ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS
SBORNÍK MENDELOVY ZEMĚDĚLSKÉ A LESNICKÉ UNIVERZITY V BRNĚ

Ročník LVI 28 Číslo 1, 2008

RESPONSE OF GROWTH PATTERNS IN SWEET PEPPER TO DIFFERENT NPK LEVELS

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Received: May 7, 2007

Abstract

ABDELAZIZ, M. E., HANNFY AHMED, A. H., BEKHIT, R. S., POKLUDA, R.: *Response of growth patterns in sweet pepper to different NPK levels.* Acta univ. agric. et silvic. Mendel. Brun., 2008, LVI, No. 1, pp. 241–244

This work was conducted to study the effect of five NPK fertigation levels on the growth rate of sweet pepper (*Capsicum annuum* L. cv. Bruyo) grown under the plastic greenhouse using different growth analysis formulas. Leaf area ratio (LAR), specific leaf area (SLA), relative growth rate (RGR) and net assimilation rate (NAR) was evaluated in two periods (60–90 and 90–120 days after transplanting). The mean values of LAR, SLA, RGR and NAR tended to decrease significantly with advancing plant age in both seasons. In general, at the moderate level (34N-42P-29K / plastic house 540 m^2) was found the highest significant values of LAR and SLA in the two growth periods. On the other hand, the highest values of NAR were recorded at the plants treated with the lowest NPK fertigation level (17N-21P-15K / plastic house 540 m^2). However, increase of NPK fertigation doses to the moderate levels had favorable effects on LAR and SLA of sweet pepper plants.

sweet pepper, growth analysis formulas, NPK, greenhouse

Sweet pepper (*Capsicum annuum* L.) is one of the most important vegetable crops grown in Egypt. Pepper fruits contain some important nutritional compounds for human diet such as proteins (1.2 %), fats (0.4 %), carbohydrates (5 %) in addition to minerals and vitamins, especially vitamins A and C. Egyptian land are suffering from insufficient macro and micronutrients. Therefore, application of fertilizers might be a successful tool for improving the agrochemical conditions of the soil. It could induce simulative effect on plant growth and productivity, especially with applying chemical fertilizer through drip irrigation water in plastic houses (Hanafy Ahmed et al., 2002). In commercial production, quantity's of NPK fertilizers is very important factor affecting plant growth and production, especially the balance among N, P and K in soil. On the other hand, intensive application of NPK fertilizers causes pollution in under ground water, increasing soil salinity which does not sustain the sustainable production (Chen et al., 2004). This work investigated the response of sweet pepper plants growth pattern to different NPK fertigation levels using different growth analysis formulas under plastic greenhouse condition.

MATERIAL AND METHODS

An experiment was carried out during the two seasons of 1999–2000 and 2000–2001 in the plastic house of the Vegetable Crops Department, Faculty of Agriculture, Cairo University, Egypt. Seeds of sweet pepper (*Capsicum annuum* L. cv. Bruyo) were sown on 20th and 27th August in 1999 and 2000, respectively, in trays (84 cells) filled with 1:1 peat moss and vermiculite. The plastic house (60 × 9 × 3.25 m) was divided into 5 ridges, each of 1 m width and 0.2 m height. Plant spacing was 0.5 × 0.5 m. Such plastic house was equipped with drip irrigation system. The physical and chemical properties of the growing soil under study were presented in Tab. I.

I: *Physical and chemical properties of the soil in both seasons*

Properties \ Season	1999–2000	2000–2001
Physical properties:		
Clay (%)	22.9	26.1
Silt (%)	36.2	34.6
Fine sand (%)	37.1	36.0
Coarse sand (%)	3.8	3.3
Soil texture	Clay loam	Clay loam
Chemical properties:		
Available N (%)	1.15	0.95
Available P (%)	0.44	0.39
Available K (%)	1.25	1.48
EC (mmohs/cm)	1.11	1.25
pH	8.03	7.89
Organic matter (%)	2.40	2.55

The plastic cover was local UV-treated polyethylene sheet of 7.5 m in width and 200 microns in thickness. Transplants were placed, after 38 and 40 days in 1999–2000 and 2000–2001 season respectively, to the plastic house in split plot design with three replicates. In both seasons, the experiment included five different levels of NPK fertilizers as ammonium nitrate (33.5% N), phosphoric acid (85% P) and potassium sulphate (48% K), respectively were applied *via* drip irrigation water started after 2 weeks from transplanting date, as follow per plastic house 540 m^2:

(1) 17 N - 21 P- 15 K (control)
(2) 25 N - 32 P - 22 K
(3) 34 N - 42 P - 29 K
(4) 42 N - 53 P - 36 K
(5) 51 N - 64 P - 43 K

In general, concentration of N was higher than K in all doses basic on the fact that N is the major element affects formation of plant canopy, and also a part of this experiment was conducted to study the effect of different NPK levels on nitrate accumulation in fruit tissues (data not shown). The EC of nutrient solution was 2.5 $mS.cm^{-1}$ and the pH was 6.0. Three vegetative growth plant samples were collected randomly from each replicate during the whole course of growth period at 60, 90 and 120 days after transplanting to determine fresh as well as dry weights of leaves, stem and roots. From these growth characteristics the following growth analyses were determined as described by Hunt (1978).

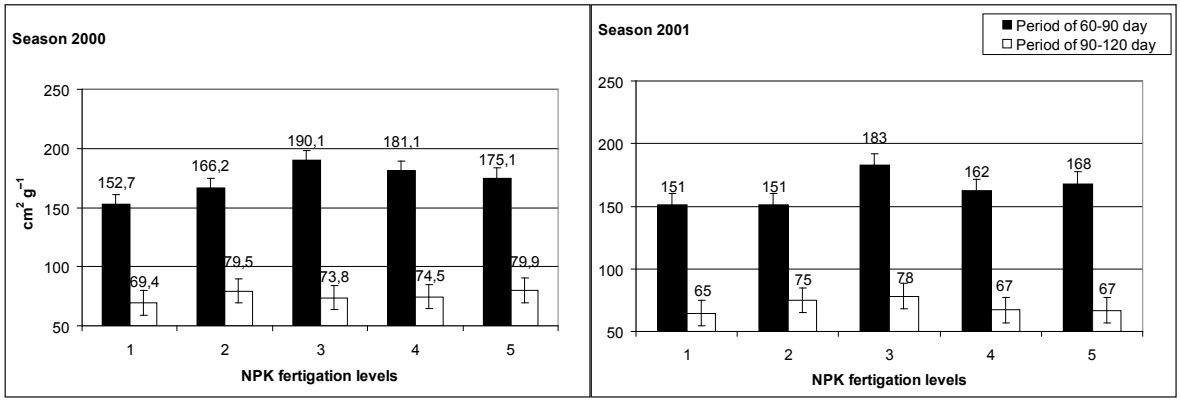
1) Leaf area ratio ($cm^2.g^{-1}$) = $({}_1L_A/{}_1W) + ({}_2L_A/{}_2W)$
2) Specific leaf area ($cm^2.g^{-1}$) = $({}_1L_A/{}_1L_w) + ({}_2L_A/{}_2L_w)$
3) Relative growth rate ($mg.g^{-1}.day^{-1}$) = $(\text{Lin } W_2 - \text{Lin } W_1) / (T_2 - T_1)$
4) Net assimilation rate ($g.m^{-2}.day^{-1}$) = $[(W_2 - W_1) / (T_2 - T_1)]*[(\text{Lin } {}_2L_A - \text{Lin } {}_1L_A) / ({}_2L_A - {}_1L_A)]$

where:
W_1 = Total dry weight of plant at T_1
W_2 = Total dry weight of plant at T_2
T_1 = Constant time 1
T_2 = Constant time 2
${}_1L_A$ = Leaf area of plant at T_1
${}_2L_A$ = Leaf area of plant at T_2
${}_1L_w$ = Dry weight of leaves at T_1
${}_2L_w$ = Dry weight of leaves at T_2
Lin = 2.32

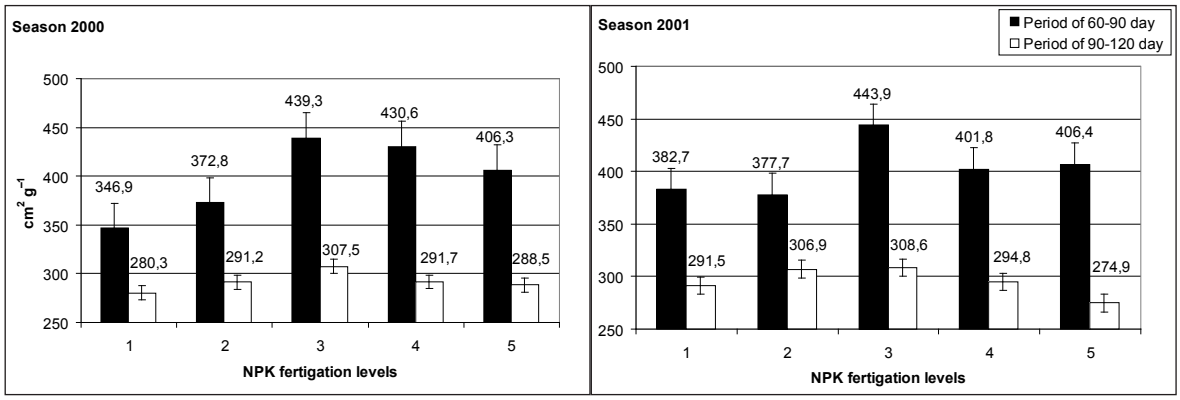
All data were subjected to the statistical analysis and means were compared according to the L.S.D. test described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

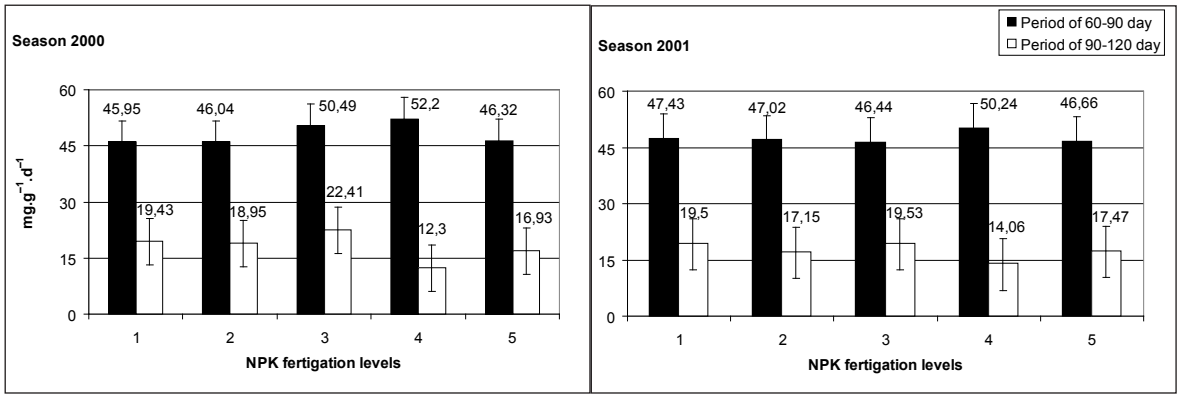
In general, Figs. 1–4, show that the main values of leaf area ratio (LAR), specific leaf area (SLA), relative growth rate (RGR) and net assimilation rate (NAR) tended to decrease significantly with advancing plant age in both seasons. Such decrease in these parameters appeared to agree with those reported by Nilwik (1981 a,b) and Hanafy Ahmed (1986) on sweet pepper, Hanafy Ahmed (1991) on spinach as well as Singh and Srivastava (1988) on *Vicia faba* plants. Furthermore, Figs. 1–2, reveals that mean values of LAR and SLA increased with increasing NPK fertigation levels. The highest values were obtained by the plants treated with the moderate NPK fertigation level (25N-32P-22K / plastic house 540 m^2) compared with the lowest or highest levels in the two seasons. Meanwhile, LAR in the period between (90–120) days in the first season showed no clear trend between treatments. These results indicate that depressing effect of increasing NPK doses up to moderate level on dry matter accumulation was more severe when compared with its effect on leaf expansion. Thus, it led to a pronounce high values of LAR when compared with low NPK fertigation levels. Moreover, these results confirm that the highest NPK fertigation levels adversely affected dry matter accumulation per plant than its effect on leaf expansion. Concerning the effect of NPK fertigation levels on RGR, it is clear from the results in Fig. 3, that slight increase in RGR was recorded by the plants treated with the moderate NPK fertigation level in both seasons. However, no significant difference could be detected in the mean values of RGR between the plants fertigated with the lower and the higher levels of NPK. In addition, the results in Figs. 4, indicate that the NAR of sweet pepper plants was gradually decreased with increasing NPK fertigation level when compared with the control plants (17N-21P-15K / plastic house 540 m^2), except NAR in the period between (90–120) days of the first season. Nicola *et al.* (1999) found that the interaction between N rates and NPK ratio was significant in relation to RGR and NAR values in tomato seedling. Also, Merghany (1997) working on tomato plants found that subsurface drip irrigation + 330 kg N/ha increased RGR and NAR when compared with the lower rates of N (110 and 220 $kg.ha^{-1}$). In this respect, it can be suggested that such gradual decrease in NAR with increasing NPK fertigation levels might be attributed to a low photosynthesis activity. In addition, increasing NPK fertilizing dose consequently efficient and/or enhanced respiration rate, this may be implicated in decreasing rate of dry matter production per unit leaf area.



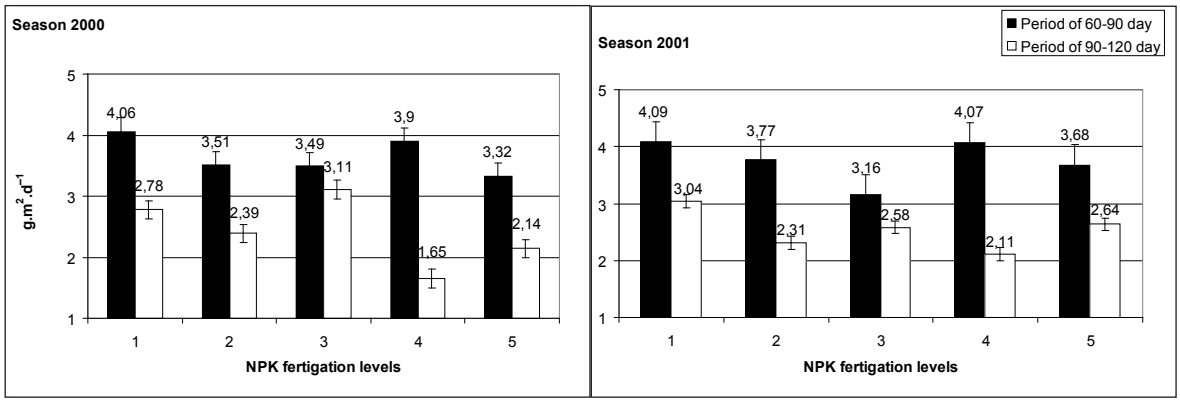
1: *Leaf Area Ratio (LAR) of sweet pepper plants as affected by different NPK fertigation levels*



2: *Specific Leaf Area (SLA) of sweet pepper plants as affected by different NPK fertigation levels*



3: *Relative Growth Rate (RGR) of sweet pepper plants as affected by different NPK fertigation levels*



4: *Net Assimilation Rate (NAR) of sweet pepper plants as affected by different NPK fertigation levelsnet*
*Intervals represent LSD 0.05

SOUHRN

Reakce růstových parametrů papriky na rozdílné úrovně výživy NPK

Práce byla zaměřena na studium vlivu pěti různých hladin přihnojování NPK na intenzitu růstu papriky (*Capsicum annuum* L. odrůda ´Bruyo´) pěstované ve foliovníku a hodnocené pomocí růstové analýzy. Velikosti listové plochy (LAR), specifické listové plochy (SLA), relativní míry růstu (RGR) a čisté míry asimilace (NAR) byly hodnoceny za dvě periody (60–90 a 90–120 dnů) od výsadby. Průměrné hodnoty LAR, SLA, RGR a NAR signifikantně poklesly s narůstající dobou vegetace rostlin v obou letech pěstování. Střední dávky NPK (34N-42P-29K / foliovníku 540 m^2) vykázaly průkazně nejvyšší hodnoty LAR a SLA za obě pěstební periody. Na druhé straně byly nejvyšší hodnoty NAR zjištěny ve variantě s nejnižší dávkou NPK (17N-21P-15K / foliovníku 540 m^2). Zvyšování přihnojovacích dávek NPK na střední hladinu mělo pozitivní vliv na LAR a SLA u papriky.

paprika, růstová analýza, NPK, skleník

SUMMARY

In the light of the above results, it can be concluded that the application of moderate NPK fertigation level (34N-42P-29K / plastic house 540 m^2) had a better effect on leaf area ratio and specific leaf area of sweet pepper plants compared with those treated plants by higher or lower NPK fertigation levels.

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