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RESPONSE OF SNAP BEAN (*PHASEOLUS VULGARIS L.*) TO SOIL MOISTURE CONTENT AND NITROGEN FERTILIZATION UNDER SANDY SOIL CONDITIONS

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ABSTRACT

Two field experiments were carried out at the Experimental Farm of the Faculty of Agriculture, Suez Canal University, Ismailia, Egypt during the two spring successive seasons of 2003 and 2004 to investigate the effect of available soil moisture content (ASMC) of 40 %, 60% and 80% of the available water and nitrogen levels (0, 40 and 80 kg N./*fed*). on vegetative growth measurements, number and weight of pods/ plant and yield/ *fed.* Photosynthetic pigments and chemical contents of snap bean (*Phaseolus vulgaris* L.) under sandy soil conditions.

Vegetative growth parameters (plant height, number of branches, shoot fresh and dry weights and leaves area, per plant) were significantly increased as available moisture or nitrogen rates increased. The interaction effect of the two factors showed that the highest values of all parameters were obtained from 80 % ASMC and 80 kg N /fed. Similar results were obtained for relative growth rate (RGR) and net assimilation rate (NAR)

Yield and its components (number of pods, fresh weight of pods / plant and yield of green pods/ *fed.*) were increased with increasing of the available soil moisture or nitrogen application. The interaction revealed positive significant effect and the best yield was obtained from plants subjected to 80 available water % and.80 kg N/ fed.

The leaves contents of chlorophylls a, b, total chlorophyll and carotenoids were increased with decreasing available soil moisture or increasing nitrogen level. On the other hand NPK and carbohydrate contents were significantly increased with increasing both available soil moisture content and nitrogen levels.

INTRODUCTION

Snap bean (*Phaseolus vulgaris* L.) is one of the most important members of leguminous crops in Egypt for either local consumption or export as an out of vegetable season to the European countries. It plays an important role in human nutrition as a cheap source of protein and other nutrients, in addition to it's essential role in restoring soil fertility through nitrogen fixation.

Snap bean is susceptible to excess as well as to deficiency of soil moisture, therefor water is limiting factor for its production in arid and semi arid regions. Growing vegetables in sandy soil faced various problems; the most important one is the low fertility, also low soil water retention and poor physical and biological properties of such soil (Ismail, 2004).

The legume- Rhizobium symbiosis is a highly integrated system, and factors that limit plant growth normally also limit symbiotic nitrogen fixation Drought markedly limits legume production by impairing symbiotic nitrogen fixation (Bordeleau and Prevost, 1994).

If uptake and assimilation of soil N is less sensitive to drought than N_2 fixation, then application of N fertilizer might supply the crop N requirement under drought stress and ameliorate the effect of drought. Wery *et al.* (1988) found that mineral N supply stimulated plant growth of chickpea under drought stress. Also Purcell and King (1996) found in field experiment that high rates of NH_4NO_3 application increased yield of soybean for a drought treatment by 18 % compared with plants without supplemental N.

Smittle *et al.*(1990) , Dahatonde *et al.* (1992) and Merghany (1999) concluded that the yield of snap bean was strongly influenced by nitrogen fertilization rate and levels of moisture content .They added that highest yield was obtained as nitrogen and moisture levels increased

MATERIALS AND METHODS

Two field experiments were carried out at the Experimental Farm of the Faculty of Agriculture, Suez Canal University, Ismailia, Egypt during the two spring successive seasons of 2003 and 2004 to investigate the effect of available soil moisture content (ASMC) of 40 %, 60% and 80% of the available water and nitrogen levels (0, 40 and 80 kg. N./*fed*) on vegetative growth measurements, weight of pods / plant, yield/ *fed.* photosynthetic pigments and chemical contents of snap bean (*Phaseolus vulgaris* L.) under sandy soil conditions.

The experimental soil is sandy in texture with 90.92 and 89.77 sand . 2.84 and 3.46 silt . 6.24 and 6.77 clay . 8.06 and 7.8 pH . 0.15 and 0.19 N (gm/kg) . 6.44 and 6.94 P . 0.58 and 0.65 K (*meq*/L) . 0.85 and 0.93 organic matter % and 0.55 . 0.60 $CaCO_3$ and.14.98% .15.14% field capacity (FC) and 6.90% and 7.12% wilting point (WP) in the two seasons, respectively. Plants were irrigated at the available soil moisture contents of 40 %, 60 % and 80 %, which measured by Tensiometer (Bachofer, Laboratorum-Sgeraete, 7410 Reulingen) at pF 2.4, 2.7 and 3.6, respectively. Each experiment included nine treatments which were combination between three levels of available soil moisture contents i.e.. 40%, 60% and 80% and three rates of N i.e .0, 40 and 80 kg N/fed. applied as NH_4NO_3 (33.5 %)

Seeds of snap bean cv. bronco were inoculated with Rhizobium phaseoli (produced by Microbiology section, Agricultural Research Center, Giza) and planted on 8 and 10 of March in 2003 and 2004, respectively, in hills of 7.5 cm apart. The experimental design was split plot, where the levels of (ASMC) occupied the main plots and nitrogen levels were distributed in the sub plots. The area of the sub plot was 14 m^2 which contained six ridges.

All plots received 20 m^3/ fed. FYM with 200 and 150 kg/ fed calcium super phosphate (15.5 %) and potassium sulphate (48 %), respectively. FYM and 150 kg super phosphate, 50 kg potassium sulphate and one third of N levels at the preparation of soil Other amounts of fertilizers were divided to two equal doses and applied with all other agricultural practices as recommended by the Egyptian Ministry of Agriculture for production of beans in sandy soil. Random samples were taken after 50 and 60 days of planting for vegetative growth measurements in the two seasons. First sample was taken only for relative growth rate and net assimilation rate calculations. After 60 days six plants were taken to record plant height (cm), number of branches/ plant, shoot fresh weight (gm), shoot dry weight (gm) and leaves area,cm^2 per plant.

- Relative growth rate (RGR) and net assimilation rate (NAR) were determined by the following equations as described by (Radford, 1967).

$$RGR\ (gm/gm/day) = \frac{\log W_2 - \log W_1}{t_2 - t_1}$$

$$NAR\ (mg/dm^2/day) = \frac{(W_2 - W_1)(\log A_2 - \log A_1)}{(t_2 - t_1)(A_2 - A_1)}$$

Where

W_1 = total dry weight of plant at t_1

W_2 = total dry weight of plant at t_2

t_1 and t_2 = constant time t_1 and t_2

A_1 = leaf area of plant at t_1

A_2 = leaf area of plant at t_2

- Leaf pigments and chemical analysis

Disc samples from the third true leaf were taken at 60 days after sowing to determine chlorophyll a, b as well as carotenoids according to A.O.A.C (1975).

Samples of leaves were oven dried at 70 C^o till constant weight to determine the following chemical contents.

- Total nitrogen (% of dry wt.) was measured as described by A.O.A.C. (1975).
- Phosphorus (% of dry wt.) was determined according to Jackson (1967).
- Potassium (% of dry wt.) according to Jackson (1967).
- Total carbohydrate according to Somogy (1952).
- Yield and its components: the following data were recorded
- Number of green pods/ plant
- Pods weight/ plant in gm
- Total yield of pods (ton/fed.)

Statistical analysis

The obtained data were subjected to statistical analysis according to Snedecor and Cochran (1989). Treatment means were compared using L.S.D. test as described Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1. Plant growth.

1.1. . Effect of moisture content.

Results of Table (1) indicate that all plant growth parameters were significantly increased as the available soil moisture increased. Plant height showed the lowest value when plants were grown under 40% (ASMC) and 80% (ASMC) gave the tallest plants. Number of branches / plant was significantly increased in plants subjected to 60% or 80% as compared with those grown under 40% of the available water. The differences between 60%

and 80% were significant. The fresh and dry weights and leaves area, significantly increased with increasing available soil moisture from 40% to 80%. This was true in the two seasons of the study. Shortening plants and reductions in plant growth parameters under low soil moisture level may be explained . on the fact that water stress causes losses in tissue water, which reduces turgor pressure in the cell, thereby inhibiting enlargement and division of cells and this in turn causes a reduction in number of branches and leaves area (Hsiao and Acevedo,1974, Ragaa, 1992 and Esmail and Ibrahim, 1995). Regarding the dry matter Merghany (1999) reported that photosynthetic efficiency (PE) in *Phaseolus vulgaris* began to decrease with a slight deficit in the soil moisture content due to the decrease in the mesophyll photosynthetic activity at high xylem water potential and this in turn might explain the reduction in dry matter of snap bean under low SMC.

Table (1): Main effect of available soil moisture content and nitrogen levels on plant height, number of branches, shoot fresh weight, shoot dry weight, and leaves area, per plant during 2003 and 2004 seasons.

Characters / Treatments	Plant height (cm)	No. of branches	Shoot fresh wt.(gm)	Shoot dry wt.(gm)	Leaves area (cm^2)
2003					
ASMC					
40 %	50.23	3.39	104.20	10.62	470.51
60 %	56.21	3.80	111.27	12.01	523.91
80 %	60.27	3.94	120.35	12.76	621.45
L.S.D 5 %	4.17	0.11	12.19	0.64	27.15
Nitrogen levels (kg N/ fed)					
0	6.149	3.19	92.78	8.07	355.06
40	55.17	3.63	114.72	12.60	508.88
80	65.40	4.32	128.33	14.72	751.95
L.S.D 5 %	4.52	0.34	10.15	1.17	33.17
2004					
ASMC					
40 %	53.52	3.47	110.18	11.00	492.52
60 %	60.68	3.88	116.54	12.28	541.16
80 %	62.92	4.00	125.75	13.08	643.02
L.S.D 5 %	3.98	0.10	8.22	0.74	32.14
Nitrogen levels (kg N/ fed)					
0	48.40	3.28	96.62	8.14	370.63
40	58.22	3.69	121.59	13.19	532.98
80	69.39	4.37	134.75	15.33	773.36
L.S.D 5 %	4.73	0.45	11.02	1.25	34.11

1.2. Effect of nitrogen.

Data presented in Table (1) show that plant height, number of branches and leaves area per plant were strongly affected by nitrogen fertilization. The highest nitrogen level (80 kg N/*fed*) gave the highest values of all parameters followed by the other two levels (40 and 0 kg N/*fed*). Both fresh and dry weights of shoots were increased with increasing the nitrogen application rate in the two seasons. The differences were significant among the three levels of nitrogen in both seasons. The increments in vegetative growth parameter with increasing nitrogen application rate were a result of the essential and vital role of nitrogen in the metabolic processes, (El-Oksh *et al.*, 1991) in addition to that nitrogen has prominent influence on both root growth and production and export of CYT to the shoots and thus in turn affect plant growth . These results are in agreement with those of El-Oksh *et al.*(1991) on common bean, El-Awag (1998), Mehasen (1998) on faba bean and Merghany (1999) on snap bean, who concluded that high nitrogen application rate increased plant height, number of branches and leaves area/ plant.

1.3. The effect of interaction between available soil moisture content and nitrogen levels

It is clear from data in Table (2) that the interaction between the available soil moisture and nitrogen application significantly affected all the growth parameters of the treated plants. Within each ASMC treatment, the increase in nitrogen application increased all growth parameters.

Table (2): Effect of interaction between available soil moisture content and nitrogen levels on plant height, number of branches shoot fresh weight shoot dry weight, and leaves area, per plant during 2003 and 2004 seasons.

Treatments		Plant height (cm)	No. of branches	Shoot fresh. wt. (gm)	Shoot dry wt .(gm)	Leaves area (cm^2)
ASMC	Kg N/ fed					
			2003			
40%	0	40.26	2.82	82.741	6.54	328.45
	40	52.34	3.42	106.17	11.08	394.52
	80	58.10	3.94	123.69	14.24	688.56
60%	0	46.62	3.34	87.34	7.76	351.17
	40	55.26	3.66	116.81	13.44	456.36
	80	66.76	4.40	129.67	14.84	764.19
80%	0	51.55	3.42	108.27	9.91	385.56
	40	57.91	3.80	121.17	13.28	٦٧٥,٧٦
	80	71.34	4.61	131.62	15.09	803.11
L.S.D. 5 %		5.01	0.14	10.75	1.32	34.27
			2004			
40 %	0	42.32	2.94	85.92	6.58	350.10
	40	55.12	٣,٤٩	114.22	11.73	419.33
	80	63.11	3.98	130.40	14.68	708.14
60 %	0	49.14	3.43	92.18	7.89	363.15
	40	58.72	3.74	122.82	13.89	478.18
	80	70.87	4.46	134.63	15.06	782.16
80 %	0	53.74	3.47	111.77	9.96	397.82
	40	60.82	3.85	127.72	13.95	701.44
	80	74.19	4.67	137.75	15.33	829.79
L.S.D. 5 %		6.21	0.18	11.09	1.36	37.23

This means that increasing nitrogen fertilization can compensate the depletion in ASMC. The highest values of all parameters were obtained from plants subjected to 80% of the available soil moisture and. received 80 kg N / fed. This could be attributed to that high levels of water and nitrogen contributed the best condition for the various phytoprocesses i.e. mineral absorption and uptake, cell division and enlargement, enzymes activity, photosynthesis etc. Wery *et al.* (1988) on chickpea indicated that mineral N supply stimulated plant growth under drought stress. El-Awag (1998) on broad bean and Merghany (1999) on snap bean reported that the highest values of number of branches/ plant and fresh and dry weight were obtained from the interaction between the highest level of nitrogen and the highest water regime

2. Relative growth rate (RGR) and net assimilation rate (NAR).

2.1 Effect of moisture content.

Results of Table (3) cleared that RGR and NAR were increased as the available soil moisture content increased from 40% to 80% in both seasons of the study. This could be attributed to the stimulatory effect of water to the division and enlargement of cells and on minerals absorption and uptake which increased leaf area and dry weight of the leaves and in turn reflect on the increase in RGR and NAR. Ragaa 1992) came to similar conclusion on snap bean.

Table (3): Main effect of available soil moisture content and nitrogen levels on relative growth rate (RGR gm / gm /day) and net assimilation rate (NAR mg/ dm^2/ day) during 2003 and 2004 seasons.

Seasons	2003		2004	
Characters / Treatments	RGR	NAR	RGR	NAR
ASMC				
40 %	0.030	0.030	0.033	0.033
60 %	0.034	0.035	0.034	0.036
80 %	0.036	0.040	0.039	0.043
L.S.D 5 %	0.001	0.002	0.001	0.001
Nitrogen level (kg N/ fed)				
0	0.024	0.022	0.028	0.024
40	0.033	0.032	0.037	0.035
80	0.042	0.050	0.045	0.052
L.S.D 5 %	0.001	0.001	.0.001	0.002

2.2. Effect of nitrogen

Data in Table (3) show that RGR and NAR were depressed significantly with zero level of nitrogen fertilization and increased with the increasing of nitrogen application rate up to 80 kg N/ *fed*. This result could be due to the increase of dry weight and leaves area of the treated plants as shown in Table (1).

2.3. Effect of interaction

Data in Table (4) indicated that the increase in RGR and NAR were corresponding to the increase in both available soil moisture contents and nitrogen rates. In all treatments increasing nitrogen rates stimulated both RGR and NAR under low levels of ASMC. However, the highest values of RGR and NAR were obtained from plants grown in 80% available moisture and. received 80 kg N/ fed.

Table (4): Effect of interaction between available soil moisture content and nitrogen levels on relative growth rate (RGR gm/gm /day) and net assimilation rate (NAR mg/ dm^2/ day) during 2003 and 2004 seasons.

Seasons		2003		2004	
Characters / Treatments		RGR	NAR	RGR	NAR
ASMC	N kg/ fed				
	0	0.021	0.019	0.025	0.021
40 %	40	0.031	0.027	0.034	0.031
	80	0.039	0.044	0.041	0.046
	0	0.024	0.023	0.028	0.023
60 %	40	0.034	0.032	0.037	0.033
	80	0.043	0.049	0.046	0.051
	0	0.027	0.025	0.031	0.028
80 %	40	0.035	0.038	0.038	0.042
	80	0.045	0.056	0.049	0.058
L.S.D. 5%		0.001	0.002	0.003	0.003

3. Yield and its components

3.1 Effect of moisture content.

As shown in Table (5) number of pods per plant, fresh weight of pod per plant and pods yield / fed. were strongly affected by the level of soil moisture. There was a progressive increase in all traits as the available soil moisture content increased from 40% up to 80 %. The increases were significant among the three levels of available soil moisture contents and were corresponded with increase in ASMC. This was observed in the two seasons. The detrimental effect of low moisture content may be attributed to the reduction in plant height, number of branches and leaves area/plant in addition to the adverse effect of low soil moisture potential on plant development, translocation and partition of assimilates of photosynthesis among different organs (Hsiao and Acevedo, 1974), which in turn reduced the yield. These results coincided with those of Wahdan *et al.*,(1991), . Ragaa (1992), . Merghany (1999), Ibrahim and Ibrahim (2003) and Ismail (2004) all on snap bean.

3.2 Effect of nitrogen

Data presented in Table (5) show that number of pods per plant, pods fresh weight per plant and yield of pods per feddan were increased significantly with increasing the applied nitrogen from 0 up to 80 kg N/ fed. The increments were significant among the three levels of nitrogen. Similar trend was observed in both seasons. This could be attributed to the stimulative effect of nitrogen on vegetative growth which was directly reflected on the yield. The obtained results are in line with those of El-Oksh *et al.*,(1991) on common bean. Shahein (1996) . Amer, (1998) on pea, Abd_El-Naby (1998), .Mehasen (1998) both on faba bean and Merghany (1999) on snap bean.

Table (5): Main effect of available soil moisture content and nitrogen levels on number of pod s/plant, pods fresh weight (gm/ plant) and yield of pods (ton/ fed) during 2003 and 2004 seasons..

Seasons	2003			2004		
Characters / Treatments	No. of pods	Pods wt/ plant.	Pods yield/ fed	No. of pods	Pods wt/ plant.	Pods yield/ fed
ASMC						
40 %	42.15	153.40	3.93	40.96	160.11	3.98
60 %	45.88	170.29	4.35	47.83	178.02	4.39
80 %	49.33	187.06	4.88	51.96	195.02	4.93
L.S.D. 5%	2.38	15.11	0.03	5.78	15.22	0.02
Nitrogen level (kg N/ fed)						
0	34.97	122.02	3.07	36.47	129.17	3.11
40	45.92	166.19	4.26	48.15	178.02	4.31
80	56.97	222.54	5.84	59.12	239.80	5.88
L.S.D. 5 %	2.48	16.22	0.04	5.42	16.14	0.03

3.3 Effect of interaction

Results of Table (6) illustrate noticeable increase in number of pods per plant, pods weight per plant and yield of pods per faddan with increasing both soil moisture content and nitrogen rate. Data also indicated that with the same level of ASMC, increasing nitrogen application rate increased the yield and its components This could be due to the simulative effect of nitrogen on plant growth. The highest value for each parameter was obtained from plants exposed to 80% of the available water and treated with 80 kg N/ fed. This was obvious in the two seasons. Smittle *et al.*,(1990) . Dahatonde *et al.*, (1992) and Merghany (1999) concluded that the yield of snap bean was strongly influenced by nitrogen fertilization rate and levels of moisture content .They added that highest yield was obtained as nitrogen and moisture levels increased

Table (6): Effect of interaction between available soil moisture content and nitrogen levels on number of pods /plant, pods fresh weight (gm/ plant) and yield of pods (ton/ fed) during 2003 and 2004 seasons.

Seasons		2003			2004		
Treatments		No. of pods	Pods wt/ plant.	Pods yield/ fed	No. of pods	Pods wt/ plant.	Pods yield/ fed
ASM C	Kg N/ fed						
	0	32.36	112.44	2.86	34.15	119.61	2.90
40 %	40	41.22	147.88	3.77	43.11	154.52	3.81
	80	52.86	199.87	5.17	54.62	206.11	5.22
	0	33.83	120.17	2.95	35.16	126.15	2.97
60 %	40	46.19	164.49	4.19	48.26	172.71	4.22
	80	57.62	226.22	5.92	60.03	235.19	5.98
	0	37.72	133.46	3.40	40.10	141.75	3.45
80%	40	50.34	186.19	4.81	53.07	195.20	4.90
	40	60.44	241.53	6.42	62.71	248.10	6.44
L.S.D. 5%		3.17	18.61	0.14	6.22	17.32	.017

4. Photosynthetic pigments, NPK and carbohydrate contents

4.1 Effect of moisture content.

It is clear from data in Tables 7, 8) that available moisture had significant effect on photosynthetic pigments. Low levels of ASMC increased chlorophylls a, b, total chlorophylls and carotenoids in the leaves of snap bean whereas the reverse was true with the highest moisture level 80 % of ASMC. Similar results were obtained by Wahdan *et al.*,(1991) on snap bean and El-Mansi *et al.*,(1999) on pea. Ismail (2004) reported that the increase in chlorophyll with low water supply to plants resulted lowering water content in leaf tissues and this in turn increased the intensity of the green color of leaves.

Table (7): Main effect of available soil moisture content and nitrogen levels on chlorophyll a, chlorophyll b, total chlorophylls, carotenoids, nitrogen %, phosphorus %, potassium % and total carbohydrates in the leaves of snap bean during 2003 seasons.

Characters	Chlorophylls (mg/ gm dry wt)			Carotenoids mg/ gm dry wt	N %	P%	K %	Carbo-hydrates %
Treatments	a	b	Total					
ASMC								
40 %	3.68	2.88	6.56	3.39	2.05	0.39	1.72	18.66
60 %	3.53	2.86	6.39	3.25	2.29	0.43	1.81	18.71
80 %	3.26	2.69	5.95	2.96	2.39	0.47	1.97	18.88
L.S.D. 5 %	0.07	0.06	0.16	0.11	0.08	0.03	0.06	0.09
Nitrogen level (kg N/ fed)								
0	2.63	2.09	4.72	2.42	1.85	0.35	1.54	18.41
40	3.53	2.83	6.36	3.30	2.20	0.42	1.82	18.72
80	4.31	3.51	7.82	3.88	2.69	0.52	2.14	19.12
L.S.D. 5 %	0.08	0.07	0.18	0.13	0.09	0.05	0.07	0.10

Results of the same table show that N, P, K and carbohydrate contents in the leaves were increased with increasing AMSC. The highest values were obtained with the highest moisture content level. Similar trend was found by Ragaa (1992) and Merghany (1999). The increase in NPK concentration could be attributed to the stimulatory effect of water on absorbing efficiency of plants and ion movement. In addition, the increase in minerals content and uptake might be attributed to the increase in dry matter accumulation (Ismail, 2004).

4.2 Effect of nitrogen

Data in Tables (7, 8) demonstrate that chlorophyll a, b, total chlorophylls (a + b) and total carotenoids in leaves of snap bean were increased significantly with increasing nitrogen level. The increments were corresponding to the increase in nitrogen application rate for 0 kg N/fed up to 80 kg N/fed This could impute to that N supply enhanced protein synthesis and chloroplast formation which lead to an increase in chloroplast constituents such as chlorophylls (Marschner, 1995).

Data in the same table indicate significant increase in snap bean leaves contents of N, P, K and total carbohydrates as nitrogen application rate increased. This was confirmed in the two seasons. Hanna and Eisa (1998) explained the increase in NPK% as a result of increasing nitrogen level to the increase in growth of plant roots which enhances absorption of the nutrients. Increasing carbohydrate and N in snap bean leaves may resulted from photosynthesis mobilization of assimilates from stems and roots during vegetative growth (Merghany, 1999).

Table (8): Main effect of available soil moisture content and nitrogen levels on chlorophyll a, chlorophyll b, total chlorophylls, carotenoids, nitrogen %, phosphorus %, potassium % and total carbohydrates in the leaves of snap bean during 2004 season.

Characters	Chlorophylls (mg/gm dry wt)			Carotenoids	N %	P%	K %	Carbo-hydrates %
Treatments	a	b	Total					
				ASMC				
40 %	3.76	2.94	6.79	3.48	2.10	0.43	1.78	18.81
60 %	3.60	2.92	6.52	3.32	2.40	0.47	1.88	18.93
80 %	3.35	2.76	6.11	3.04	2.47	0.51	2.02	19.02
L.S.D 5%	0.08	0.05	0.17	0.08	0.06	0.003	0.09	0.10
				Nitrogen level (kg N/ fed)				
0	2.69	2.13	4.82	2.51	1.95	0.39	1.60	18.59
40	3.59	2.92	6.51	3.37	2.26	0.47	1.87	18.90
80	4.43	3.56	6.11	3.96	2.79	0.56	2.19	19.19
L.S.D. 5 %	0.07	0.06	0.15	0.10	0.07	0.004	0.05	0.12

4.3 Effect of interaction

Data in Tables (9, 10) show that chlorophylls a, b, (a + b) and total carotenoids were significantly affected by the interaction between the available water and nitrogen levels. The highest values for all appeared in the plants treated with 40% of the available water + 80 Kg N/fed.. This was evident in the two seasons.

As shown in the same tables (9, 10) the interaction effect of ASMC and nitrogen application significantly affected the leaves content of N, P, K and carbohydrate. They all were increased as the levels of both moisture content and nitrogen increase. The highest values were obtained from the plants treated with 80 % of the available water and 80 kg N/ fed. Shahien (1996) on pea and Merghany (1999) on snap bean came to similar conclusions.

Table (9): Effect of interaction between available soil moisture content and nitrogen levels on chlorophyll a, chlorophyll b, total chlorophylls, carotenoids, nitrogen %, phosphorus %, potassium % and total carbohydrates in the leaves of snap bean during2003 season.

Characters / Treatments		Chlorophylls mg/gm of dry wt			Carotenoids	N %	P%	K %	Carbo-hydrates %
ASMC	Kg N/ fed	a	b	Total					
40 %	0	2.88	1.98	4.86	2.51	1.79	0.31	1.44	18.28
	40	3.74	3.09	6.83	3.48	1.95	0.39	1.74	18.65
	80	4.42	3.58	8.00	4.91	2.41	0.48	١,٩٩	19.04
60 %	0	2.67	2.12	4.79	2.44	1.86	0.34	1.52	18.35
	40	3.55	2.89	6.44	3.34	2.29	0.42	1.80	18.68
	80	4.38	3.56	7.94	3.96	2.73	0.53	2.11	19.11
80%	0	2.33	2.17	4.50	2.31	1.89	0.39	1.66	18.60
	40	3.31	2.51	5.82	3.07	2.35	0.46	1.93	18.82
	80	4.14	3.38	7.52	3.49	2.94	0.56	2.32	19.21
L.S.D. 5%		0.09	0.15	0.19	0.14	0.11	0.07	0.09	0.13

Table (10): Effect of interaction between available soil moisture content and nitrogen levels on chlorophyll a, chlorophyll b, total chlorophylls, carotenoids, nitrogen %, phosphorus %, potassium % and total carbohydrates % in the leaves of snap bean during 2004 season

Treatments		2004							
ASMC	Kg N/ fed	Chlorophylls mg/gm of dry wt			Carotenoids	N %	P%	K %	Carbhyd-rates %
		a	b	Total					
40%	0	2.93	2.01	4.94	2.63	1.84	0.35	1.51	18.41
	40	3.78	3.15	6.93	3.54	1.99	0.43	1.79	18.92
	80	4.56	3.65	8.21	4.28	2.48	0.52	2.03	19.09
60 %	0	2.74	2.17	4.91	2.51	1.93	0.39	1.59	18.66
	40	3.61	2.96	6.57	3.42	2.37	0.47	1.85	18.97
	80	4.45	3.62	8.07	4.03	2.89	0.56	2.19	19.17
80%	40	2.40	2.21	4.61	2.40	1.98	0.44	١,٧١	18.69
	60	3.38	2.64	6.02	3.16	2.43	0.50	1.98	19.06
	80	4.27	3.42	7.69	3.57	2.99	0.59	2.36	19.30
L.S.D. 5%		0.10	0.16	0.21	0.18	0.13	0.09	0.11	0.14

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استجابة الفاصوليا لمستوى الرطوبة بالتربة و التسميد النيتروجيني تحت ظروف الأراضي الرملية

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أجريت تجربتان حقليتان بمزرعة كلية الزراعة جامعة قناة السويس بالإسماعيلية خلال موسمي ٢٠٠٣، ٢٠٠٤ وذلك لدراسة تأثير ثلاثة مستويات من الماء الميسر بالتربة (٤٠% ، ٦٠% و ٨٠%) –) و كذلك ثلاثة مستويات من النيتروجين (صفر – ٤٠ – ٨٠ كجم أزوت / فدان) على صفات النمو الخضري ومعدل النمو النسبي و الكفاءة التمثيلية و المحصول و كذلك محتوى الأوراق من كلوروفيل أ، ب ، الكلوروفيل الكلي، الكاروتين، النيتروجين، الفوسفور ، البوتاسيوم و كذلك الكربوهيدرات الكلية في الفاصوليا صنف برونكو النامية في أرض رملية. و قد أوضحت النتائج المتحصل عليها ما يلي:

١- زيادة معنوية في النمو الخضري (طول النبات، عدد الأفرع على النبات، كلا من الوزن الطازج و الجاف و المساحة الورقية) و معدل النمو النسبي و الكفاءة التمثيلية مع زيادة نسبة الماء الميسر بالتربة و أيضا مع زيادة معدل النيتروجين المضاف. و قد أعطي تداخل المعاملة (مع ٨٠% من الماء الميسر مع ٨٠ كجم أزوت للفدان) أعلي القيم لكل الصفات.

٢- زاد المحصول الأخضر ومكوناته (عدد القرون الخضراء ووزن القرون الخضراء للنبات و كذلك وزن القرون الخضراء للفدان) مع زيادة نسبة محتوي الرطوبة بالتربة و مع زيادة النيتروجين المضاف و أعطت المعاملة ٨٠% من الماء الميسر + ٨٠ كجم أزوت أفضل النتائج.

٣ – زاد محتوي الأوراق من الصبغات النباتية (كلوروفيل أ ، ب و الكاروتين) زيادة معنوية مع زيادة الأزوت المضاف بينما أظهرت تلك الصبغات نقصا معنويا مع زيادة الرطوبة الأرضية.

٤- زاد محتوي الأوراق من الكربوهيدرات و النيتروجين و الفوسفور و البوتاسيوم مع زيادة كل من محتوي الرطوبة بالتربة و معدل النيتروجين و ظهرت أعلي القيم في أوراق النباتات النامية في المعاملة + ٨٠% محتوي رطوبة أرضية. ٨٠ كجم أزوت