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EFFECT OF SOME SLOW RELEASE NITROGEN FERTILIZERS ON GROWTH AND YIELD OF POTATO PLANTS

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ABSTRACT

Two field experiments were carried out during the two successive seasons of 1999/2000 and 2000/2001 to study the effect of some slow release nitrogen fertilizers (Nile compost -enciabein and mixture of them ,Nile compost+enciabein 1:1) with 4 levels (0 ,120,150 and 180 N unit per fed.) on growth ,yield and its components as well as chemical composition of potato tubers .The data were following :

1- Addition of Nile compost as an organic fertilizer resulted the best growth characters. But the mixture of chemical (enciabein) with organic (Nile compost) had the heaviest tanage /fed. as well as the best physical tuber quality.On the other hand ,the addition of Nile compost as alone and /or mixed with the enciabein gave an enhancement in mineral content, starch, total carbohydrates and total sugars content in potato tuber tissues.
2- The best growth of potato plant was obtained by the addition of the highest levels of fertilizer, i.e. 180 N unit /fed. But, the heaviest weight and number of tubers were resulted from the addition of nitrogen within the rates of 150-180 N units / fed. The highest values of starch ,total carbohydrates , total sugars, N, P, K, and Zn content were obtained by addition nitrogen fertilizer at highest level, i.e. 180 N unit/ fed. concerning the values of Fe and Mn recorded their highest content when potato plants received 150-180 N unit /fed.
3- Application of organic nitrogen fertilizer (Nile compost) at level of 180 N unit /fed. resulted the best growth characters . Used of the mixture of enciabein + Nile compost (1:1) at level of 150 N unit /fed. gave the highest tuber yield as ton /fed., average weight and number and size as well as the highest Fe , Mn, Zn, and Cu . Also, using the mixture of them at highest level 180 N unit /fed. gained the highest values of starch, total carbohydrates, total sugars, N, P, and K content.

INTRODUCTION

Potato (*Solanium tuberosium L*.) is one of the most important vegetable crops in Egypt. It gained a considerable importance as an export crop to European Markets and one of the national income resources.

Nitrogen is an indispensable elementary constituent of numerous organic compounds of general importance (amino acids, protein, nucleic acids) and it is formation of protoplasm and new cells ,as well as , its encouragement for elongation . Mengel and Kirkby (1978), Russell (1978) and Edmoned, *et al*. (1981).

The conventional nitrogen fertilizer are rapidly lost by either evaporation or by leaching in the drainage water (Daif,1973). The problem does not only stop at losing big amounts of nitrogen, but it extends to other dangerous environmental pollution that threaten human and animal health. The technique of using slow release N -fertilizer is the available and suitable solution for minimizing this problem. However the application of slow release

N – fertilizer for some vegetable crops resulted superior in the total yield and its quality (Hegazy, *et al.,* 1994, and Abady and Barakat, 1997.

The need for supplying vegetable crops with organic and inorganic fertilizers was proved to be very essential for the production of higher yield and for improving its quality (Mengel and Kirkby 1978, Edmoned. *et al*., 1981, and Borin *et al.,* 1987).

Organic manures contain higher levels of relatively available nutrients elements which are essentially required for plant growth. Moreover its plays an important role for improving soil physical properties (Bhandari *et al*.,1989). The organic manure addition could be reputed to increase the rate of organic in soil, resulting more release of plant available nutrients.

Slow release forms of nitrogen include natural organic materials such as Nile compost (from recycling the plant residues) and animal products (chicken and cow manures) , these material release nitrogen over a period time . Natural organic materials are broken down slowly by soil microorganisms (Hegazy, *et al*., 1994, and Abady and Barakat, 1997). Safia, *et al.* (2001), also they , reported that , the addition of chemical fertilizer caused a superiority in plant growth cricerias and yield of sweet pepper plants followed in descending order by that plants which supplied the Nile compost as an organic fertilizer .

The present investigation was undertaken to study the effect of different levels of slow release fertilizers (organic, chemical and mixture of them 1:1) with 4 levels of the application on potato plant growth, yield and its physical and chemical properties.

MATERIALS AND METHODS

Two field experiments were carried out at the Experimental Station of the National Research Centre, Shalakan, Kalubia Governorat, during the two successive seasons of 1999/2000 and 2000/20001 to study the influence of different soures and levels of slow nitrogen fertilizers on the growth and yield of potato plants. Table (1) presented the physical and chemical properties of the experimental soil.

Tubers of potato cv. New Nicola were sown on October 10 and 15 in the two growing seasons, respectively, at 20 cm apart within the rows. Each plot consisted of three rows, each of six meters in length and 80 cm wide. The plot area was 14.4 m^2.

Table(1): Physical and chemical analysis of the experimental soil (1999/2000 and 2000/2001 seasons.

Physical properties	1999/2000	2000/2001
Soil texture	Clay	Clay
Clay (%)	45.83	48.30
Silt (%)	29.71	27.50
Fine sand (%)	20.53	21.14
Coarse sand (%)	2.48	2.82
Chemical analysis		
Available K (mg/100g soil)	0.61	0.58
Available P (mg/100g soil)	5.72	4.82
Total nitrogen (mg/100g soil)	128.04	151.82
CL (meq/L.)	1.82	1.65
Co_3 (meq/L.)	4.34	5.13
Na_2 Co_3 (meq/L.)	3.65	3.82
Ca Co_3 (meq/L.)	1.76	1.65
Organic matter (%)	1.82	1.86
So_4 (ppm)	76.03	95.41
Ec (mmhos/cm/25°c)	2.48	2.36
pH	7.52	7.70

Each experiment included 12 treatments resulting from the interaction between 4 levels (0, 120, 150, and 180 N unit per feddan) and 3 sources of slow release fertilizers, i.e. enciabein 40 % N ,Nile compost (resulted from recycling the agricultural residues) and mixture of them (enciabein + Nile compost at 1:1). The physical and chemical properties of compost are presented in Table (2). Whereas, the organic fertilizers (Nile compost) were added during preparing the soil for plantation , but the enciabein fertilizer added at two times , i. e the first half before tuber plantation and the second half 45 days late .

Table (2): The chemical analysis of the used organic manure.

Character	Nile compost
Weight of qubic meter (kg)	400
Moisture %	30
PH	7
Ec (mmhos)	5
Organic carbon %	41
Organic matter %	70
Total nitrogen %	2
C/N ratio	1:17
Total phosphorous %	0.6
Total potassium %	6.0
Iron mg/kg	7900
Manganese mg/kg	190
Copper mg/kg	20
Zinc mg/kg	4.75

A split plot design with three replicates was used in which fertilizers were allocated to the main plots, while the different levels were randomly assigned to the sub-plot.

The normal cultural practices used for the potato production, i.e. irrigation and pest control were followed according to the traditional cultivation in the experimental location.

Plant growth expressed as plant length (cm), number of shoots and leaves per plant as well as fresh and dry weight of shoots and leaves and whole plant (g) were determined in representative samples (4 plants), which were taken at random from every experimental plot at 90 days after planting in both investigated seasons .

A harvesting time, fresh tuber yield and its quality were calculated in terms of size (cm^3), average weight (g), number and weight of tubers per plant as well as total yield as ton /fed .

The chemical constituents of potato were determined as total nitrogen, phosphorus and potassium according to the methods of Pregl (1945), Troug and Mayer (1939) and Brown and Lilleland (1946), respectively. As well as Fe, Mn, Zn and cu concentration were determined using flame ionization atomic absorption, spectrometer model 1100 B of Perkin Elemer and according to the method of Chapman and Pratt (1978). Starch, total carbohydrates and total sugars were determined using the method of A.O.A.C. (1975).

The obtained data were subjected to the analysis variance procedure and treatment means were compared to the L.S.D.test according to Gomez and Gomez.(1984).

RESULTS AND DISCUSSION

A: Plant growth:

1-Effect of fertilizers sources:

The response of plant growth characters of potato plants to the addition of enciabein, compost as well as the mixture of 1:1 of them during the two experiments 1999/2000 and 2000/2001 are presented in Table (3). It showed that, plant length, average number of leaves / plant , fresh and dry weight of whole potato plant and its different organs, all of them significantly influenced by the addition 3 slow release fertilizers . These findings were true in both experiments. Generally, the obtained data reveal that, the addition of Nile compost as an organic fertilizer (coming from recycling the agricultural residues) resulted the best growth characters compared with enciabein as used alone or mixed with organic manure,with exception of the dry weight of whole plant and its leaves in the first season.

Also the presented data of Table (3) indicated clearly that, the poorest plant growth was associated with the application of enciabein an individual fertilizer. It means that, the Nile compost if used as an individual organic fertilizer or if mixed with enciabein as 1:1 ratio resulted in the better plant growth than using enciabein alone. The result held good in 1999/2000 and 2000/20001 experiments.

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Moreover, the statistical analysis of the obtained data showed that, no significant difference were found between the addition of Nile compost as individual or as mixing it with enciabein at rate of 1:1. These results were true for all registrated plant growth characters.

Organic manure encouraged the number of leaves and fresh and dry weight of plant through the simulation effect on the meristematic activity of tissues, where these organic manures are rich in N,P,K and other minerals which required propellant growth Safia *et al.* (2001).

As for the favorable effect of organic fertilizer, many investigators indicated that the application of organic manures tended to increase the total count of bacteria as well as improving soil biological and chemical properties. Moreover, the supplied organic manures amended the microorganisms with necessary nutrient elements and increased microbial respiration and co_2 output. These organisms consume carbon and nitrogen in a ratio of approximately 30:1 producing the proteins necessary for the growth and reproduction organisms. Furthermore, there were a fairly close relationship exists between the rates of organic matter decomposition in soils, co_2 production and the number of bacteria (Abo-Hussein 1995).

As a result of these prospects, it may be concluded that organic manure improved the structure of sandy soil and this consequently encourage the plant have a good growth. Moreover, the slow released nutrients contained in organic manure permit the plants to beneficial of it. All these response resulted to improve plant growth.

These results were indicated by Borin *et al.* 1987, Derar and Gendy 1994, Herawati *etal.* 1994, Borin *et al.* 1987 and El-Badawy, 1997, are in good accordance with the obtained results.

2-Effect of fertilizer levels:

Table (3) of the effect of different levels (0,120,150,and 180 N units)on the plant growth creterias of potatoes in 1999/2000 and 2000/20001experiments. Its obvious from the obtained data that, there are alinear relationship within the improving of plant growth and the increasing levels of fertilizer additions. It means the best plant growth of potatoes as expressed by the lengthiest plants which carried the highest and heaviest leaves and shoots were resulted with that plant received the highest levels of fertilizer, i.e. 180 N unit/ fed. On the contrary, the poorest plant growth was resulted from that plants which on-received fertilizer. However, the variation within the addition different fertilizer levels recorded a significant values at 5% level. These findings were absolutely similar in both experiments.

These results are in agreement with those reported by Herawti *et al.* (1994), Abo Hussein (1995), Kobe *et al*. (1995), Abou El-Salehein *et al*. (1999) and Abdel-Mouty *et al*. (2001) who recorded that there gradual increases in values of growth characters in potato plants by increasing organic manure level.

3-Effect of the interaction:

The effect of the interaction between the three sources of nitrogen fertilizer, (enciabein, Nile compost and mixture 1:1 of them) and the four level of addition (0, 120, 150 and 180 N unit/fed.) on the plant growth characters

of potato plant during 1999/2000 and 2000/2001 seasons are presented in Table (3). The obtained data indicated that , the length of plant, dry weight of whole plant and its leaves and shoots in both experiments significantly response by the interaction treatments. In spite of the UN-significant influences on the most plant growth character, but generally it could summarized that, the best growth was obtained when application compost as individual organic fertilizer at level of 180 N units. These were true in the two experiments full all regrstrated criteria, except dry weight of whole potato plant and its leaves only in the first season. The un- significant effect of the interaction treatments on the most creterias of plant growth may be attributed to the independent effect of the two factors. Similar results has been also obtained by Derar and Gendy 1994.

B:Tuber yield and its quality:

1-Effect of fertilizers sources:

The addition of enciabein as chemical nitrogen fertilizer, Nile compost as an organic nitrogen fertilizer and a mixed of them at 1:1 rate for potato plant significantly affected the total tuber yield and its properties (size and average weight of tuber) during the two experiments of 1999/2000 and 2000/2001.

The obtained data showed that the heaviest total tuber yield as ton/fed., i.e. 8.200 and 8.553 in the first and second seasons respectively were resulted with that plants which applied the mixture of enciabein +Nile compost, followed in descending order by that plants which supplied enciabein as alone chemical fertilizer. These findings held good in two experiments. Concerning to the average weight and number of tubers per plant as well as tuber weight as gram and tuber size as cm^3, all of them completely followed the same order of change like that of total number tuber yield as tons/fed.

Generally, it could be summarized that, the mixture of chemical (enciabein) with organic (Nile compost) had the heaviest tonge/ fed. as well as the best physical tuber quality compared with the addition each of them as individual fertilizer. These may be attributed to the following aspects.

The enciabein, in spite of its slow release, but contains nitrogen in mineral form, so, the potato plant absorbed it first. However Nile compost is an organic form which decompositied into mineral form after an enough time under the suitable environmental condition for the microorganisms. So, at the early stage of plant growth, enciabein is more suitable than organic fertilizer. On the contrary, at the later time Nile compost will be more suitable for plant growth. It means, that enciabein is necessary in early stage and Nile compost will complete the plant needs for the longer time. For these response the heaviest total tuber yield and its constituents recorded their highest values when the two sources of nitrogen are mixed.

Many investigators studied the behavior of plant yield to the slow release fertilizers and obtained results supported our findings (Derar and Gendy,1994 ; Mdhu *et al.,* 1997 and Wadas, 1998).

2-Effect of fertilizer levels:

Table (4) reveals that, all levels of nitrogen fertilizers caused an enhancement in total yield as tons/fed., average weights and number of tubers per plant as well as average size and weight of tuber if compared by that plants which no supplied N fertilizer (zero level). On the other side the above mentioned creterias increased gradually and linearly by increasing N levels from 120 up to 150 N units/fed. Moreover, increasing the levels of fertilization up to 180 N units/fed. caused a slow no-significant decrease in total tuber yield and most cases of the yield components. These findings are true in 1999/2000 and 2000/2001 experiments.

It could be concluded that the most favorable level of N fertilization for potato is more than 150 and less than 180 N units/fed. Where the heaviest weight and number of tubers were resulted.

The superiority of total tuber yield and its different components which resulted with addition nitrogen fertilizer within the rates of 150 –180 N units/fed., may be attributed to the number of leaves, shoots and weight of fresh and dry of whole plant and its different organs which recorded their highest values when added nitrogen at highest rate.

Moreover, such improving effect may be due to the enhancing effect of trace elements contained in organic manure used, i. e. Fe, Mn, Zn, and Cu on the activity of photosynthesis and the accumulation of metabolites in reproductive organs and this reflects on the tuber dry matter content, number and weight of tubers per plant and consequently per feddan. These results are in confirming with those reported by Abo-Hussein (1995); Chimitdorzhieva *et al.* (1996);Vokal and Radil (1996); Abou El-Salehein *et al.* (1999) and Abdel- Mouty *et al.* (2001).

3-Effect of the interaction:

The interaction between different nitrogen sources and different addition levels on total tuber yield as ton/fed. , average numbers and weight of tubers/plant as well as average tuber weight or size during the to experimental reasons are shown in Table (4). Its evident from the obtained results that the statistical analysis of the data that the differences within treatments for all above mentioned characters were great enough to be significant at level of 5 % except average number of tubers/plant in the second season. Generally, the total tuber yield as ton/fed. or kgs/plant, average number (first season) and size of tuber, all of them recorded its highest values with fertilization by the mixture of enciabein + Nile compost (1:1) at level of 150 N unit/fed. These results held good in the two seasons with exception of average number of tubers/plant. Similar results has been also obtained by Kamla-Singh *et al.* 1990 and Derar and Gendy 1994.

C: Nutritional status of tubers :

1-Effect of fertilizers sources:

In both seasons of 1999/2000 and 2000/2001 starch, total carbohydrates as well as total sugars content of tuber tissues of that plants supplied the mixture of enciabein + Nile compost (1:1) resulted the highest values compared with using each of two fertilizer sources as individual (Table

5). Nitrogen content in potato tubers recorded its highest concentration if potato plants supplied by the enciabein as chemical nitrogen fertilizer. But when the addition of enciabein and Nile compost together the potato tubers contained the highest values of P and K. These finding were true in the two experimental seasons. Concerning, the content of Fe, the obtained data fluctuated within the two seasons, where addition Nile compost in the first season gained the highest content of Fe in tuber tissues, but when added Nile compost +enciabein together the Fe concentration reached its highest concentration in the second season. The Mn, Zn and Cu content resulted in their highest values when using the Nile compost as an organic nitrogen fertilizer for potato plant in both two seasons.

It could be summarized that, the addition organic nitrogen fertilizer in the Nile compost form as alone and/or mixed the enciabein as chemical nitrogen fertilizer gave an enhancement in mineral content as well as starch, total carbohydrates and total sugar contents in potato tuber tissues.

Increases in nutritional elements could be explained as the manure is rich in the elemental values. With increasing its rate in the rooting zone it means that the availability and absorption of the elements increase nutritional thus their concentration in plant tissue also increased. The obtained results are in good accordance with those obtained by Kamal-Singh (1990) ; Oborn, *et al.* (1995) and Abdel- Mouty, *et al.* (2001).

2-Effect of fertilizer levels:

Potato tubers of starch, total carbohydrates, total sugars, N, P, K, Fe, Mn, Zn and Cu, all of them responsed statistical significantly at 5% level by the different levels of fertilization in both experiments (Table 5). Whereas, all levels of fertilization recorded an increase in all above characters over than the un-fertilized plants. Moreover, the obtained data reveals that, increasing levels of fertilization caused a gradual increase in the chemical analysis content of potato tuber tissues. These results held good in 1999/2000 and 2000/2001 experiments for all the previous characters, with exception Fe, Mn in both experiments and Cu in the second experiment. It could be concluded that, the highest values of starch, carbohydrate, total sugar contents as N, P, K, and Zn were obtained by addition nitrogen fertilizer at highest level, i. e. 180 N unit/fed. Concerning the values of Fe and Mn recorded its highest content when potato plants received 150 N unit/fed. ,but the variation within addition 150 and/or 180 N unit/fed. foiled to reach 5% in most cases. The obtained results are in good accordance with the others which obtained by Kamal-Singh, 1990.

3-Effect of the interactions:

The interaction between sources and levels of nitrogen fertilizers affected the nutritional values of potato tissues during the 1999/2000 and 2000/2001 experiments (Table 5).

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Using the mixture of chemical nitrogen fertilizer, viz. Enciabein and organic are, viz. Nile compost (1:1) at highest level (180 N unit/fed.) for fertilization gained the highest values of starch, total carbohydrates, total sugars, N,P and K contents during the two experimental seasons. On the contrary, the addition of organic nitrogen fertilizer (Nile compost) at level of 150 N unit/fed. ,recorded the highest Fe, Mn, Zn and Cu content compared the other treatments. These results held good for the two experiments, with slow exception particularly in the second season. Similar results has been also obtained by Kamal-Singh, 1990.

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تأثير استخدام بعض الأسمدة النتروجنية بطيئة الذوبان على نمو ومحصول نبات

فاطمة احمد رزق

قسم البساتين –المركز القومي للبحوث – الدقى – القاهرة

أجريت تجربتان حقليتان بمزرعة المركزالقومى للبحوث في عامي 1999/2000و 2001/2000 لدراسة تأثير مصادر و معدلات مختلفة من الأسمدة النيتروجنية البطيئة الذوبان (كمبوست النيل ,الانسيابين , مخلوط منهما بنسبة 1:1) تحت أربع معدلات (صفر، 120 150 180 وحدة نيتروجين /ف) على صفات النمو والمحصول والجودة وكذلك محتوى الدرنات من النشا والكربوهيدرات الكلية والسكريات الكلية والنيتروجين والفسفور والبوتاسيوم والحديد والزنك والمنجنيز والنحاس وتضمنت أهم نتائج الدراسة مايلى :

1-أدى استخدام السماد العضوي (كمبوست النيل) إلى الحصول على افضل صفات للنمو الخضري. بينما أعلى كمية محصول وكذلك افضل صفات طبيعية للدرنات تم الحصول عليها عند المعاملة بمخلوط من كمبوست + الانسيابين (1:1) .بينما عند استخدام كمبوست النيل منفردا او مخلوط مع الانسيابين أدى إلى الحصول على أعلى محتوى كيماوي للدرنات (نشا – كربوهيدرات كلية – سكريات كلية).

2-استخدام معدل 180 وحدة نيتروجين /ف أدت إلى الحصول على افضل صفات للنمو الخضري . بينما كان أعلى وزن وعدد من الدرنات عند استخدام معدل بين 150- 180 وحدة نيتروجين/ ف. سجل أعلى محتوى كيماوي للدرنات (نشا-كربوهيدرات كليه – سكريات كلية – نيتروجين – فوسفور – بوتاسيوم –زنك) عند معدل 180 وحدة نيتروجين /ف . بينما كان أعلى محتوى للدرنات من الحديد – المنجنيز بإضافة بمعدل 150-180 وحدة نيتروجين / فدان .

3-إضافة السماد العضوي (كمبوست النيل) بمعدل 180 وحدة نيتروجين /ف أعطت افضل صفات للنمو الخضري . بينما استخدام مخلوط من السماد ين العضوي (كمبوست النيل) والكيماوي (الانسيابين) بنسبة 1:1 بمعدل 150 وحدة نيتروجين /ف أدى إلى الحصول على أعلى كمية محصول طن/ ف ومتوسط ومتوسط وزن وعدد وحجم الدرنات وكذلك المحتوى الكيماوي للدرنات (الحديد – المنجنيز – الزنك – النحاس). بينما إضافة معدل 180 وحدة نيتروجين /ف من مخلوط السماد ين أدى إلى الحصول على أعلى محتوى كيماوي الدرنات (نشا - كربوهيدرات كليه – سكريات كلية – نيتروجين – فوسفور – بوتاسيوم).

Table (3): Effect of different sources and levels of slow release nitrogen fertilizers on growth characters of potato plants during 1999/2000 seasons.

Treatments	Characters	Plant length (cm)	No./plant		Fresh weight (g.)			Dry weight (g.)		
			Shoots	Leaves	Shoots	Leaves	Whole plant	Shoots	Leaves	Whole plant
Enciabein	0	51.20	3.67	28.67	46.93	82.01	128.95	7.36	7.67	15.03
	120	57.87	4.67	46.00	66.12	158.23	224.39	8.93	12.17	21.09
	150	57.17	4.00	52.00	69.76	166.40	236.16	9.29	13.97	23.26
	180	62.67	5.33	57.33	84.40	195.12	279.52	13.22	23.10	36.32
	Average	57.73	4.42	46.00	66.80	150.45	217.25	9.70	14.23	23.93
Nile compost	0	52.33	4.00	45.00	60.67	151.17	211.84	6.52	7.18	13.70
	120	64.67	4.67	59.67	82.90	168.64	251.54	10.00	15.15	26.15
	150	69.20	5.67	64.33	94.45	199.33	293.78	11.44	19.49	30.93
	180	76.00	5.67	73.00	103.33	253.96	357.29	17.34	20.67	38.04
	Average	65.55	5.00	60.50	85.34	193.28	278.61	11.33	15.88	27.21
Enciabein + Nile compost	0	50.67	4.67	37.33	54.47	148.23	192.70	5.67	7.62	13.29
	120	55.10	5.00	54.67	76.01	171.76	247.94	11.15	18.38	29.53
	150	59.73	5.00	62.33	93.54	205.58	299.12	13.63	23.94	37.24
	180	68.83	5.33	65.33	96.61	236.39	333.00	14.84	25.35	40.19
	Average	58.59	5.00	54.92	80.61	190.53	268.19	11.32	18.82	30.15
Mean of	0	52.07	4.11	37.00	54.02	127.13	177.83	6.52	7.49	14.01
	120	59.22	4.78	53.44	75.01	166.28	241.29	10.03	15.56	25.59
	150	62.03	4.88	59.84	85.92	190.44	276.35	11.45	19.13	30.59
	180	69.17	5.44	65.22	94.78	228.49	323.27	15.14	23.05	38.18
L.S.D. of 5% level	Fertilizers	6.27	N.S.	8.36	13.60	19.99	24.56	0.78	2.40	1.94
	Levels	3.65	0.86	8.95	14.66	43.76	44.92	1.62	2.03	2.92
	Interaction	6.32	N.S.	N.S.	N.S.	N.S.	N.S.	2.81	3.52	5.06

Table (3): Con d. 2000/2001.

Characters	Treatments	Plant length (cm)	No./plant		Fresh weight (g.)			Dry weight (g.)		
			Shoots	Leaves	Shoots	Leaves	Whole plant	Shoots	Leaves	Whole plant
Enciabein	0	41.80	3.00	40.67	57.63	65.68	123.32	5.06	13.22	18.28
	120	49.97	5.00	43.67	72.53	1499.08	221.62	6.81	16.72	23.52
	150	53.07	4.67	44.67	80.47	154.37	234.84	7.56	16.95	24.51
	180	61.13	5.67	53.33	89.20	196.87	286.07	8.54	18.71	27.25
	Average	51.74	4.58	45.58	74.96	141.50	216.46	6.94	16.40	23.39
Nile compost	0	42.13	3.33	42.67	67.17	129.51	196.68	5.29	15.04	20.33
	120	53.07	5.33	46.33	82.07	174.00	256.07	7.96	17.27	25.33
	150	60.93	5.67	54.33	88.97	193.49	282.46	8.94	18.58	27.52
	180	76.37	5.67	65.67	100.07	269.52	369.59	13.23	23.63	38.86
	Average	58.13	5.00	52.25	84.57	191.63	276.20	8.86	18.63	27.49
Enciabein + Nile compost	0	37.23	4.00	44.33	60.97	129.77	190.74	4.44	14.94	19.38
	120	52.83	5.33	46.00	83.80	179.20	263.00	8.00	18.29	26.29
	150	62.57	5.67	56.00	90.53	189.62	280.15	9.40	19.03	28.43
	180	68.93	4.67	60.33	91.74	222.99	314.66	10.37	19.24	29.61
	Average	55.39	4.92	51.67	81.74	180.40	262.14	8.05	17.88	25.93
Mean of	0	40.72	3.44	42.56	61.92	108.32	170.25	4.93	14.40	19.33
	120	51.96	5.22	45.33	79.47	167.43	246.90	7.59	17.43	25.02
	150	58.86	5.33	51.67	86.66	179.16	265.82	8.63	18.19	26.82
	180	68.81	5.33	59.78	93.64	229.80	323.44	10.71	20.53	31.24
L.S.D. of 5% level	FERTILIZERS	4.55	N.S.	5.23	7.20	39.11	36.22	1.39	1.30	1.04
	Levels	4.33	1.06	5.07	8.75	25.48	25.96	0.99	1.24	1.69
	Interaction	7.49	N.S.	N.S.	N.S.	N.S.	N.S.	1.71	2.14	2.92

Table (5): Effect of different sources and levels of slow release nitrogen fertilizers on nutritional status of potato

plants during 1999/2000 seasons.

Characters	Treatments	%						.p.m.			
		Starch	Total carbohydrate	Total sugars	N	P	K	Fe	Mn	Zn	Cu
Enciabein	0	65.35	7.00	3.57	1.53	0.240	20.45	7.60	16.13	15.43	11.34
	120	69.30	74.49	4.34	1.68	0.261	2.66	8.40	17.95	16.32	12.21
	150	71.53	76.02	5.35	1.95	0.279	2.93	8.63	18.79	16.81	12.79
	180	72.75	77.40	5.32	1.81	0.293	2.89	8.83	17.92	17.57	12.22
	Average	69.73	75.23	4.72	1.74	0.268	2.73	8.21	17.70	16.53	12.14
Nile compost	0	65.79	72.42	3.99	1.48	0.219	2.31	7.50	16.96	15.64	11.36
	120	72.71	75.74	4.80	1.54	0.327	2.84	9.13	20.36	17.37	13.48
	150	72.59	76.56	5.17	1.50	0.327	2.96	9.70	21.66	18.84	14.96
	180	73.12	77.73	6.64	1.80	0.295	3.12	9.47	19.60	18.48	14.56
	Average	71.05	75.61	4.90	1.58	0.292	2.81	8.95	19.65	17.58	13.59
Enciabein + Nile compost	0	68.96	71.72	3.99	1.44	0.247	2.43	7.20	16.95	15.42	11.50
	120	70.83	76.19	4.78	1.80	0.256	2.77	9.33	19.91	16.80	12.74
	150	74.66	77.88	5.57	1.73	0.357	3.08	9.63	20.01	18.05	13.28
	180	78.75	78.79	6.23	1.79	0.397	3.54	9.50	19.58	18.33	13.63
	Average	73.30	76.15	5.14	1.69	0.310	2.96	8.92	19.11	17.15	12.79
Mean of	0	66.70	72.38	3.95	1.48	0.235	2.40	7.43	16.68	15.50	11.40
	120	70.95	75.47	4.64	1.67	0.281	2.76	8.96	19.41	16.83	12.81
	150	72.92	76.82	5.36	1.73	0.321	2.99	9.32	20.15	17.90	13.68
	180	74.87	77.97	5.73	1.80	0.322	3.18	9.17	19.03	18.13	13.47
L.S.D. of 5% level	FERTILIZERS	2.63	0.31	0.20	0.08	0.013	0.12	0.36	1.08	0.75	0.68
	Levels	2.67	0.64	0.23	0.23	0.010	0.24	0.19	0.78	0.73	0.56
	Interaction	N.S.	1.11	0.39	N.S.	0.017	N.S.	0.33	N.S.	1.26	0.97

Table (5):Cont d. 2000/2001

Treatments	Characters	%						p.p.m.			
		Starch	Total carbohydrate	Total sugars	N	P	K	Fe	Mn	Zn	Cu
Enciabein	0	63.81	73.61	3.33	1.56	0.203	2.38	7.20	17.09	15.43	11.05
	120	71.10	75.01	4.65	1.65	0.236	2.77	8.20	18.41	16.18	12.45
	150	71.03	77.01	4.70	1.91	0.264	2.80	8.47	18.69	17.02	12.81
	180	71.76	77.00	5.72	1.88	0.303	2.94	8.37	17.26	17.66	12.72
	Average	69.43	75.66	4.60	1.75	0.252	2.72	8.06	17.86	16.57	12.26
Nile compost	0	65.03	73.41	3.30	1.46	0.233	2.46	7.63	17.35	14.95	11.38
	120	72.64	76.35	4.19	1.61	0.269	2.75	8.93	21.19	17.05	14.21
	150	74.61	72.02	4.89	1.65	0.344	3.10	9.50	21.43	19.29	15.61
	180	72.53	76.38	5.71	1.80	0.380	3.02	9.27	19.53	19.73	15.23
	Average	71.20	74.54	4.52	1.63	0.306	2.84	8.86	19.88	17.75	14.11
Enciabein + Nile compost	0	68.73	74.51	3.74	1.50	0.223	2.33	7.17	17.01	14.90	10.85
	120	71.86	77.09	4.57	1.82	0.284	2.95	9.47	19.67	16.92	12.83
	150	72.59	76.48	5.62	1.75	0.358	3.12	9.60	20.55	17.52	13.60
	180	77.67	77.96	6.42	1.86	0.384	3.38	9.37	19.64	18.81	14.13
	Average	72.72	76.50	5.09	1.73	0.312	2.94	8.88	19.22	17.04	12.85
Mean of	0	65.86	73.84	3.46	1.51	0.220	2.39	7.33	17.15	15.09	11.09
	120	71.87	76.15	4.47	1.70	0.263	2.82	8.87	19.76	16.72	13.16
	150	72.74	75.17	5.07	1.77	0.322	3.01	9.20	20.22	17.94	14.01
	180	73.99	77.11	5.95	1.85	0.356	3.11	9.00	18.81	18.73	14.03
L.S.D. of 5% level	FERTILIZERS	2.39	1.03	0.42	0.08	0.030	0.17	0.45	1.43	0.91	0.98
	Levels	1.68	1.39	0.23	0.08	0.024	0.11	0.26	0.74	0.55	1.06
	Interaction	2.90	2.41	0.40	0.14	N.S.	0.20	0.46	1.28	N.S.	N.S.

Table (4): Effect of different sources and levels of slow release nitrogen fertilizers on yield and its components of potato plants during 1999/2000 seasons.

Treatments	Characters	1999/2000					2000/2001				
		Average tuber		Tubers/plant		Total yield (ton/fed.)	Average tuber		Tubers/plant		Total yield (ton/fed.)
		Weight (g.)	Size (cm)	No.	Weight (g.)		Weight (g.)	Size (cm)	No.	Weight (g.)	
Enciabein	0	58.27	14.98	3.82	222.59	4.395	52.47	14.16	3.77	197.81	4.586
	120	66.81	15.60	5.48	366.12	6.507	55.34	15.11	6.61	365.80	7.278
	150	87.08	22.36	6.37	554.70	10.416	83.71	24.57	5.80	485.52	10.544
	180	81.17	20.39	6.22	504.88	8.461	71.96	19.43	5.81	418.09	9.569
	Average	73.33	18.33	5.47	401.12	7.445	66.52	18.32	5.50	365.86	7.994
Nile compost	0	51.72	13.91	3.58	185.16	4.452	50.65	13.55	3.48	176.26	4.205
	120	64.73	14.91	5.02	324.95	5.952	53.98	13.55	4.62	249.39	7.452
	150	71.21	17.07	5.24	373.14	7.370	61.74	16.14	5.97	368.59	8.372
	180	77.93	19.13	5.83	454.33	9.618	66.69	18.90	6.72	448.16	9.578
	Average	66.40	16.30	4.92	326.69	6.848	58.27	15.53	5.20	303.00	7.402
Enciabein + Nile compost	0	53.50	15.06	3.85	205.98	4.515	51.45	13.82	4.32	222.26	4.445
	120	66.94	15.65	5.20	348.09	6.379	62.87	17.62	5.51	346.41	8.422
	150	91.50	31.61	6.91	632.27	11.592	95.69	29.45	6.84	654.52	10.987
	180	78.16	18.17	6.46	504.91	10.312	66.52	16.76	7.06	469.63	10.293
	Average	72.53	20.11	5.61	406.89	8.200	73.76	21.53	5.93	437.40	8.537
Mean of	0	54.5	14.65	3.75	204.38	4.454	51.52	13.84	3.85	198.35	4.412
	120	66.16	15.39	5.33	352.63	6.279	57.40	15.43	5.58	320.29	7.717
	150	83.27	23.68	6.17	513.78	9.793	80.15	23.39	6.21	497.73	9.968
	180	79.09	19.28	6.17	487.99	9.464	75.78	21.53	6.53	494.84	9.613
L.S.D. of 5% level	Fertilizers	3.55	1.72	0.42	1.49	0.361	6.86	0.80	0.46	3.16	0.319
	Levels	4.62	1.09	0.36	1.66	0.390	3.41	0.54	0.41	1.40	0.454
	Interaction	8.00	1.88	0.63	5.04	0.672	5.90	0.94	N.S.	4.13	0.787