and four levels of nitrogen and found that the best interaction for increasing the yield /ha. was ARCH-226 x 200 kg N /ha.

2.5 Effect of the interaction between sweet pepper hybrids and potassium rates:

Data in Table (6) show a significant interaction effects on all studied traits. Sonar hybrid fertilized with the high K rate gave the highest records of sweet pepper yield studied traits in both seasons.

2.6 Effect of the interaction between nitrogen and potassium rates:

Data in Table (6) show that the high N and K rates interaction treatment gave the highest number of fruits and the highest early and total yield in both seasons. However, there were no significant differences among the interaction of the medium N rate and the high K rate as well as the interaction of the high N rate and the high K rate in both seasons. Prince *et al.*(1988) found that yields were highest with N:K ratio of 1:1.16 compared with the ratios of 1:1 or 1:1.32.

2.7 Effect of the interaction among sweet pepper hybrids, nitrogen rate and potassium rate:

Data in Table (7) show that the interaction among hybrids, N rates and K rates had significant effects in both seasons. Sonar hybrid plants fertilized with the high N and K rates recorded the highest number of fruits for both early and total yields. Also, Sonar hybrid plants fertilized with the high or medium N rates and received the high K rate gave the highest early and total fruit yield in both seasons.

3. Fruit Quality:

3.1 Effect of sweet pepper hybrids:

Data in Table (8) reveal that Sonar pepper hybrid recorded the highest value of fruit length as well as Gedion and Lamoyo hybrids had the highest flesh thickness in both seasons . Fruit diameter increased significantly with Lamoyo hybrid in the second season , but it was not significantly affected in the first one . The same data also show that the content of V.C and dry matter % were not significantly affected in both seasons. Chaurasia *et al.* (2002) illustrated that fruit length , fruit diameter and fruit size were significantly high with ARCH-226 Chilli hybrid compared to other pepper hybrids.

Table 6: Effect of interaction between sweet pepper hybrids X nitrogen rates, sweet pepper hybrids X potassium rates and nitrogen X potassium rates on yield of sweet pepper plants in 2002/2003 and 2003/2004 seasons

Characters / Variables		Early yield		Total Yield		Early yield/m^2(kg)		Total Yield	
		No. of fruits/ m^2	Fruit weight (kg/m^2)	No. of fruits/ m^2	Fruit weight (kg/m^2)	No. of fruits/ m^2	Fruit weight (kg/m^2)	No. of fruits/ m^2	Fruit weight (kg/m^2)
		First season(2002/2003)				Second season(2003/2004)			
Sweet pepper hybrids X N rates (Kg.N/fed.)									
Sonar	80	5.94 cd	0.64 bc	17.14 d	1.82 d	5.97 d	0.61 de	17.06def	1.82 d
	100	6.87 ab	0.75 a	20.48 a	2.26 b	7.28 b	0.78 b	19.89 b	2.22 a
	120	7.06 a	0.80 a	21.14 a	2.41 a	7.80 a	0.88 a	20.74 a	2.35 a
Gedion	80	5.44 ef	0.55 de	15.89 ef	1.64 e	5.51 ef	0.56 ef	16.24 f	1.65 e
	100	6.08 c	0.60 cd	17.83 c	1.95 c	6.40 c	0.67 c	17.98 c	1.90 c
	120	6.53 b	0.68 b	19.48 b	1.89 cd	6.33 c	0.62 cd	19.16 b	1.86 cd
Lamoyo	80	5.70 de	0.50 e	17.03cd	1.52 f	5.06 g	0.44 g	17.48cd	1.50 f
	100	5.22 f	0.53 e	15.78 f	1.61 ef	5.39 f	0.52 f	16.56 ef	1.60 ef
	120	5.66 de	0.55 de	16.81de	1.65 e	5.59 e	0.53 f	17.38cde	1.65 e
Sweet pepper hybrids X K rates (Kg K_2O/Fed.)									
Sonar	50	5.46 f	0.55 e	16.22 e	1.65 f	5.40 g	0.56 d	15.80 e	1.65 f
	100	6.93 b	0.79 b	20.56 b	2.34 b	7.52 b	0.81 b	20.29 b	2.28 b
	150	7.48 a	0.85 a	21.99 a	2.48 a	8.12 a	0.90 a	21.60 a	2.46 a
Gedion	50	4.90 g	0.45 f	14.98 f	1.37 g	4.47 h	0.41 e	14.90 e	1.36 g
	100	6.39 cd	0.68 c	18.54 c	1.97 d	6.50 d	0.67 c	18.76 c	1.92 d
	150	6.77 bc	0.71 c	19.68 b	2.15 c	7.28 c	0.78 b	19.72 b	2.12 c
Lamoyo	50	4.73 g	0.41 f	14.50 f	1.25 h	4.14 l	0.35 f	14.91 e	1.24 h
	100	5.74 ef	0.56 de	17.16de	1.72 ef	5.66 f	0.54 d	17.74 d	1.71 f
	150	6.10 de	0.61 d	17.97cd	1.81 e	6.23 e	0.59 d	18.76 c	1.81 e
N rates (Kg.N/fed.) X K rates (Kg K_2O/Fed.)									
80	50	5.02 e	0.44 f	14.71 f	1.29 e	4.24 h	0.37 e	14.81 e	1.28 g
	100	5.90 d	0.61 d	17.37 d	1.89 c	5.96 e	0.62 c	17.53 d	1.80 d
	150	6.17 cd	0.65 cd	17.99cd	1.88 c	6.33 d	0.62 c	18.43 c	1.88 c
100	50	4.82 e	0.44 f	15.08ef	1.46 d	4.78 g	0.46 d	15.06 e	1.45 f
	100	6.43 bc	0.70 bc	18.92 c	2.11 b	6.84 c	0.70 b	19.08 c	2.05 b
	150	6.91 ab	0.74 ab	20.09 b	2.25 a	7.44 d	0.81 a	20.29 b	2.23 a
120	50	5.24 e	0.52 e	15.91 e	1.53 d	4.99 f	0.49 d	15.74 e	1.52 e
	100	6.73 b	0.73 ab	19.97 b	2.12 b	6.88 c	0.71 b	20.18 b	2.06 b
	150	7.27 a	0.77 a	21.56 a	2.31 a	7.86 a	0.83 a	21.36 a	2.27 a

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of significance, according to Duncan's multiple range test.

Table 7: Effect of interaction among sweet pepper hybrids X nitrogen rates X potassium rates on yield of sweet pepper plants in 2002/2003 and 2003/2004 seasons

Characters / Variables			Early yield		Total Yield		Early yield		Total Yield	
			No. of fruits/ m^2	Fruit weight (kg/m^2)	No. of fruits/ m^2	Fruit weight (kg/m^2)	No. of fruits/ m^2	Fruit weight (kg/m^2)	No. of fruits/ m^2	Fruit weight (kg/m^2)
Sweet pepper hybrids	N rates (Kg.N/ fed.)	K rates (Kg K_2O/ fed.)	First season(2002/2003)				Second season(2003/2004)			
Sonar	80	50	5.50 l-l	0.51 j	15.67 lm	1.46 k	4.73 p	0.45 k	15.47m-p	1.48 l
		100	6.00 ghi	0.68 cd	17.57 hij	1.99 e	6.47 ij	0.72 de	17.47 jk	1.95 fg
		150	6.33 fg	0.73 c	18.20 fgh	2.02 e	6.70 h	0.67 ef	18.23 g-j	2.02 ef
	100	50	5.57 h-k	0.55 g-j	16.67 jkl	1.65 j	5.37 o	0.55 hi	16.03lmn	1.64 k
		100	7.20 cde	0.82 b	21.43 d	2.44 b	7.83 e	0.78 cd	21.00 cd	2.37 c
		150	7.83 ab	0.90 a	23.33 b	2.68 a	8.63 b	1.01 a	22.63 b	2.64 a
	120	50	5.30 klm	0.59 e-h	16.33 k	1.85 fgh	6.10 l	0.70 e	15.90 l-o	1.83 hi
		100	7.60 bc	0.88 a	22.66 b	2.65 a	8.27 c	0.93 b	22.40 b	2.53 b
		150	8.27 a	0.92 a	24.43 a	2.74 a	9.03 a	1.01 a	23.93 a	2.70 a
Gedion	80	50	4.77 n	0.42 k	13.97 n	1.24 lm	4.10 s	0.34 l	14.33 qr	1.21 no
		100	5.70 h-k	0.62 ef	16.57 jkl	1.80 ghi	6.10 l	0.67 ef	16.53 kl	1.83 hi
		150	5.87 g-j	0.64 de	17.13 ijk	1.89 fg	6.33 k	0.67 ef	17.87 ij	1.89 gh
	100	50	4.47 n	0.38 k	14.33 n	1.43 k	4.70 pq	0.47 ijk	14.03 r	1.43 l
		100	6.77 ef	0.72 c	19.23 ef	2.16 d	6.97 g	0.72 de	19.70 ef	2.06 e
		150	7.00 de	0.71 c	19.93 e	2.25 cd	7.53 f	0.83 c	20.20cde	2.22 d
	120	50	5.47 l-l	0.54 hij	16.63 jkl	1.43 k	4.60 q	0.40 kl	16.33klm	1.43 l
		100	6.70 ef	0.72 c	19.83 e	1.93 ef	6.43 jk	0.61 fgh	20.03 def	1.89 gh
		150	7.43 bcd	0.78 b	21.97 cd	2.31 c	7.97 d	0.85 c	21.10 c	2.26 d
Lamoyo	80	50	4.80 mn	0.40 k	14.50 n	1.16 m	3.90 t	0.32 l	14.63pqr	1.15 o
		100	6.00 ghi	0.53 ij	17.97 ghi	1.66 j	5.30 o	0.46 jk	18.60 ghi	1.62 k
		150	6.30 fg	0.58 e-l	18.63 fg	1.74 ij	5.97 m	0.53 hij	19.20 efg	1.74 j
	100	50	4.43 n	0.40 k	14.23 n	1.29 l	4.27 r	0.36 l	15.10n-q	1.26 mn
		100	5.33 jkl	0.57 f-l	16.10 kl	1.73 ij	5.73 n	0.59 fgh	16.53 kl	1.72 j
		150	5.90 ghi	0.63 def	17.00 ijk	1.82 ghi	6.17 l	0.60 fgh	18.03 hij	1.82 hi
	120	50	4.97 lmn	0.44 k	14.77 mn	1.30 l	4.27 r	0.37 l	15.00 o-r	1.31 m
		100	5.90 ghi	0.60 efg	17.40 hij	1.78 hi	5.93 m	0.58 gh	18.10 hij	1.78 ij
		150	6.10 gh	0.62 def	18.27 fgh	1.87 fgh	6.57 l	0.64 efg	19.03 fgh	1.86 h

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of significance, according to Duncan's multiple range test.

3.2 Effect of nitrogen rates:

It is obvious from the data presented in Table (8) that application of the high N rate (120 kg N/ fed.) was the superior treatment which increased fruit length and dry matter % in both seasons as well as fruit diameter in the second season . In the first season, flesh thickness as well as the content of V.C were not significantly affected by N rates. In this respect, Hegde (1986) found that N fertilization(up to 180 kg/ ha.) increased fruit dry weight , volume and pericarp thickness and Chaurasia *et al.* (2002) found that fruit length , fruit diameter and fruit size were increased with increasing N application up to 200 kg /ha.

Table 8: Effect of sweet pepper hybrids , nitrogen and potassium rates on fruit quality of sweet pepper fruits in 2002/2003 and 2003/2004 seasons.

Characters / Variables	Fruit length (cm)	Fruit diameter (cm)	Flesh thickness (mm)	Fruit dry matter %	V.C (mg./100 g fresh weight	Fruit length (cm)	Fruit diameter (cm)	Flesh thickness (mm)	Fruit dry matter %	V.C (mg./100 g fresh weight
	First season(2002/2003)					Second season(2003/2004)				
Effect of hybrids										
Sonar	10.91 a	8.29 a	5.73b	7.13 a	186.59a	10.65 a	5.66 b	8.32 b	7.07 a	184.89a
Gedion	9.67 b	8.36 a	6.20a	7.07 a	184.52a	9.57 b	6.16 a	8.28 b	7.04 a	184.44a
Lamoyo	9.07 b	8.79 a	6.23a	7.06 a	181.26a	9.02 c	6.17 a	8.75 a	7.01 a	180.67a
Effect of nitrogen										
80	9.55 b	8.22 a	6.00 a	6.80 c	179.37a	9.40 c	8.29 b	5.96 a	6.75 c	179.67a
100	9.92ab	8.49 a	6.05 a	7.11 b	183.74a	9.72 b	8.44ab	6.02 a	7.07 b	182.89a
120	10.18 a	8.73 a	6.10 a	7.35 a	188.70a	10.10 a	8.62 a	6.03 a	7.30 a	187.44a
Effect of potassium										
50	9.55 b	8.22 a	6.00 a	6.80 c	179.37a	9.40 c	8.29 b	5.96 a	6.75 c	179.67a
100	9.92 ab	8.49 a	6.05 a	7.11 b	183.74a	9.72 b	8.44 ab	6.02 a	7.07 b	182.89a
150	10.18 a	8.73 a	6.10 a	7.35 a	188.70a	10.10 a	8.62 a	6.03 a	7.30 a	187.44a

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of significance, according to Duncan's multiple range test.

3.3 Effect of potassium rates:

The data presented in Table (8) clear that the high rate of potassium (150 kg/ fed.) recorded the maximum values of dry matter %, fruit length and the content of V.C in the two growing seasons, and the same trend took place with fruit diameter in the second season. The same data reveal that flesh thickness was not significantly affected in both seasons. Also, fruit diameter was not significantly affected in the first season. The obtained results are in good line with those reported by Abdel-Maksoud *et al.*(1977) who found that application of 200 kg K_2SO_4/ fed. produced the best quality of pepper fruits. Zhu and Shu (1991) came to similar conclusion on tomato.

3.4 Effect of interaction between sweet pepper hybrids and nitrogen rates:

Data in Table (9) reveal that the interaction between Sonar hybrid and application of 120 kg N/ fed. recorded the highest value of dry matter % in both seasons, with no significant differences with the interactions between Gedion and Lamoyo hybrids with the high rate of nitrogen in the first season.

The same data reveal that the interaction between Sonar hybrid and application of 120 kg.N/fed.; the interactions among Gedion and Lamoyo hybrids at all nitrogen rates as well as the interaction between Lamoyo hybrid and application of 100 or 120 kg N / fed. were the best treatments for enhancing fruit length , flesh thickness and fruit diameter , respectively, in both seasons. The content of V.C was increased with the interaction between Sonar hybrid and application of 120kg.N/fed. in the second season only. Chaurasia *et al.* (2002) found that the best interaction for enhancing fruit quality expressed as fruit size , fruit length and fruit diameter was ARCH-226 hybrid x 200 kg N /ha.

Table 9: Effect of interaction between sweet pepper hybrids X nitrogen rates, sweet pepper hybrids X potassium rates and nitrogen X potassium rates on fruit quality of sweet pepper fruits in 2002/2003 and 2003/2004 seasons.

Characters / Variables		Fruit length (cm)	Fruit diameter (cm))	Flesh thickness (mm)	Fruit dry matter %	V.C mg./100g fresh weight	Fruit length (cm)	Fruit diameter (cm)	Flesh thickness (mm)	Fruit dry matter %	V.C mg./100g fresh weight
		First season(2002/2003)					Second season(2003/2004)				
Sweet pepper hybrids X N rates (Kg.N/fed.)											
Sonar	80	10.36 b	7.90 c	5.62 b	6.83 c	180.44a	10.10 c	8.29 cd	5.58 b	6.75 e	179.44c
	100	11.03 a	8.36abc	5.76 b	7.16 b	185.00a	10.63 b	8.30 cd	5.72 b	7.11 c	184.33bc
	120	11.33 a	8.62 ab	5.82 b	7.39 a	192.67a	11.21 a	8.48 bc	5.69 a	7.35 a	190.89 a
Gedion	80	9.47cde	8.17 bc	6.18 a	6.79 c	179.67a	9.32 f	8.17 d	6.16 a	6.77 e	180.22 c
	100	9.67 cd	8.29abc	6.21 a	7.09 b	185.00a	9.58 e	8.19 d	6.16 a	7.06cd	184.00bc
	120	9.88 c	8.62 ab	6.23 a	7.33 a	188.89a	9.81 d	8.48 bc	6.18 a	7.31ab	189.11ab
Lamoyo	80	8.83 f	8.60 ab	6.22 a	6.79 c	178.00a	8.78 h	8.52 b	6.16 a	6.74 e	179.33 c
	100	9.05 ef	8.82 a	6.21 a	7.08 b	181.22a	8.96 g	8.83 a	6.18 a	7.05 d	180.33 c
	120	9.33 de	8.97 a	6.27 a	7.32 a	184.56a	9.30 f	8.89 a	6.22 a	7.26 b	182.33 c
Sweet pepper hybrids X K rates (Kg K_2O/Fed.)											
Sonar	50	10.18 c	8.11 c	5.59 c	6.89 d	171.89a	10.06 c	8.18 de	5.57 b	6.81 c	74.67 e
	100	10.98 b	8.42 bc	5.74 bc	7.16 c	181.00a	10.53 b	8.36 cd	5.69 b	7.11 b	86.11cd
	150	11.57 a	8.64 bc	5.87 b	7.33 a	185.22a	11.36 a	8.53 bc	5.73 b	7.28 a	93.89 a
Gedion	50	8.96 e	8.11 c	6.12 a	6.86 d	175.11a	8.79 f	8.03 e	6.09 a	6.83 c	76.00 e
	100	9.89 cd	8.41bnc	6.21 a	7.10 c	184.22a	9.76 d	8.30 cd	6.19 a	7.07 b	85.78cd
	150	10.17 c	8.56 bc	6.29 a	7.26 b	191.89a	10.17 c	8.50 c	6.21 a	7.23 a	91.56ab
Lamoyo	50	8.39 f	8.50 bc	6.17 a	6.85 d	176.33a	8.34 g	8.42 cd	6.13 a	7.76 c	71.33 e
	100	9.13 e	8.76 ab	6.23 a	7.10 c	191.22a	9.07 e	8.76 b	6.18 a	7.06 b	82.11 d
	150	9.70 d	9.12 a	6.29 a	7.24 b	198.56a	9.63 d	8.06 a	6.24 a	7.22 a	88.56bc
N rates (Kg.N/fed.) X K rates (Kg K_2O/Fed.)											
80	50	8.94 e	8.14d	5.92 c	6.66 g	171.89a	8.84 f	8.21 c	5.90 b	6.55 g	72.56 f
	100	9.63 c	8.32bcd	6.03 bc	6.82 f	181.00a	9.42 d	8.31 c	5.98 ab	6.79 f	80.33 e
	150	10.07 b	8.50 cd	6.06abc	6.93 e	185.22a	9.93 c	8.46 bc	6.01 ab	6.91de	86.11cd
100	50	9.20 de	8.22bcd	5.99 bc	6.87 ef	175.11a	9.07 e	8.19 c	5.93 ab	6.84 ef	73.78 f
	100	10.04 b	8.51bcd	6.06abc	7.09 d	184.22a	9.72 c	8.44 bc	6.02 ab	7.05 c	83.56de
	150	10.51 b	8.73abc	6.13 ab	7.37 c	191.89a	10.39 b	8.69 b	6.10 a	7.32 b	91.33 b
120	50	9.38 cd	8.36bcd	5.97 bc	7.07 d	176.33a	9.28 de	8.23 c	5.96 ab	7.00cd	75.67 f
	100	10.32 b	8.76 ab	6.10abc	7.45 b	191.22a	10.21 b	8.66 b	6.06 ab	7.41ab	90.11bc
	150	10.84 a	9.08 a	6.24 a	7.53 a	198.56a	10.83 a	8.96 a	6.08 ab	7.50 a	96.56 a

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of significance, according to Duncan's multiple range test.

3.5 Effect of interaction between sweet pepper hybrids and potassium rates:

It is obvious from the data presented in Table (9) that the interaction between Sonar hybrid and application of 150 kg.K_2O/fed. was the superior interaction for increasing dry matter % in both seasons . The content of V.C was enhanced by the same abovementioned interaction treatment in the second season, but, it was not significantly affected in the first one .

Referring to the fruit length , fruit thickness ,and fruit diameter , the same data show that the interaction between Sonar hybrid and the high K rate was the best treatment for increasing fruit length, while, the interaction between Gedion or Lamoyo hybrids with all rates of potassium increased fruit flesh thickness .The interaction between Lamoyo hybrid and application of 100 or 150 kg K_2O / fed. enhanced the fruit diameter . The previous results are true in the two growing seasons. The obtained results of fruit dimensions may be related with the variability among pepper fruit genotypes .

3.6 Effect of interaction between nitrogen and potassium rates:

Data in Table (9) illustrate that the interaction between application of the high N and K rates was the best interaction treatment for increasing dry matter % in both seasons . The same trends were obtained with fruit dimensions expressed as fruit length and diameter. The same previous interaction treatment increased the content of V.C in the first season , but, it had no significant effect in the second one . The increment in fruit dimensions due to application of the high rates of nitrogen and potassium may be owe to the stimulative effect of nitrogen and potassium on plant growth and dry weight which reversed on fruit quality under study. Dangler and Locascio (1990) found that the highest tomato quality fruits was obtained with 50% trickle irrigated applied N +K .

3.7 Effect of interaction among sweet pepper hybrids, nitrogen and potassium rates:

Data recorded in Table (10) illustrate that interaction among Sonar hybrid and the high rates of N and K was the best treatment, wherein, had a significant effect on dry matter % in both seasons and the content of V.C in the second season , but, it had no significant effect in the first one .

Table 10: Effect of interaction among sweet pepper hybrids X nitrogen rates X potassium rates on fruit quality of sweet pepper fruits in 2002/2003 and 2003/2004 seasons

Characters / Variables			Fruit length (cm)	Fruit diameter (cm)	Flesh thickness (mm)	Fruit dry matter %	V.C mg/100 g fresh weight	Fruit length (cm)	Fruit diameter (cm	Flesh thickness (mm	Fruit dry matter %	V.C mg/100g fresh weight
Sweet pepper hybrids	N rates (Kg.N/ fed.)	K rates (Kg K_2O/ Fed.)	First season(2002/2003)					Second season(2003/2004)				
Sonar	80	50	9.83ghi	8.03 hi	5.50 h	6.69 h	173.67a	9.77 fg	8.40 e-h	5.47 e	6.53 kl	172.33 ij
		100	10.43def	8.23 f-i	5.67 fgh	6.85 fg	180.67 a	10.07 e	8.23 f-i	5.60 de	6.79 j	179.67fgs
		150	10.80 cd	8.33 ij	5.70 efg	6.95 e	187.00 a	10.47 d	8.27 e-i	5.67 cd	6.92 f-i	186.33 d
	100	50	10.17efg	8.13 ghi	5.63 fgh	6.91 ef	176.00 a	9.93 ef	8.13 hij	5.60 de	6.87 hij	174.00hij
		100	11.13 bc	8.43 d-i	5.77 efg	7.13 d	184.67 a	10.47 d	8.33 e-h	5.73 cd	7.09 e	185.33d
		150	11.80 b	8.50 d-i	5.87 de	7.45 b	194.33 a	11.50 b	8.43 e-g	5.83 c	7.37 cd	193.67 b
	120	50	10.53 de	8.17 ghi	5.63 gh	7.09 d	177.33 a	10.47 d	8.03 ij	5.63 de	7.03 efg	177.67gh
		100	11.37 b	8.60 c-h	5.80 ef	7.49 b	195.67 a	11.07 c	8.50 def	5.73 cd	7.46 abc	193.33 b
		150	12.10 a	9.10 abc	6.03 cd	7.6 a	205.00 a	12.10 a	8.90 bc	5.70 cd	7.55 a	201.67 a
Gedion	80	50	8.80 kl	8.00 i	6.03 cd	6.65 h	171.00 a	8.57 kl	8.03 ij	6.06 b	6.62 k	173.00hij
		100	9.60 hi	8.20 f-i	6.23 abc	6.81 g	181.67 a	9.43 hi	8.17 g-j	6.23 ab	6.79 j	181.00efg
		150	10.00fgh	8.30 e-i	6.27 ab	6.92 ef	186.33 a	9.97 ef	8.30 e-i	6.17 ab	6.90 hij	186.67 d
	100	50	8.97 k	8.03 hi	6.20 abc	6.86 fg	177.33 a	8.97 j	7.90 j	6.10 ab	6.83 hij	176.00ghi
		100	9.90 gh	8.33 e-i	6.17 abc	7.07 d	186.33 a	9.73 fg	8.27 e-i	6.17 ab	7.03 efg	184.33def
		150	10.13efg	8.50 d-i	6.27 ab	7.35 c	191.33 a	10.03 e	8.40egh	6.20 ab	7.31 d	191.67bc
	120	50	9.10 jk	8.30 e-i	6.13 bc	7.06 d	179.67 a	8.83 j	8.17 g-j	6.10 ab	7.04 ef	179.00 g
		100	10.17efg	8.70 b-g	6.23 abc	7.44 b	191.67 a	10.10 e	8.47 def	6.17 ab	7.39 bcd	192.00bc
		150	10.37def	8.87 a-e	6.33 ab	7.51 b	195.33 a	10.50 d	8.80 bc	6.27 a	7.50 ab	196.33 b
Lamoyo	80	50	8.20 m	8.40 d-i	6.23 abc	6.64 h	171.00 a	8.20 m	8.23 f-i	6.17 ab	6.50 l	172.33 ij
		100	8.87 kl	8.53 d-i	6.20 abc	6.81 g	180.67 a	8.77 jk	8.53 de	6.10 ab	6.79 j	180.33efg
		150	9.43 ij	8.87 a-e	6.23 abc	6.93 ef	182.33 a	9.37 i	8.80 bc	6.20 ab	6.92 ghi	185.33de
	100	50	8.47 lm	8.50 d-i	6.13 bc	6.85 fg	172.00 a	8.30 m	8.53 de	6.10 ab	6.83 ij	171.33 ij
		100	9.10 jk	8.77 a-f	6.23 abc	7.07 d	181.67 a	8.97 j	8.73 cd	6.17 ab	7.03 efg	181.00efg
		150	9.60 hi	9.20 ab	6.26 ab	7.32 c	190.00 a	9.63 gh	8.23a	6.27 a	7.29 d	188.67cd
	120	50	8.50 lm	8.60 d-i	6.13 ab	7.05 d	172.00 a	8.53 l	8.50 def	6.13 ab	6.95 fgh	170.33 j
		100	9.43 ij	8.97 a-d	6.27 ab	7.42 b	186.33 a	9.47 hi	9.00 ab	6.27 a	7.37 cd	185.00de
		150	9.83 ghi	8.03 hi	5.50 h	7.49b	195.33 a	9.77 fg	8.40 e-h	5.47 e	7.46 abc	191.67bc

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of significance, according to Duncan's multiple range test.

The same previous interaction treatment significantly increased fruit length in both seasons, while, the interaction among Lamoyo hybrid and the high rates of N and K had a significant effect on fruit diameter in both seasons.

Referring to fruit flesh thickness, the same data show that the interaction among Lamoyo hybrid and the high rates of both N and K was the superior treatment for increasing the previous traits without differences with all interactions among Lamoyo and Gedion hybrids with all rates of N and K, except, the interaction among the low rate of both N and K with Gedion hybrid in both seasons .

4. Fruit content of N, P and K

4.1 Effect of hybrids

Data in Table (11) show that there were no significant differences among all sweet pepper hybrids on N, P and K contents of fruits in both seasons. In this connection, Midan (1995) found that fruits of pepper genotypes showed differences in their fruits N, P and K contents.

Table 11: Effect of sweet pepper hybrids , nitrogen and potassium rates on on N, P and K contents of sweet pepper fruit in 2002/2003 and 2003/2004 seasons

Characters / Variables	N (%)	P (%)	K (%)	N (%)	P (%)	K (%)
	First season(2002/2003)			Second season(2003/2004)		
Effect of hybrids						
Sonar	2.64 a	0.214 a	1.89 a	2.63 a	0.215 a	1.87 a
Gedion	2.63 a	0.213 a	1.87 a	2.62 a	0.213 a	1.85 a
Lamoyo	2.61 a	0.214 a	1.87 a	2.60 a	0.212 a	1.85 a
Effect of nitrogen (Kg N/fed.)						
80	2.54 b	0.214 a	1.82 b	2.53 b	0.215 a	1.80 b
100	2.66 a	0.214 a	1.89 a	2.64 a	0.213 a	1.86 ab
120	2.68 a	0.214 a	1.93 a	2.67 a	0.213 a	1.91 a
Effect of potassium (Kg K_2O/fed.)						
50	2.54 c	0.213 a	1.79 c	2.54 c	0.213 a	1.77 c
100	2.64 b	0.210 a	1.88 b	2.63 b	0.216 a	1.86 b
150	2.69 a	0.210 a	1.96 a	2.68 a	0.216 a	1.94. a

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of significance, according to Duncan's multiple range test.

4.2 Effect of nitrogen rates

Data in Table (11) show significant effects for N rate on N and K contents of sweet pepper fruits in both seasons, while there was no significant effect on P content. The highest N and K contents were recorded with the medium and high N rates. These results are in agreement with those reported by Mishriky and Alphonse (1994) who reported that fruit N content was significantly increased with increasing N rates to 60 kg N/ fed.. In this connection, Kulvinder and Srivastava (1988) found that both N and P contents of pepper fruits *cv.* Pan-C-1 were significantly higher with 120 kg N /ha.

4.3 Effect of potassium rates

Data in Table (11) show significant effects in both seasons for K rates on fruit N and K contents, while there was no significant effect on P content in both seasons. The high K rate recorded the highest N and K values in sweet pepper fruits in both seasons.

4.4 Effect of interaction between the hybrids and nitrogen rates

Data in Table (12) show significant effects for the interaction between hybrids and N rates on fruit N and K contents in both seasons. The highest N and K contents were recorded with Sonar and Gedion hybrids fertilizedwith high N rate and did not significantly differ than the medium N rate with Sonar hybrid.

Table 12: Effect of interaction between sweet pepper hybrids X nitrogen rates, sweet pepper hybrids X potassium rates and nitrogen X potassium rates on N, P, and K contents of sweet pepper fruit in 2002/2003 and 2003/2004 seasons

Characters / Variables		N (%)	P (%)	K (%)	N (%)	P (%)	K (%)
		First season(2002/2003)			Second season(2003/2004)		
Sweet pepper hybrids X N rates (Kg.N/fed.)							
Sonar	80	2.53 c	0.212 a	1.81 c	2.52 c	0.213 a	1.80 cd
	100	2.68 ab	0.216 a	1.90 ab	2.66 ab	0.216 a	1.87 abc
	120	2.72 a	0.216 a	1.94 a	2.70 a	0.215 a	1.93 a
Gedion	80	2.55 c	0.216 a	1.81 c	2.54 c	0.211 a	1.80 d
	100	2.65 b	0.213 a	1.89 b	2.64 b	0.214 a	1.86 a-d
	120	2.68 ab	0.211 a	1.91 ab	2.67 ab	0.214 a	1.90 ab
Lamoyo	80	2.54 c	0.213 a	1.81 c	2.54 c	0.212 a	1.81 cd
	100	2.64 b	0.214 a	1.87 b	2.63 b	0.208 a	1.85 bcd
	120	2.65 b	0.215 a	1.91 ab	2.64 b	0.214 a	1.89 a-d
Sweet pepper hybrids X K rates (Kg K_2O/Fed.)							
Sonar	50	2.56 c	0.211 a	1.79 c	2.56 d	0.211 a	1.78 d
	100	2.65 b	0.218 a	1.88 b	2.64 bc	0.214 a	1.87 b
	150	2.70 a	0.212 a	1.97 a	2.69 a	0.220 a	1.95 a
Gedion	50	2.54 c	0.210 a	1.79 c	2.53 d	0.208 a	1.77 d
	100	2.64 b	0.214 a	1.87 b	2.63 bc	0.211 a	1.86 bc
	150	2.70 a	0.219 a	1.95 a	2.70 a	0.220 a	1.93 a
Lamoyo	50	2.53 c	0.217 a	1.78 c	2.52 d	0.208 a	1.76 d
	100	2.63 b	0.211 a	1.87 b	2.61 c	0.208 a	1.85 cd
	150	2.67 ab	0.214 a	1.95 a	2.66 ab	0.217 a	1.93 a
N rates (Kg.N/fed.) X K rates (Kg K_2O/Fed.)							
80	50	2.50 e	0.211 a	1.74 f	2.49 f	0.208 a	1.73 e
	100	2.55 d	0.218 a	1.82 e	2.54 e	0.212 a	1.82 cd
	150	2.57 d	0.212 a	1.87 d	2.58 d	0.215 a	1.86 bc
100	50	2.56 d	0.210 a	1.80 e	2.55 de	0.210 a	1.77 de
	100	2.68 c	0.214 a	1.88 d	2.66 c	0.210 a	1.86 bc
	150	2.73 ab	0.219 a	1.98 b	2.72 ab	0.220 a	1.95 a
120	50	2.57 d	0.217 a	1.82 e	2.56 de	0.210 a	1.81 cd
	100	2.70 bc	0.211 a	1.92 c	2.69 bc	0.212 a	1.91 b
	150	2.77 a	0.214 a	2.02 a	2.75 a	0.222 a	2.00 a

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of significance, according to Duncan's multiple range test.

4.5-Effect of interaction between the hybrids and potassium rates:

Data in Table (12) show significant effects for the interaction between hybrids and K rates on fruit N and K contents in both seasons. The highest N and K contents were recorded with the high rate of K applied to all hybrids.

4.6-Effect of interaction between the nitrogen rates and potassium rates

Data in Table (12) show significant effects for the interaction between N and K rates in both seasons. The medium and the high N rates with the high K rate gave the highest fruit N and K contents in both seasons. There was no significant effect on P content in both seasons.

4.7 Effect of interaction among hybrids, nitrogen rates and potassium rates:

Data in Table (13) show significant effects for the interaction among hybrids , N and K rates in both seasons. Sonar hybrid had the highest records for fruit content of N and K when fertilized by high N and K rates. As regard to P contents there were no significant differences among most treatments in both seasons, however, the higher values, in general, were recorded with the high N and K rates.

Table 13: Effect of interaction among sweet pepper hybrids X nitrogen rates X potassium rates on N, P, and K contents of sweet pepper fruit in 2002/2003 and 2003/2004 seasons

Characters / Variables			N (%)	P (%)	K (%)	N (%)	P (%)	K (%)
Sweet pepper hybrids	N rates (Kg.N/fed.)	K rates (Kg K_2O/ Fed.)	First season(2002/2003)			Second season(2003/2004)		
Sonar	80	50	2.50 kl	0.210 bc	1.75 mn	2.50 kl	0.210 ab	1.73 m
		100	2.55 h-k	0.217 abc	1.83 h-k	2.54 j	0.216 ab	1.83 f-l
		150	2.54 l-l	0.210 bc	1.86 g-j	2.53 jk	0.213 ab	1.85 e-h
	100	50	2.59 fgh	0.210 bc	1.81 kl	2.58 hi	0.210 ab	1.79 l-l
		100	2.68 e	0.213 abc	1.88 fg	2.67 efg	0.216 ab	1.86 ef
		150	2.76 bc	0.223 a	2.00 b	2.74 bc	0.223 a	1.96 bc
	120	50	2.60 fg	0.217 abc	1.83 h-k	2.60 h	0.213 ab	1.83 f-j
		100	2.73 bcd	0.217 abc	1.93 de	2.72 cd	0.210 ab	1.92 cd
		150	2.82 a	0.213 abc	2.06 a	2.80 a	0.223 a	2.04 a
Gedion	80	50	2.50 jkl	0.213 abc	1.75 mn	2.49 l	0.206 ab	1.73 lm
		100	2.56 f-l	0.220 ab	1.82 l-l	2.53 jk	0.210 ab	1.81 f-k
		150	2.61 f	0.213 abc	1.86 ghi	2.61 h	0.216 ab	1.85 e-h
	100	50	2.55 g-j	0.210 bc	1.80 kl	2.54 j	0.210 ab	1.77 j-m
		100	2.67 e	0.213 abc	1.88 fg	2.67 efg	0.210 ab	1.86 efg
		150	2.73 bcd	0.217 abc	1.98 bc	2.73 bcd	0.223 a	1.96 bc
	120	50	2.56 f-l	0.217 abc	1.81 kl	2.55 ij	0.210 ab	1.80 g-k
		100	2.71 cde	0.207 c	1.91 ef	2.69 def	0.213 ab	1.93 cd
		150	2.78 ab	0.210 bc	2.02 b	2.76 b	0.220 ab	1.99 b
Lamoyo	80	50	2.49 l	0.210 bc	1.74 n	2.49 l	0.210 ab	172.33 m
		100	2.54 h-l	0.217 abc	1.82 jkl	2.54 jk	0.210 ab	1.81 f-k
		150	2.58 f-l	0.213 abc	1.89 fg	2.59 h	0.216 ab	1.89 de
	100	50	2.54 l-l	0.210 bc	1.78 lm	2.54 jk	0.210 ab	1.76 klm
		100	2.68 de	0.217 abc	1.87 gh	2.65 g	0.203 b	1.85 e-h
		150	2.71 cde	0.217 abc	1.95 cd	2.70 cde	0.213 ab	1.94 bcd
	120	50	2.55 h-k	0.217 abc	1.83 ijk	2.55 ij	0.206 ab	1.81 f-k
		100	2.67 e	0.210 bc	1.92 def	2.66 fg	0.213 ab	1.90 h-k
		150	2.72 cde	0.220 ab	2.00 b	2.70 cde	0.223 a	1.97 bc

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of significance, according to Duncan's multiple range test.

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استجابة بعض هجن الفلفل الحلو لمعدلات التسميد الأزوتي والبوتاسي تحت الأنفاق البلاستيكية المنخفضة بشمال سيناء

على إبراهيم القصاص

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أجريت هذه الدراسة خلال العروة الصيفية المبكرة لموسمي ٢٠٠٢/٢٠٠٣ و٢٠٠٣/٢٠٠٤ في المزرعة التجريبية لكلية العلوم الزراعية البيئية بالعريش، جامعة قناة السويس لدراسة استجابة ثلاثة هجن من الفلفل الحلو (سونار ،جديون، لامويو) لثلاثة معدلات من الأزوت وهي ٨٠ و ١٠٠و١٢٠كجم نيتروجين/فدان و ثلاثة معدلات من البوتاسيوم وهي٥٠و١٠٠و١٥٠ كجم بوتاسيوم/فدان وذلك تحت ظروف الأراضي الرملية و تحت الأنفاق البلاستيكية المنخفضة مع استخدام نظام الري بالتنقيط . ويمكن تلخيص النتائج كالتالي :-

أعطى الهجين سونار أعلى تأثير معنوي لجميع الصفات المدروسة أدى استخدام المعدل العالي من الازوت وهو ١٢٠ كجم نيتروجين للفدان إلي زيادة معنوية لكل من الصفات الخضرية ومحصول الثمار وجودتها في كلا موسمي الدراسة مع عدم وجود اختلافات معنوية مع معدل الازوت المتوسط فيما يتعلق بارتفاع النبات وعدد الأوراق/نبات في كلا موسمي الدراسة . كما كان لاستخدام المعدل العالي من البوتاسيوم اكبر تأثير على جميع الصفات تحت الدراسة في كلا موسمي الدراسة.

أدى تسميد الهجين سونار بمعدل ١٢٠كجم نيتروجين و ١٥٠كجم من ثاني أكسيد البوتاسيوم إلى زيادة معنوية في جميع صفات النمو الخضري والنسبة المئوية للمادة الجافة بالثمار والمحصول الثمري المبكر والكلي وطول الثمرة في كلا موسمي الزراعة بينما كان التأثير عاليا على محتوى الثمار من فيتامين ج في موسم الزراعة الثاني فقط بينما أدى استخدام المعدلات العالية من التسميد الآزوتي والبوتاسي إلى زيادة قطر الثمرة معنويا في الهجين لامويو أما بالنسبة لمحتوى الثمرة من النيتروجين والبوتاسيوم فقد كانت أعلى القيم عند تسميد الهجين سونار بالمعدلات العالية من الازوت والبوتاسيوم.