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Growth and Productivity of *Vicia Faba* Plants as Influenced by some Different Bio- and Chemical Nitrogen Fertilizers

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TWO FIELD experiments were carried out in the Experimental Farm of the National Research Centre at Shalakan, Kalubia Governorate in 1999/2000 and 2000/2001 seasons to explore the response of *Vicia faba* plants to the bio-nitrogen fertilizer (Nitrobein) and some different rates of chemical nitrogen fertilizers. Each experiment included nine treatments representing the combination of three application methods of bio-nitrogen, *i.e.* without, one dose and two doses with three rates of chemical nitrogen fertilizer, *i.e.* 100, 150 and 200 kg/fed of Ammonium sulphate (20.5 % N).

The obtained results indicated that plant growth, I.E., plant height, number of leaves and branches as well as dry weight of whole plant was improved due to Nitrobein application (two doses), as compared with other treatments. However, addition of chemical nitrogen (100-200 kg/fed of Ammonium sulphate) resulted in a slow increase in the vegetative growth parameters. The interaction between the bio- and chemical nitrogen fertilizer significantly improved plant growth showing its highest values with *Vicia faba* plants which treated with bio-N fertilizer (two doses) combined with the medium rate of chemical nitrogen addition.

Total green pods yield as well as average pod weight were less affected by bio-N fertilizer treatments than that of chemical ones. The interaction between bio- and chemical fertilizer significantly stimulated pods yield and its characters of *Vicia faba* and showed its highest values by applying two doses of bio-N fertilizer with addition of 200 kg/fed of Ammonium sulphate.

Nutritional value of *Vicia faba* pods (protein, N, P, K, T.S.S. and Vitamin C) were higher with bio-fertilizer (two doses) and 200 kg fed of chemical nitrogen than other treatments.

There is great debate among scientists about the role played by microorganisms in promoting plant growth, while some other investigators directed their contribution to N_2-fixation, P or K solubilization, cellulose decomposition ...etc. others went to production of plant growth modifying substances by such bio-fertilizers (El-Sheekh, 1997).

Many investigators reported that bio-fertilizer affected plant growth (Ascosta *et al.*, 1995 and Shen , 1997) and total yield of plant (Arkhipchenko, 1996 and Kwon *et al.* (1996) as well as its physical and chemical properties (Ranganthan & Selaseelan, 1997 and Zahir, *et al.* 1997).

Micirobein and Nitrobein are considered bio-fertilizers of high performance as compared to some other bio-fertilizers, when applied in addition to soil application with 50, 70 or 80 kg N/fed for old and new land, respectively (Bedaiwi *et al.*, 1997).

The inoculation of legumes seeds crops with associative N-fixing bacteria led to change and improve plant growth and yield (Sankaranayanan *et al.*, 1995 and Bedawi, *et al.*, 1997). Whereas, Micirobein, Nitrobein gave the same effect of full nitrogen application which saves about 1/3 of the recommended nitrogen (Bedaiwi *et al.*, 1997).

Bio-N-fertilizer has greater amounts of symbiotic and non symbiotic bacteria which were responsible for nitrogen fixation by atmosphere. Its application achieved the reduction of mineral N by 25 % and increasing the availability of various nutrients by plants as well as increasing the resistance of plants to root disease and reducing the environmental pollution by chemical fertilizer application (Rizk & Shafeek, 2000).

The significant effect of bio-fertilizers may be due to the effect of different strain groups such as nitrogen fixers, nutrients mobilizing microorganisms which

help in availability of metals and their forms in the composted material and increased levels of extractable N, P, K, Fe, Zn, Mn (El-Kramany *et al.*, 2000).

Bio-fertilizer application improves plant growth, fruit yield and chemical composition, as compared with the untreated plants (Abdallah *et al.*, 2001 and Abd El-Mouty *et al.*, 2001). Application of NPK with bio-fertilizer resulted in the best growth, total yield and fruit characters (Ali *et al.*, 2001).

This study aimed to investigate the response of *Vicia faba* plants growth and productivity to nitrobein application in comparison with different doses of mineral nitrogen fertilization.

Mateiral and Methods

Two field experiments were carried out in the Experimental Farm of the National Research Centre at Shalakan, Kalubia Governorate in 1999/2000 and 2000/2001 seasons to explore the response of *Vicia faba* plants to the interaction effect of bio-nitrogen fertilizer (Nitrobein) and some different rates of chemical fertilizers.

The experimental soil was clay loam in texture with E.C. 2.3 mmhos/cm, pH 7.8 and 141 meq/L. available N, 4.9 meq./L P and 0.32 meq./L exchangeable K.

Each experiment included nine treatments representing the combination of three application methods of bio-nitrogen fertilizer *i.e.* without, one dose and two doses with three rates of chemical nitrogen fertilizer, *i.e.* 100, 150 and 200 kg/fed of Ammonium sulphate (20.5 % N), applied as the recommended. The phosphorus and potassium chemical fertilizers were applied at the recommended dose, *i.e.* 150 kg superphosphate (16.5 % P_2O_5) and 100 kg potassium sulphate (48% K_2O)/ fed. Nitrobein was added as the recommended rate of Ministry of Agriculture (two packages of 250 g for each) once during the growing season at sowing time and/or two times, *i.e.* at sowing and one month later, as compared to the control, *i.e.* without bio nitrogen fertilizer .

Broad bean seeds cv. El-Kobrsy were sown at 10^{th} and 12^{th} of October in the first and the second seasons, respectively. The experimental plot area was 10.5

m^2 and included 5 rows each was of 3.5 m length and 60 cm width. The distance between plants was 20 cm.

The treatments were arranged in a split block design with 4 replicates where the Nitrobein treatments distributed in the main plots and the nitrogenous chemical fertilizers occupied the sub-plots.

At the vegetative growth stage, samples were taken 45 and 90 days after sowing. Five plants were randomly chosen from each plot for determinations of plant height, number of leaves/plant and shoots as well as dry matter content measurements.

At harvesting time, pods number per plant and some other characters of pods were also recorded, *i.e.* average pod weight and green yield as g per plant and as tons per feddan.

For some chemical analysis, a random sample of ten pods of each treatment was taken to determine : N, P, K, protein, total soluble sugars and Ascorbic acid (Vitamin C). N, P and K were determined according to Black (1983), Watanab & Olsen (1965) and Jackson (1965), respectively. The percentage of crude protein, total soluble sugars and Ascorbic acid (Vitamin C) were determined according to A.O.A.C. (1975).

The obtained data were subjected to the analysis of variance procedure and means were compared using the L.S.D. method at 5 % level of significance according to Gomez & Gomez (1984).

Results and Discussion

A. Plant growth

Effect of bio-fertilizer

Table 1 shows clearly that mixing Nitrobein as bio-N-fertilizer with seeds of *Vicia faba* at sowing time resulted in an increment in values of all plant growth measurements, if compared with the untreated plants. Such effect was true in both samples (45 and 90 days old) of the two experimental seasons. Moreover, adding Nitrobein at two times, *i.e.* one dose (250 g) at seeding time and the

second one month later, gave more growth than addition of one dose only. However, the differences within these two treatments failed to reach the 5 % level of significance, in most cases. It could be concluded that applying the bio-N-fertilizer named Nitrobein inoculated with seeds or added directly to the soil one month after sowing increased plant height, leaves and shoots numbers as well as dry weight of whole plant. Such superiority may be attributed to that applying bio-fertilizer enhanced the microorganisms living in the soil which working on the organic matter in the soil to convert the organic form of nutrients such as nitrogen to mineral form. Thus reflexed to increase the uptake of nutrients from soil by roots of plant (Lampking, 1990).

Effect of chemical nitrogen fertilizer

The obtained results (Table 1) clearly indicated that addition of nitrogen fertilizer at rates within 100 - 200 kg of Ammonium sulphate resulted in a slight increase in values of growth characters of *Vicia faba* in both samples of the two experiments. Whereas, the better growth was obtained with application of Ammonium sulphate at a rate of 100 - 150 kg/fed, while increasing nitrogen rate more than 150 kg/fed showed no significant response. Such result could be explained by means that *Vicia faba* plant as one of the leguminace crops which had a bacterial rooting nodles that contain a group of microorganism can fix the arial nitrogen. Thus, the addition of lower chemical nitrogen may be necessary to enhance the microorganisms of rooting nodles. On the other hand, the higher rate of chemical nitrogen addition may inhibit it. These findings were reported by previous workers such as Kunwar & Pandey (1992), Selvaraj *et al.* (1993); Wange (1995 and 1997) and Ali *et al.*(2001).

Effect of the interaction

The interaction effect of nitrogen addition as N-bio-fertilizer and or Ammonium sulphate as a chemical fertilizer on the growth of *Vicia faba* plants is presented in Table 1.

All plant growth measurements significantly responded to the interaction treatments. These results held good in both plant samples of the two experimental seasons, except plant height at 90 days old of the 1999/2000 and 2000/2001 seasons. Generally, it could be concluded that the highest values of plant height, number of leaves and shoots per plant as well as dry weight of whole plant were recorded by plants treated with bio-N-fertilizer at two doses

and supplied with the medium rate of chemical nitrogen. On the contrary, the poorest plant growth was noticed in case of plants received no bio -N-fertilizer, and supplied with the lowest rate of Ammonium sulphate (100 kg/fed). These findings were in good accordance in the two dates of samples of the two experimental seasons.

TABLE 1. Effect of bio and chemical fertilizer treatments on the growth characters of *Vicia faba* plants during 1999/2000 and 2000/2001 seasons.

Treatments	Characters	Plant height (cm)		Leaves No.		Shoots No.		Dry wt. (g/plant) 90 days
Bio-Nitrogen fertilizer	Chemical-N-fertilizer	45 day	90 day	45 day	90 day	45 day	90 day	
First season (1999/2000)								
Without	100 kg	45	62	23	33	3	3	58
	150 kg	52	66	23	36	3	4	63
	200 kg	57	67	27	41	4	4	67
	Mean	51.3	65	24.3	36.7	3.33	3.67	62.67
One dose	100 kg	55	64	28	43	4	5	63
	150 kg	60	68	31	45	5	5	77
	200 kg	67	69	37	48	4	6	89
	Mean	60.7	67	32	45.3	4.33	5.33	76.33
Two doses	100 kg	65	72	35	45	4	5	84
	150 kg	68	74	39	51	6	8	98
	200 kg	68	73	38	49	5	7	86
	Mean	67	73	37.3	48.3	5	6.67	89.33
Average of	100 kg	55	66	28.7	40.3	3.7	4.3	68.3
	150 kg	60	69.3	31	44.0	4.7	5.7	79.3
	200 kg	64	69.7	34	46.0	4.3	5.7	80.7
L.S.D. at 5% level	Interaction	11.1	12.6	6.6	7.1	2.0	2.3	13.6
	Bio-fertilizer	8.2	N.S	N.S	6.4	0.83	1.08	9.0
	Chemical Fertilizer	6.8	N.S	4.2	4.4	0.41	0.63	7.3
Second season (2000/2001)								
Without	100 kg	38	57	20	29	3	4	60
	150 kg	50	63	21	34	3	4	64
	200 kg	57	66	26	39	4	4	67
	Mean	48.3	62	22.3	34	3.3	4.0	63.67
One dose	100 kg	52	60	28	44	5	5	63
	150 kg	59	66	32	45	5	6	78
	200 kg	66	69	36	46	6	6	86
	Mean	59	65	32	45	5.3	5.7	75.7
Two doses	100 kg	64	71	34	44	5	5	83
	150 kg	67	74	38	49	6	7	96
	200 kg	68	72	37	48	6	7	84
	Mean	66.3	72.3	36.3	47	5.67	6.33	87.7
Average of	100 kg	51.3	62.7	27.3	39.0	4.3	4.7	68.7
	150 kg	58.7	67.7	30.3	42.7	4.7	5.7	79.3
	200 kg	63.7	69.0	33.0	44.3	5.3	5.7	79.0
L.S.D. at 5% level	Interaction	13.1	14.7	5.6	8.3	1.9	2.1	12.2
	Bio-fertilizer	N.S	N.S	N.S	N.S	0.71	0.84	8.3
	Chemical Fertilizer	4.2	N.S	4.3	4.2	0.63	0.70	7.6

B. Total yield and its components

Effect of bio-N-fertilizer

Table 2 shows clearly that applying Nitrobein to *Vicia faba* plants as a bio-N-fertilizer at 3 doses (0, one and two times), had a slight enhancement on total green pods yield, whereas the variation within treatments failed to reach the 5 % level of significance. These results held good for number and average weight of pods/plant as well as the total yield as g/plant and/or tons/fed. Many investigators studied response of plant yield to bio-fertilizer and registered similar results.

The response of plants to Bio-N-fertilized was studied by Rizk & Shafeek (2000) who reported that bio-N-fertilizer has greater number amounts of symbiotic and non-symbiotic bacteria which were responsible for nitrogen fixation by atmosphere. Its application achieved to increasing the availability of various nutrients by plants as well as increasing the resistance of plants to root disease and reducing the environmental pollution by chemical fertilizer application. On the other hand, El-Kramany *et al.* (2000) indicated that the effect of bio-fertilizer may be due to the effect of different strain groups such as nitrogen fixers and nutrient mobilizing of microorganisms.

Effect of chemical nitrogen fertilizer

The response of total green pod yield of *Vicia faba* to the different rates of Ammonium sulphate additions (0, 100, 150 and 200 kg/fed) in the two experiments is presented in Table 3.

Increasing chemical nitrogen fertilizer resulted in an increase in total green pods yield as well as its components, *i.e.* number of pods/plant and average pod weight (g/plant). The statistical analysis of the obtained data reveals that the variation within different nitrogen fertilizer rates was enough to be significant at 5 % level. These results were true in both seasons, except the average pods number. It could be concluded that the highest pods yield of *Vicia faba* was recorded with addition of 200 kg/fed of Ammonium sulphate, but mostly, the differences with150 kg/fed were not significant. It means that the economic rate of chemical nitrogen addition, is 150 kg/fed at least under the conditions of this study. The obtained results are in good accordance with those obtained by El-Beheidi *et al.* (1983), Kunwar & Pandey (1992); Selvaraj *et al.* (1993); Wange (1995 and 1997) and Ali *et al.* (2001) who reported that low N rate enhancing the endogenous microorganisms which promote its activity for more availability of the soil nutrients.

TABLE 2. Effect of some bio and chemical fertilizer treatments on the pod yield of *Vicia faba* in 1999/2000 and 2000/2001 seasons.

Treatments / Characters		Pods No. /plant	Avr. Pod wt. (g)	Green yield (g/plant)	Green yield (ton/fed.)
Bio-Nitrogen fertilizer	Chemical-N-fertilizer				
First season (1999/2000)					
Without	100 kg	15	13	195	3.90
	150 kg	17	15	255	5.10
	200 kg	19	15	285	5.70
Average		17	14.3	245	4.90
One dose	100 kg	15	14	210	4.20
	150 kg	16	15	240	4.80
	200 kg	18	17	306	6.12
Average		16.3	15.3	352	5.04
Two doses	100 kg	16	14	224	4.48
	150 kg	18	17	306	6.12
	200 kg	19	18	342	6.84
Average		17.7	16.3	290.07	5.81
Average of nitrogen fertilizer	100 kg	15.3	13.7	209.7	4.19
	150 kg	17.0	15.7	267.0	5.34
	200 kg	18.7	16.7	311.0	6.22
L.S.D. at 5% level	Interaction	2.7	3.4	27.6	1.3
	Bio-fertilizer	N.S	N.S	N.S	N.S
	N Fertilizer	N.S	2.5	39.4	1.8
Second season (2000/2001)					
Without	100 kg	16	15	240	4.80
	150 kg	16	15	240	4.80
	200 kg	17	17	289	5.78
Average		16.3	15.7	256.3	5.13
One dose	100 kg	15	14	210	4.20
	150 kg	17	16	272	5.44
	200 kg	17	18	306	6.12
Average		16.3	16	262.7	5.25
Two doses	100 kg	16	15	240	4.80
	150 kg	18	18	324	6.48
	200 kg	19	18	342	6.84
Average		17.7	17	302	6.04
Average of nitrogen fertilizer	100 kg	15.7	14.7	230.0	4.60
	150 kg	17.0	16.3	278.7	5.57
	200 kg	17.7	17.7	312.3	6.25
L.S.D. at 5% level	Interaction	N.S	2.3	31.3	1.5
	Bio-fertilizer	N.S	N.S	N.S	N.S
	N Fertilizer	N.S	2.9	38.6	1.6

TABLE 3. Effect of bio and chemical fertilizer treatments on the chemical composition of *Vicia faba* pods in 1999/2000 and 2000/2001.

Treatments / Characters		N %	Protein %	P %	K %	Total soluble sugars %	V.C. (mg/100 g fresh wt.)
Bio-Nitrogen fertilizer	Chemical-N-fertilizer						
First season (1999/2000)							
Without	100 kg	3.1	2.7	0.36	2.13	5.6	16.3
	150 kg	3.4	2.9	0.39	2.36	6.3	17.6
	200 kg	3.5	3.1	0.41	2.47	6.8	18.3
Average		3.33	2.9	0.39	2.32	6.2	17.4
One dose	100 kg	3.4	2.8	0.36	2.20	6.2	16.7
	150 kg	3.7	3.1	0.42	2.46	6.9	18.2
	200 kg	3.9	3.3	0.42	2.53	7.4	18.9
Average		3.67	3.07	0.40	2.40	6.83	17.93
Two doses	100 kg	3.5	2.8	0.38	2.32	6.8	16.9
	150 kg	3.9	3.3	0.42	2.58	7.2	18.7
	200 kg	4.2	3.4	0.43	2.68	7.8	19.2
Average		3.87	3.17	0.41	2.53	7.27	18.2
Average of nitrogen fertilizer	100 kg	3.33	2.77	0.37	2.22	6.20	16.63
	150 kg	3.67	3.10	0.43	2.47	6.80	18.17
	200 kg	3.87	3.27	0.42	2.56	7.33	18.80
L.S.D. at 5% level	Interaction	0.42	0.26	0.06	0.43	0.62	1.63
	Bio-fertilizer	0.36	0.24	N.S	N.S	0.53	N.S
	N Fertilizer	0.32	0.18	N.S	N.S	0.42	N.S
Second season (2000/2001)							
Without	100 kg	2.9	2.6	0.34	2.17	5.7	15.9
	150 kg	3.2	3.0	0.40	2.23	6.4	16.3
	200 kg	3.3	3.2	0.42	2.51	6.8	17.2
Average		3.13	2.93	0.39	3.30	6.63	16.47
One dose	100 kg	3.3	2.9	0.35	2.32	6.2	16.4
	150 kg	3.8	3.3	0.42	2.47	7.1	17.9
	200 kg	3.9	3.5	0.44	2.61	7.5	18.4
Average		3.7	3.23	0.40	2.47	6.93	17.57
Two doses	100 kg	3.5	2.9	0.38	2.33	6.9	16.6
	150 kg	4.1	3.5	0.44	2.61	7.3	17.9
	200 kg	4.2	3.6	0.46	2.69	7.7	18.7
Average		3.90	3.33	0.43	2.54	7.3	17.7
Average of nitrogen fertilizer	100 kg	3.23	2.80	0.36	2.27	6.27	16.30
	150 kg	3.70	3.27	0.42	2.44	6.93	17.37
	200 kg	3.80	3.43	0.44	2.60	7.33	16.10
L.S.D. at 5% level	Interaction	0.45	0.31	0.07	0.32	0.76	1.41
	Bio-fertilizer	0.33	0.22	N.S	N.S	0.52	N.S
	N Fertilizer	0.29	0.21	N.S	N.S	0.47	N.S

Effect of the interaction

The data of Table 2 indicated that *Vicia faba* plans supplied with the highest rate of chemical N fertilizer and received two doses of Nitrobein as bio-N-fertilizer gave the heaviest total green pod yield as Ton/fed and/or as g/plant as well as the highest number of pods/plant and average weight of pod. These results were similar in both 1999/2000 and 2000/2001 seasons. The differences within different interaction treatments were significant at 5 % level for total pod yield and its components in both experiment, except number of pods/plant in the second season.

C. Nutritional value of pods

Effect of bio-N-fertilizer

Applying Nitrobein as bio-N-fertilizer resulted in higher values of protein, N, P, K,T.S.S. and Vitamin C compared with the control (without bio-fertilizer) (Table 3). Moreover, when Nitrobein was applied twice it improved the pods nutritional value than one dose application. It means that the highest nutritional value of pods was recorded with Nitrobein at two times (1 kg/fed for each). These results were true in both seasons.

However, the previous investigations reported that bio-N-fertilizer improved the physical and chemical properties of the yield (Ranganathan & Selvaseclan, 1997 and Zahir *et al.*, 1997).

Effect of chemical nitrogen fertilizer

With increasing the rate of Ammonium sulphate as chemical nitrogen fertilizer up to 200 kg/fed, the green pods contents of protein, N, P, K, T.S.S. and Vitamin C were enhanced. However, the differences within the two higher levels, *i.e.* 150 and 200 kg/fed failed to reach the 5 % level of significance. These results kept good in both seasons (Table 3). It could be concluded that the best nutritional value of *Vicia faba* pods was obtained when Ammonium sulphate as N source added at a rate within 150 - 200 kg/fed. This superiority may be attributed to the promotion effect of chemical nitrogen on the parameters of plant growth which are enable to adsorb more minerals by its rooting system and thus reflected on the total pod yield and its properties.

Many investigators obtained results which supported our results (El-Beheidi *et al.*, 1983; Kunwar & Pandey ,1992; Selvaraj *et al.*, 1993 and Ali *et al.*, 2001).

Effect the interaction

The interaction treatments between 3 methods of bio-N-fertilizer (Nitrobein) with 3 applications rates of chemical-N-fertilizer significantly improved the nutritional values of green pods yield of *Vicia faba* in both seasons (Table 3). The obtained results indicated that the highest contents of protein, N, P, K, T.S.S. and Vitamin C. were recorded with plants received bio-N-fertilizer as two doses (during sowing, and one month later) and supplied with the highest rate of chemical nitrogen as Ammonium sulphate (200 kg/fed). On the contrary, the poorest nutritional values were recorded with *Vicia faba* plants received no bio-N-fertilizer and supplied with 100 kg/fed of Ammonium sulphate. These results held good in the two experimental seasons.

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نمو وانتاجية نباتات الفول الرومى واستجابتها لبعض معاملات التسميد النتروجينى الحيوى والكيماوى

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تم اجراء تجربتين حقليتين فى محطة التجارب الزراعية الخاصة بالمركز القومى للبحوث بشلقان - محافظة القليوبية فى عامى ١٩٩٩/٢٠٠٠ ، ٢٠٠٠/ ٢٠٠١ وذلك لدراسة استجابة نباتات الفول الرومى للمعاملة بالسماد الحيوى (نتروبين) مقارنة ببعض معدلات من النتروجين للسماد المعدنى سلقات النشادر . واشتملت كل تجربة على ٩ معاملات ممثلة التفاعل بين ثلاث طرق لاضافة السماد الحيوى (بدون ، اضافة دفعة واحدة ، اضافة دفعتين) مع ثلاث معدلات للسماد المعدنى وهى (١٠٠ / ١٥٠ ، ٢٠٠ كجم سلفات نشادر /فدان) .

أوضحت النتائج المتحصل عليها الآتى :-

١- النمو الخضرى لنبات الفول ممثلا فى ارتفاع النبات - عدد الأوراق وعدد الأفرع للنبات وكذلك الوزن الجاف للنبات . قد سجل تحسنا نتيجة لاضافة السماد الحيوى (اضافة دفعتين) بالمقارنة ببقية المعاملات .

٢- اضافة النتروجين المعدنى بمعدل ما بين ١٠٠ - ٢٠٠ كجم / فدان سلفات النشادر أدى الى زيادة فى قيم صفات النمو الخضرى السابق ذكرها .

٣- أفضل قيم للنمو الخضرى سجلت مع معاملة اضافة دفعتين من السماد الحيوى مع ١٥٠ كجم سلفات نشادر / للفدان .

٤- كانت قراءات محصول القرون وصفات القرون أقل تأثرا بمعاملات السماد الحيوى عن مثيلاتها من السماد المعدنى وأدى التفاعل بين السماد الحيوى والمعدنى الى زيادة معنوية فى محصول القرون الأخضر - وكذلك صفات القرن وقد ظهرت أفضل القيم للمحصول مع معاملة اضافة دفعتين من السماد الحيوى مع ٢٠٠ كجم من السماد المعدنى للفدان .

٥- زادت صفات القيمة الغذائية للقرون ممثلة فى محتوى البروتين والنتروجين والفوسفور والبوتاسيوم والمواد الصلبة الكلية وفيتامين (C) بالمعاملة باضافة دفعيتن من السماد الحيوى و ٢٠٠ كجم من سلفات نشادر / للفدان .