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Effect of Organic Fertilizers on Some Agronomic and Chemical Properties of Potato (*Solanum tuberosum* L.)

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In the present study, we report the effects of cattle and chicken manure applied in different doses on the yield, some quality components and nutrition contents of potato. The cattle and chicken manure were applied of two different doses (0–3–6 t da^{-1} and 0–2–4 t da^{-1} respectively). The experimental soil is slightly acidic, sandy loam in texture and poor in humus, nitrogen and calcium content. The C/N ratios of the tested cattle and chicken manure were 16.3 and 15.1 respectively. In this research, the highest yield and yield component (number of tuber, weight of tuber) were obtained with application of 6 t da^{-1} cattle manure and 2 t da^{-1} chicken manure. The application of cattle and chicken manure increased tuber yields by 21% and 22% respectively compared with control. Starch content in potatoes was high with cattle manure application than chicken manure. Organic fertilizer did not significantly affect ascorbic acid content in potatoes. Maximum N, K, Ca content of leaves and N, Ca content of tubers was determined at 2 t da^{-1} chicken manure and 6 t da^{-1} cattle manure doses.

Key Words: Cattle manure, Chicken manure, Potato, Chemical properties.

INTRODUCTION

Potato is an important agricultural crop of our country. To have high yield and good quality from potatoes, we have to make proper and balanced fertilization. Nowadays, human and public health and environmental protection are becoming more important and in this case, the use of organic manures is increasing day by day. Organic matter has a fairly high importance in soil productivity and soil serves several functions. Applying manure provides advantages for the soil's physical, chemical and biological characteristics. The stable organic fraction (humus), because of its negative charge, adsorbs and holds nutrients in plant available form. Additionally, organic matter as an agent to improve soil structure, maintain tilt and minimises erosion.

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The active and some of the resistant soil organic components, together with micro-organisms (especially fungi) are involved in binding small soil particles into larger aggregates. Aggregation is important for good soil structure, aeration, water infiltration and resistance to erosion and crusting[1, 2].

Pagel and Hauff[3] observed the effects of farmyard manure, different tillage systems and times of manure applications on potato growing. They have the maximum yield on farmyard manure applications. At the same time they have the maximum yield by mixing manures in depth.

Grzeskiewicz and Trawczynsky[4] stated that their investigation was about the effects of various application forms and rates of organic manure on potato tuber yields. They obtained that there was no difference between various organic manure applications but organic manure applications increased the yield approximately 6 t ha^{-1} compared to the control parcels.

It was found that the maximum yield, dry matter and total-N contents were obtained from chicken manure parcels. Compost + mineral fertilizer combination was not so good as the chicken manure performance.

EXPERIMENTAL

The present study was conducted at the experimental field of Odemis Technical Training College. Potato was grown as first crop and Marabel variety was used. The experiment was arranged in randomized block design with three replications. The plot area was 17.5 m^2 and consisted of five rows, 0.7 m apart, with 0.25 m spacing in rows. Planting date was February 13, 2001 and harvesting was done on June 21, 2001. The soil characteristics of the field are given in Table-1. The cattle and chicken manure were applied of two different doses (0–3–6 t da^{-1} and 0–2–4 t da^{-1} respectively). The cattle and chicken manure characteristics are given in Table-2.

Artificial fertilizers and synthetic chemicals were not applied in plantation. Weed control was done by hand. Leaf samples were collected from youngest mature whole (blade and petiole) full leaves at the flowering stage[6–8] and dried at 65–70°C to make then ready for analysis. After the plot yields were determined, approximately 4–5 kg of tuber samples were taken from each plot. The samples were then washed up by tap and distilled water, cleaned and dried. Half of the samples were sliced into small pieces, dried at 65–70°C and then ground for chemical analysis[9].

At the end of the experiment, yield component (number of tubers, weight of tuber, length of plant) were determined. Also, potato tubers were classified as < 35 mm, 35–55 mm and >55 mm, counted for all parcels and determined as a percentage. Additionally, the tuber quality parameters (starch and ascorbic acid) were measured through the methods used by Schinck and Klinkowski, Schaller[10, 11]. The total N of leaf and tuber was determined by the modified Kjeldahl method.

From the wet digestion of samples, the P content was determined by colorimetrical method[12]. K, Ca, Mg contents were analyzed by flame photometer[9]. Results were evaluated statistically by tarist programme[13].

TABLE-1
SOME PROPERTIES OF CATTLE AND CHICKEN MANURE

Parameters	Cattle manure	Chicken manure
pH	8.12	8.02
Total salt (%)	1.36	1.20
Ash (%)	54.99	81.20
Organic manure (%)	39.82	21.30
Total N (%)	1.41	1.74
C/N (%)	16.38	15.12
Available P (%)	0.47	1.56
Available K (%)	1.80	1.00
Available Ca (%)	0.68	12.20
Available Mg (%)	0.82	0.72
Available Na (%)	< 0.08	0.30
Available Fe (%)	1.79	0.29
Available Cu (mg kg^{-1})	26.6	16
Available Zn (mg kg^{-1})	126.1	221
Available Mn (mg kg^{-1})	273.2	157
Available B (mg kg^{-1})	15	21

TABLE-2
SOME PHYSICAL AND CHEMICAL PROPERTIES OF EXPERIMENTAL SOIL

Characteristics	Value
pH	5.85
$CaCO_3$ (%)	0.82
Souble salt (%)	< 0.03
Organic manure (%)	1.48
Sand (%)	74.87
Loam (%)	22.00
Clay (%)	3.12
Texture (%)	Sandy-loam
Total N (%)	0.098
Available P (mg kg^{-1})	4.5
Available K (mg kg^{-1})	290
Available Ca (mg kg^{-1})	680
Available Mg (mg kg^{-1})	144
Available Na (mg kg^{-1})	60
Available Fe (mg kg^{-1})	37
Available Zn (mg kg^{-1})	0.9
Available Mn (mg kg^{-1})	10.4
Available Cu (mg kg^{-1})	2.8

RESULTS AND DISCUSION

Fig. 1 shows the maximum yield determined by using cattle manure at doses 6 t da^{-1} and chicken manure at doses 2 t da^{-1}. When the results compared to the control, those applications the yield increased 21% and 22% respectively. As a result of statistical analyses, manure doses and manure × dose interactions affected the yield at important levels. Recke *et al.*[14] determined yield increase on potatoes by using 5 t ha^{-1} manure. Romero *et al.*[5] were stated the maximum yield on chicken manure applications on their investigations that studying the effect of compost, chicken manure (2–4–6 t ha^{-1}) and organic manure + mineral fertilizer. In another investigation[4] on potatoes, it was determined that 6 t ha^{-1} yield increase was determined by using organic manure.

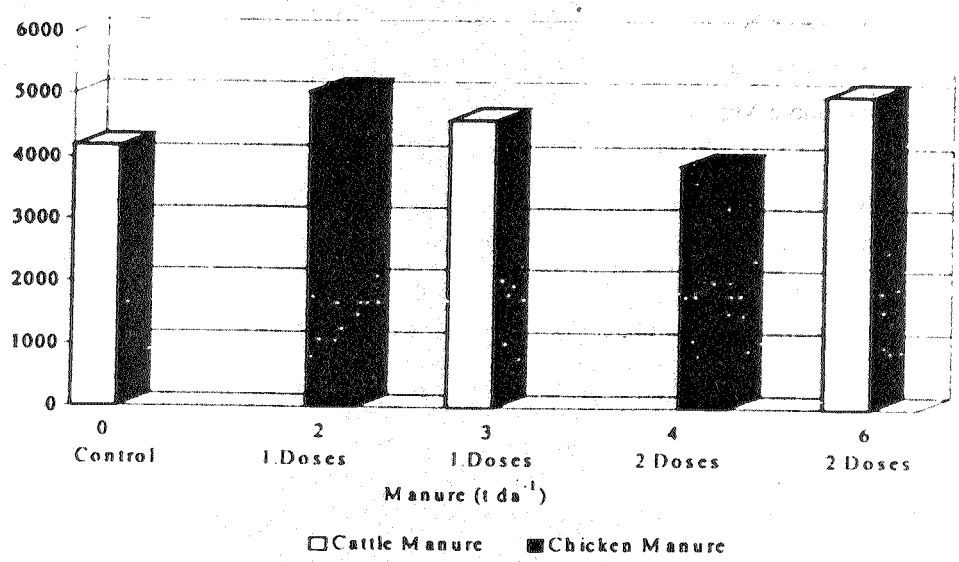

Fig. 1. Effect of cattle and chicken manures on potato yield

It was determined that the kind of manure, doses and manure × dose interactions affected plant length at important levels. Maximum plant length was obtained by using chicken manure at a dose of 2 t da^{-1}. There was not much difference between cattle manure doses (Fig. 2).

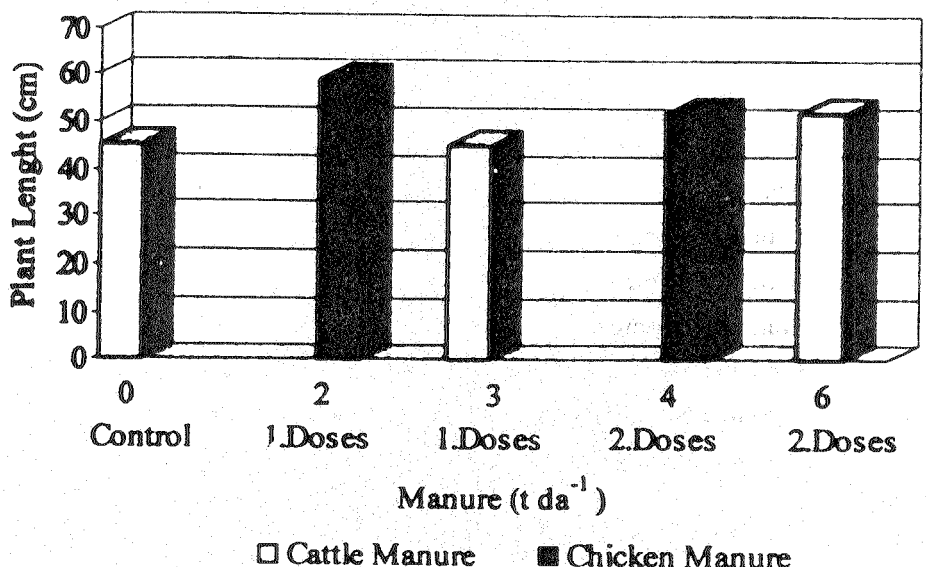

Fig. 2. Effect of cattle chicken manures on plant length of potato

Yield criteria such as number, weight and size 55 mm of tuber plant were affected significantly by doses and manure × dose interactions (Table-3).

TABLE-3
EFFECTS OF CATTLE AND CHICKEN MANURE ON SOME YIELD AND QUALITY CHARACTERISTICS

Manure	Tuber number		Tuber weight (g plant^{-1})		Tuber size >55 mm (%)		Starch (%)		Ascorbic acid (mg 100 g^{-1})	
	Cattle	Chicken	Cattle	Chicken	Cattle	Chicken	Cattle	Chicken	Cattle	Chicken
Control	6.8 a	6.8 b	896 b	896 b	37.3 b	37.3 b	27.3 a	25.7 a	19.1	19.1
Dose[1]	9.1 a	11.1 a	1023 b	1270 a	42.0 ab	50.6 a	25.0 a	25.0 a	20.8	21.4
Dose[2]	9.3 a	9.0 ab	1320 a	920 b	49.3 a	38.6 b	24.1 a	20.6 b	22.6	21.3
Average	8.4	8.9	1028	1028	42.8	42.2	24.9	23.8	20.8	20.6
LSD	Manure: N.S. Dose ($p<0.05$): 2.026 Manure × dose ($p<0.05$): 2.866		Manure: N.S. Dose ($p<0.05$): 131.232 Manure × dose ($p<0.05$): 263.838		Manure: N.S. Dose ($p<0.05$): 6.224 Manure × dose ($p<0.05$): 8.802		Manure: 0.876 Dose ($p<0.05$): 1.526 Manure × dose ($p<0.05$): 2.158		Manure: N.S. Dose ($p<0.05$): N.S. Manure × dose ($p<0.05$): N.S	

[1] Dose: Cattle: 3 t da^{-1}, Chicken: 2 t da^{-1}
[2] Dose: Cattle: 6 t da^{-1}, Chicken: 4 t da^{-1}

There wasn't any difference between tuber numbers by using cattle manure and chicken manure. Maximum values of tuber weight and tuber size 55 mm were obtained by the application of 2 t da^{-1} chicken manure and 6 t da^{-1} cattle manure. But the tuber sizes at < 35 mm and 35–55 mm were not affected. Yield criteria except plant length, had no important difference between cattle and chicken manures. Starch ingredients of potato tubers were determined at low levels on second doses of manures. There was not much difference between cattle manure but on chicken manure at dose of 4 t da^{-1} starch ingredient was effectively low. Sikora determined 12–22% starch ingredient in different potato varieties by using organic manure[15]. Dzienia and Szarek[16] stated that tuber starch ingredient was not affected by organic manure applications. At the same point Akdemir *et al.*[17] stated that it was not affected by nitrogen fertilizers.

Maximum N, K, Ca contents of potato leaves were analyzed at 2 t da^{-1} chicken manure and 6 t da^{-1} cattle manure applications (Table-4).

Ascorbic acid content of tubers increased by the application of chicken and cattle manures when it was compared to the control. But those increases were not found important statistically.

TABLE-4
EFFECTS OF CATTLE AND CHICKEN MANURE ON MACRO NUTRIENT CONTENT OF LEAVES

Manure	N (%)		P (%)		K (%)		Ca (%)		Mg (%)	
	Cattle	Chicken	Cattle	Chicken	Cattle	Chicken	Cattle	Chicken	Cattle	Chicken
Control	2.84 b	2.84 b	0.19	0.19	1.70 c	1.70 c	1.36 c	1.36 c	1.38	1.38
Dose[1]	2.82 b	3.80 a	0.21	0.23	1.98 b	2.08 a	1.54 b	2.08 a	1.58	1.67
Dose[2]	3.41 a	3.36 a	0.22	0.21	2.14 a	1.80 b	1.76 a	1.86 a	1.73	1.49
Average	3.02 b	3.33 a	0.20	0.21	1.94 a	1.86 b	1.55 b	1.76 b	1.56	1.51
LSD	Manure: 0.278 Dose ($p<0.05$): 0.340 Manure × dose ($p<0.05$): 0.481		Manure: N.S. Dose ($p<0.05$): N.S. Manure × dose ($p<0.05$): N.S.		Manure: 0.055 Dose ($p<0.05$): 0.067 Manure × dose ($p<0.05$): 0.095		Manure: 0.049 Dose ($p<0.05$): 0.060 Manure × dose ($p<0.05$): 0.085		Manure: N.S. Dose ($p<0.05$): N.S. Manure × dose ($p<0.05$): N.S.	

[1] Dose: Cattle: 3 t da^{-1}, Chicken: 2 t da^{-1}
[2] Dose: Cattle: 6 t da^{-1}, Chicken: 4 t da^{-1}

This situation proved that the yield and yield characteristics were maximum on these doses. N and Ca content of leaves was maximum on chicken manure applications and K content was maximum on cattle manure. In this investigation N, P, K ingredients of leaves were low when compare to Bergmann[18]. P and Mg content of leaves and P, K and Mg contents of tubers were not affected by the kind of manure and dose (Tables 4 and 5).

TABLE-5
EFFECTS OF CATTLE AND CHICKEN MANURE ON MACRO NUTRIENT CONTENT OF TUBER

Manure	N (%)		P (%)		K (%)		Ca (%)		Mg (%)	
	Cattle	Chicken	Cattle	Chicken	Cattle	Chicken	Cattle	Chicken	Cattle	Chicken
Control	1.22 b	1.22 b	0.22	0.22	1.45	1.45	244.0 a	244.0 b	1.38	1.38
1. Dose[1]	1.38 a	1.31 ab	0.22	0.23	1.49	1.50	259.0 a	296.0 a	1.58	1.67
2. Dose[2]	1.44 a	1.38 a	0.23	0.23	1.53	1.51	267.0 a	318.0 a	1.73	1.49
Average	1.34	1.30	0.22	0.22	1.49	1.48	256.6 b	286.0 a	1.56	1.51
LSD	Manure: N.S. Dose ($p<0.05$): 0.093 Manure × dose ($p<0.05$): 0.132		Manure: N.S. Dose ($p<0.05$): N.S. Manure × dose ($p<0.05$): N.S.		Manure: N.S. Dose ($p<0.05$): N.S. Manure × dose ($p<0.05$): N.S.		Manure: 20.751 Dose ($p<0.05$): 36.126 Manure × dose ($p<0.05$): 35.941		Manure: N.S. Dose ($p<0.05$): N.S. Manure × dose ($p<0.05$): N.S.	

[1] Dose: Cattle: 3 t da^{-1}, Chicken: 2 t da^{-1}
[2] Dose: Cattle: 6 t da^{-1}, Chicken: 4 t da^{-1}

By the dose of 6 t da^{-1} cattle manure and 4 t da^{-1} chicken manure, N and Ca contents of tubers were observed at maximum levels. But, between the first and the second doses of those manures, there was no significant difference. It was observed that N and K contents of tuber were lower than leaves. It is considered that the decrease in the elements content of tubers by applying cattle and chicken manure would be due to cell-division of the elements which causes enlargement of tuber and consequently reduces the unit amount of N, K (dilution effect).

Conclusion

As a conclusion, at doses of 6 t da^{-1} cattle and 2 t da^{-1} chicken manures, significant increases were determined on yield and yield characteristics (number of tubers, weight of tubers and size of tubers) of potatoes.

Potatoes taken from control plot had problems of low yield, low marketing value (due to small tubers). Irregularities could be reduced.

Because organic manures have great importance in all the world today, to obtain an increase on the yield and yield characteristics at the same conditions, manures have been suggested at the doses above.

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