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RESEARCH ARTICLE

EFFECT OF ORGANIC FERTILIZER AND UREA ON GROWTH, YIELD AND QUALITY OF FODDER MAIZE (Zea mays L.)

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ABSTRACT

A field experiment was conducted for two consecutive seasons in 2004/2005 and 2005/2006 at the demonstration farm of the faculty of agriculture – Omdurman Islamic University – Sudan, to investigate the effect of organic manure and urea applied alone and in combination on growth, yield and quality of fodder maize chicken manure. The design used was spilt – plot with four replicates. The growth parameters measured were plant height, stem diameter, number of leaves, leaf area index. Reproduction attributes investigated were days to 50% tasseling – silking and fresh/dry matter yield. The crude protein and crude fibre were also investigated. The results revealed that organic manure and urea significantly affected growth parameters at all sampling occasions during the two seasons. Remarkable results noticed at combination of organic fertilizer with urea followed by single addition of manure and urea. The results showed that the number of the days to 50% tasseling, fresh and dry matter yield were significantly affected by organic manure and urea during two seasons. Moreover, fresh and dry matter yield increased progressively by the combination of chicken manure and urea compared to the others treatments. The present data revealed that the crude protein and crude fibre were non significantly by organic manure and urea in both seasons. Generally crude protein and crude fibre were higher in the second seasons compared to first season.

INTRODUCTION

Maize (Zea Mays L.) is a monaceous plant belongs to the family commonly cultivated in tropical areas and grown as summer crop in temperate regions (Skerman and Riveros, 1989). The most important forage crops grown under irrigation in Sudan are Abou Sabein (Sorghum bicolor L.), Sudan grass (Sorghum Sudanese), Pioneer (S, Bicolor X. S. Sudanese). Alfa alfa (Medicago sativa) and Lubia (Lablab purpurs). On the other hand maize is grown in limited area because it is not a common animal feed, except in case of shortage of other cereal forage.

In world production maize ranks the third major cereal crop flowing wheat and rice. Maize forage production solves the problem of livestock feed shortage during winter. Moreover, forage is scarce in natural range lands during this dry period. To days its grown commercial grain crop at latitude 55° and 40°, and form sea level to 3800 meter altitude.

Compared to other cereal forage crops maize was found to be a high forage yielder in winter with a high protein content and lower fibre content (kambal, 1984). The positive response of cereal forage to inorganic nitrogen fertilizers have been reported by many investigators (Abu Suwar, 1981; Mustafa and Abdelmagid, 1981; Mohmed, 1985; Eltayeb,(1991). Recently, Koul (1997) detected the positive response of forage maize to inorganic nitrogen fertilizers. On the other hands studies using organic nitrogen source to improve forage production were limited to the use of the farmyard manure for Abu Sabein under saline soils (Abu Suwar 1981; Eltayeb, 1991). The animal manure is abundantly available so it is considered as a cheapest source of nitrogen for crops fertilization compared to inorganic source as urea.

The maize plant can be used as green forage or in the farm of silage made form the whole plant. Also the dried leaves and stalks after grain harvest can be used for feeding animals. The time required to obtain green forage is less than that for grain production, because the crop

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always harvested before the maturity of the grains. In temperate countries, forage maize become one of the most important feed stuff for ruminants specially cattle (Rouanet, 1987). In some conditions, maize fails to produce mature grains as in the case of semi- arid conditions so the stalks produced are more palatable with a high a mount of portion (Walton, 1988). In Sudan according to AOAD (1981) green forage maize grown as winter crop to feed dairy caws. Forage maize compared to other grasses a relatively high content of non- structural carbohydrates. In case of silage maize sugars within the cell and the water soluble carbohydrates are more important in the preservation of the silage material (Pain, 1978).

One of the most important factors the wide spread of maize is the varietals differences. Varieties may differ in their physiological processes (Fisher and Palmer, 1982), genetic variations (Dwer *et al*., 1989) and differential response to climatic conditions. In west and central Africa there was an increase in production due to the introduction of high yielding drought to lerant, early and extra- early maturing varieties (IITA,1995). Tossy (1972), reported that it is necessary to match the maturity of the variety to the purpose for which the crop is planted. The objective of this study is to evaluate the impact of organic manure, urea and their combinations on growth, yield and quality of forage of tow maize cultivars.

MATERIALS AND METHODS

The experiment was conducted for two consective seasons (2004/2005) and (2005/2006) at the Demonstration Farm of the Faculty of Agriculture, Omdurman Islamic University. Latitude 15^0 34- N , Longitude 32 ^{0} 43- E and altitude 393 meter above sea level. The climate of the locality is semi desert and characterized by long hot winter, little rain fall, low relative humidity and prevailing North- South wind. The maximum temperature is about 30-39 C^0 in summer and relatively low temperature in winter (Mustafa and Salim, 1978). The soil is non saline non sodic, moderately deep with Sandy clay loam texture.

Treatments involved in the experiment consist of fertilization and tow maize cultivars Giza -2 (V_1) and Mugtama- 45 (V_2) which were sown in the first week of November for tow seasons at a seed rate of 45/kg / fed. The treatments were arranged in split- plot design with four replications. The main –plots were allotted for the cultivars, and the sub- plots were allotted for fertilizers.

Treatments are:-

1- (6.46) tons/ ha cattle manure (Ca).
2- (3.36) tons/ ha chicken manure (Ch)
3- (3.23) tans/ ha cattle manure + 43.8kg N/ha (Ca+IN).
4- (4.62) tons/ ha chicken manure + 43.8kg N/ha) (C h +1N).
5- (87.6) kg N/ha urea (2N).
6- No fertilization (control).

Organic fertilizers were applied before Sowing. Homogeneous samples were taken form cattle and chicken manure to determine the percentage of N. Nitrogen fertilizer in form of urea (46%N) was applied once at sowing before the first irrigation. The crop was irrigated immediately after planting and then at 10-14 days intervals. Growth parameters measured, were plant height, stem diameter, number of leaves, and leaf area index. The plants were chosen and removed from each plot randomly after 45, 60, 75 and 90 days form sowing one manual weeding was done four weeks after planting. Reproduction attributes investigated were 50% days tasseling-silking and forage yield. The crude protein and crude fibre were also investigated. For the seasons analysis of variance was performed and means were compared using least significant difference (LSD). (Gomes and Gomes, 1984).

RESULTS

Plant height

The effect of organic fertilization and urea on plant height of two maize cultivars is presented in Table (1). The cultivars were significantly different in plant height during the first season at all sampling occasions, with the stalk height of the cultivar (V_1) higher than that of (V_2). In the second seasons, the difference between the two cultivars in stalk height was not significant. Application of fertilizers resulted in a significant differences in plant height at all sampling occasions during two seasons. The combination of organic fertilizers with urea gave the tallest plants followed by single addition of chicken and cattle manure respectively. Whereas, the urea resulted in shortest plants compared with applied organic fertilizers.

Stem diameter

The effect of organic fertilization and urea on stem diameter of maize presented in table (2). Cultivars showed significant difference in stem diameter at all sampling occasions in the two seasons with variety Giza-2 thicker than variety Mugtama- 45. In the two seasons fertilization resulted in a significant effect on stem diameter in all sampling occasions and the all fertilized plots produced thicker stems than the control. On the other hand organic manure alone and their combination with urea resulted in thicker stem diameter than the urea.

Number of leaves per plant

The effect of organic fertilization and urea on number of leaves per plant of maize was presented in table (3).The two cultivars showed a significant difference in number of leaves per plant at all sampling occasions in the first season. While the difference between them was not significant in the second season. Giza-2 gave higher number of leaves than Mugtama -45 in the first and the second season except after 90 days from sowing in the second season where variety Mugtama gave the higher number of leaves. Fertilization in the two seasons resulted in a significant effect on leaves number in all sampling occasions in comparison with control. The combination of organic fertilizers with urea gave the higher number of leaves followed by single addition of chicken and cattle manure respectively. Whereas, urea resulted in a lower number of leaves compared with applied organic fertilizer.

Leaf area Index

The obtained results revealed that the difference between the two cultivars in leaf area index was significant at all sampling occasions in the two seasons (Table 4).With the cultivars Giza gave the best result. The effect of fertilization on leaf area index during two seasons was significant, compared to control. The combination of organic fertilizers with urea gave the higher leaf area index followed by single additions of chicken and cattle

Table 1. Effect of cultivars and fertilization on plant height at different sampling occasions

Treatments	First season				Second season			
	Days after sowing				Days after sowing			
	45	60	75	90	45	60	75	90
				Cultivars				
V_1	57.8a	118.8a	149.4a	165.6a	47.2a	81.6a	89.7a	118.3a
V_2	50.3b	92.5b	122.1b	149.3b	40.9a	70.8a	78.9a	98.a
LSD	4.4	3.2	9.8	10.9	24.0	22.9	32.2	51.2
C.V	7.5	4.4	7.0	7.8	51.6	26.9	33.8	43.6
				Fertilizers				
Control	45.5c	57.0 f	75.3 f	80.5d	36.3c	46.5f	55.5c	69.8c
Ca	54.2b	96.1c	123.5c	149.9b	40.3b	62.2c	74.7b	87.6b
Ca+1N	58.6b	112.5a	142.2a	163.8a	47.4a	83.9a	96.9a	138.9a
Ch	54.5b	107.1b	119.2b	148.9b	44.0b	73.6b	79.3b	93.5b
Ch+1N	62.2a	119.9a	151.3a	168.2a	52.9a	96.0a	107.7a	154.0a
2N	54.0b	79.5d	100.8d	112.0c	39.8b	59.0d	69.7b	81.8b
LSD	7.2	8.9	10.6	18.9	7.0	12.1	11.4	22.4
C.V	12.0	9.8	12.7	12.1	17.5	62.0	13.9	20.8

Means within column followed by the same letters are not significant at LSD 5%.

Table 2. Effect of cultivars and fertilization on stem diameter at different sampling occasions

Treatments	*First season*				*Second season*			
	Days after sowing				Days after sowing			
	45	60	75	90	45	60	75	90
				Cultivars				
V_1	1.56a	1.59a	1.63a	1.64a	1.47a	1.58a	1.65a	1.66a
V_2	1.37b	1.41b	1.46b	1.47b	1.26b	1.36b	1.48b	1.50b
LSD	0.17	0.15	0.16	0.16	0.17	0.20	0.16	0.17
C.V	11.50	10.80	11.00	11.80	20.7	18.00	11.00	10.80
				Fertilizers				
Control	0.79d	0.93d	0.95d	1.10d	0.68d	0.88d	0.98d	1.18d
Ca	1.25b	1.30b	1.35b	1.47b	0.90b	1.20b	1.35b	1.45b
Ca+1N	1.49a	1.51a	1.60a	1.67a	1.20a	1.35a	1.52a	1.62a
Ch	1.27b	1.34b	1.39b	1.49b	1.00b	1.24b	1.38b	1.50b
Ch+1N	1.50a	1.55a	1.65a	1.70a	1.30a	1.40a	1.55a	1.65a
2N	1.00c	1.13c	1.15c	1.28c	0.79c	1.00c	1.20c	1.30c
LSD	0.20	0.16	0.19	0.17	0.10	0.11	0.12	0.11
C.V	16.5	11.5	12.0	10.8	12.5	12.8	11.20	11.9

Means within column followed by the same letters are not significantly different at LSD 5%.

Table 3. Effect of cultivars and fertilization on number of leaves per plant at different sampling occasions.

Treatments	First season				Second season			
	Days after sowing				Days after sowing			
	45	60	75	90	45	60	75	90
				Cultivars				
V_1	7.16a	10.16a	11.49a	12.30a	6.16a	8.53a	11.09a	14.58a
V_2	6.21b	8.24b	10.03b	11.13b	5.66a	9.85a	10.36a	14.54a
LSD	0.75	1.86	1.37	0.99	18.2	13.9	8.8	2.3
C.V	6.9	16.5	10.5	5.8	1.78	1.66	1.56	0.86
				Fertilizers				
Control	7.00d	9.30d	9.70d	10.00d	6.80d	7.70d	9.65d	10.40d
Ca	8.60b	10.80b	11.10b	14.39b	7.80b	9.66b	11.15b	15.18b
Ca+1N	9.84a	11.25a	12.30a	14.99a	9.37a	10.70a	12.15a	15.93a
Ch	8.65b	11.00b	11.37b	14.58b	8.03b	9.70b	11.30b	15.27b
Ch+1N	10.05a	11.30a	12.93a	15.10a	10.14a	11.10a	12.70a	16.03a
2N	7.80c	1020c	10.40c	11.50c	7.30c	8.68c	10.40c	11.30c
LSD	0.72	0.22	0.66	0.57	0.46	0.95	0.73	0.55
C.V	7.92	2.40	5.50	3.90	5.80	8.70	6.0	3.70

Means within column followed by the same letters are not significantly different at LSD 5%.

manure respectively. On the other hand the urea treatment resulted in a lower leaf area index compared with applied organic fertilizers.

Days to 50% tasseling – silking

The results showed that in the first and second seasons, both cultivars and fertilization significantly affected days to 50% tasseling and silking (table 5). The cultivars Mugatama attained 50% tasseling and silking earlier than Giza**.** The combination of organic fertilizers with urea allows the crop to reach 50% tasseling and silking earlier than the organic fertilizers and urea alone.

Fresh and dry matter yield

The attained results show that in the two seasons the difference in fresh and dry matter yield between the maize cultivars was significant (table 6). The cultivar Giza gave higher forage fresh and dry matter yield compared to the cultivar Mugtama in both seasons. The effect of fertilization on fresh and dry matter yield in both seasons was significant. The combination of chicken manure and urea significantly gave higher fresh and dry matter yield compared to the others treatments. The lowest fresh and dry yield was given by the control followed by urea alone.

Table 4. Effect of cultivars and fertilization on leaf area index at different sampling occasions

Treatments	First season				Second season			
	Days after sowing				Days after sowing			
	45	60	75	90	45	60	75	90
				Cultivars				
V_1	3.9b	15.8b	17.9b	15.2b	8.0b	14.5b	18.1b	15.5b
V_2	13.9a	18.9a	22.8a	19.0a	12.8a	22.6a	28.1a	25.9a
LSD	4.1	2.8	3.9	3.2	4.2	7.9	9.3	10.2
C.V	34.9	13.8	21.8	7.1	101.8	64.0	54.0	69.9
				Fertilizers				
Control	6.0d	7.9d	8.5d	7.9d	8.8d	10.5d	14.0d	12.5d
Ca	14.0b	16.8b	19.6b	18.0b	12.2b	19.0b	24.0b	20.3b
Ca+1N	18.6a	22.0a	27.0a	23.0a	14.9a	24.5a	30.0a	26.9a
Ch	14.6b	17.5b	21.2b	18.9b	13.2b	20.0b	25.0b	23.5b
Ch+1N	20.4a	24.0a	28.0a	25.0a	15.4a	25.8a	32.0a	28.5a
2N	10.0c	12.2c	14.2c	13.9c	10.5c	14.7c	19.0c	15.8c
LSD	3.5	4.0	5.3	3.9	1.5	4.1	4.9	3.2
C.V	37.8	24.9	25.9	20.5	33.5	31.0	26.2	19.8

Means within column followed by the same letters are not significantly different at LSD 5%.

Table 5. Effect of cultivars and fertilization on number of days to 50% tasseling and silking during the two seasons.

Treatments	First season		Second season	
	Days to 50% Tasseling	Days to 50% silking	Days to 50% Tasseling	Days to 50% silking
		Cultivars		
V_1	65.1a	72.5a	69.6a	79.5a
V_2	62.5b	70.1b	65.9b	73.9b
LSD	2.5	2.2	3.0	2.4
C.V	3.0	2.4	3.9	2.8
		Fertilizers		
Control	70.5a	73.5a	73.8a	78.5a
Ca	68.8a	71.8a	71.9a	77.2a
Ca+1N	61.5c	64.8c	64.7c	71.9c
Ch	64.6b	69.0b	69.5b	74.9b
Ch+1N	61.3c	64.0c	63.5c	70.4c
2N	66.2b	67.9b	67.5b	73.6b
LSD	1.7	1.7	1.8	1.9
C.V	2.2	1.9	2.4	2.2

Means within column followed by the same letters are not significantly different at LSD 5%.

Crude protein and crude fibre

The results indicated that there is no significant difference between the two cultivars in crude protein and crude fibre content (Table: 7). The effect of fertilization on crude protein and crude fibre content were not significant at the two seasons. However, the treated plants resulted in higher crude protein and crude fibre content. Generally crude protein and crude fibre were higher in the second season compared to first season.

DISCUSSION

Growth Parameters

The results showed the difference between cultivars in plant height and number of leaves per plant was significant only in the first season. The cultivars Giza gave taller plants and exceeded cultivars Mugatama in number of leaves in the two seasons. This indicated that these cultivars vary in these parameters. Similar results were reported by (Fisher and Palmer, 1984) and (Dwer *et al*., 1989). The obtained results reveled that the difference between cultivars in stem diameter was significant in all sampling occasions in the two seasons. The general trend was that the cultivars Giza produced relatively thicker stem diameter than Mugtama. This might be due to lower plant population of Giza. This low population resulted in less competition between plants and consequently thicker stem diameter. This result is supported by Early *et al.*, (1967) reported that increasing population reduce stem diameter. In all sampling occasions the cultivar Mugtama resulted in a large leaf area index than Giza with significant difference in the two seasons. This indicate a varietals difference in this parameter and may be due to higher plant population produced by Mugtama which offset the effect of large leaf number per plant as well as leaf area produced by Giza . This results is in conformity with that of Winter and Ohlrogge (1973) and Scarbrook and Doss (1973) who reported that leaf area index increased with the increase of plant population.

Table 6. Effect of cultivars and fertilization on forage fresh and dry matter yield at harvest

Treatments	First season		Second season	
	Fresh weight (tons/ha)	Dry weight (tons/ha)	Fresh weight (tons/ha)	Dry weight (tons/ha)
		Cultivars		
V_1	64.6 a	14.2 a	33.6 a	9.3 a
V_2	53.8 b	9.9 b	28.5 b	5.4 b
LSD	10.5	3.5	3.6	3.7
C.V	15.3	4.4	58.2	38.0
		Fertilizers		
Control	15.7 c	8.2 c	16.2 c	6.2 c
Ca	32.0 b	12.2 b	29.8 b	10.0 b
Ca+1N	37.6 b	14.5 b	35.4 b	12.3 b
Ch	34.7 b	14.0 b	32.5 b	11.8 b
Ch+1N	52.8 a	16.9 a	51.6 a	14.7 a
2N	28.6 b	10.6 b	26.4 b	8.4 b
LSD	12.4	2.0	9.8	2.0
C.V	17.4	4.7	27.0	30.0

Means within column followed by the same letters are not significantly different at LSD 5%.

The results showed that cattle and chicken manure in combination with urea gave taller plants and thicker stem diameter compared to single addition of manure, urea and control in the two seasons, and this can be attributed to high nitrogen content in these treatments. This result is supported by finding of Kabayshi and Nagatomo (1983) who reported that manure combined with urea increase

Table 7. Effect of cultivars and fertilization on crude protein and crude fibre of forage at harvest

Treatments	First season		Second season	
	Crude Protein (%)	Crude fibre (%)	Crude Protein (%)	Crude fibre (%)
		Cultivars		
V_1	5.6 a	27.4 a	6.5 a	27.9 a
V_2	5.2 a	27.9 a	6.2 a	30.1 a
LSD	27.6	49.2	0.8	22.5
C.V	40.6	6.4	3.9	4.4
		Fertilizers		
Control	3.4 a	26.2 a	3.8 a	27.4 a
Ca	5.4 a	27.7 a	5.8 a	28.9 a
Ca+1N	5.6 a	27.9 a	6.0 a	29.1 a
Ch	5.5 a	27.7a	5.9 a	28.9a
Ch+1N	6.3 a	28.2 a	6.7 a	29.4 a
2N	4.2 a	27.6 a	4.6 a	28.8 a
LSD	1.2	2.5	1.3	1.6
C.V	22.8	4.8	7.9	2.7

Means within column followed by the same letters are not significantly different at LSD 5%

plant height and stem nitrogen diameter. However, addition of nitrogen from different sources increased the height of plants because nitrogen found to increase number of nodes as well as internodes length and consequently plant height. Since nitrogen enhances plant growth in general, this increase in stem diameter due nitrogen fertilization was expected. Similar results were reported by Sharma (1973), Omara (1989) and Akintoye (1996). The shorter plants and thiner stem diameter resulted from the addition of manure alone and urea was due to low nitrogen in these treatments.

All the fertilized plots gave higher number of leaves and leaf area index than the control with the higher value under manure in combination with urea in the two seasons. This results was expected since nitrogen increase stem height that resulted in increase in umber of nodes, in number of leaves per plant and consequently leaf area index. Nitrogen dement was reported to increase leaf area index through the increase in leaf length and width (Ragheb *et al.*, 1990) and leaf blade size (Kabayshi and Nagatomo, 1993).

Flowering

The results showed the cultivars Mugtama always reach 50% tasseling and silking earlier than cultivar Giza in all sampling occasions in the two seasons with significant difference. This may be due to the fact that the adaptation and biological characteristics of the cultivars Mugtama accelerated the time to reach flowering (Elamir, 2003; Abdu Elgader, 2007). Fertilization with cattle and chicken manure in combination with urea treatments resulted in earlier tasseling and silking compared to single addition of manure, urea and control in the two seasons. In general nitrogen fertilization delays flowering, in this study nitrogen enhanced flowering. This results was supported by Richards *et al*., (1983) who reported that nitrogen decrease the interval from seeding to tasseling and silking.

Forage yield

The plant height and stem diameters are more effective in increasing yield. As shown earlier, the cultivar Giza gave taller plants with thicker stems than Mugtama. This resulted in high forage yield for Giza compared to Mugtaama with significant difference. Fertilization generally increased forage yield. All fertilized plots gave significantly higher fresh and dry forage yield compared to the control in the two seasons. This result was expected since all forms of fertilizers used contain nitrogen which positively increased growth. The higher response under chicken and cattle manure in combination with urea. Similar results were reported by Gupta *et al*., (1983) found that the application of farmyard manure combined with urea gave higher yield. Also this result is supported by finding of Abuswar (1994) who reported formyard manure in combination with urea increased forage dry and fresh yield. Moreover, the results of growth attributes showed that the fertilization treatments increased forage dry and fresh yield. Morever, the results of growth attributes increased plant height, number of leaves per plant, stem diameter. Consequently higher forage yield was expected with nitrogen fertilization (Sharma, (1973); Akintoye, 1996). Supporting the results in this study, many workers reported that addition of nitrogen fertilizers increased forage yield (Ellis *et al*., 1956; Singh *et a*l., 1965; Reddy *et a*l., 1985; Singh *et a*l., 1992; Elamin, 2005; AbuduElgader, 2007).

Forage quality

As shown in table (7) the two cultivars used were not different in both crude protein and crude fibre. This indicates that cultivars used are similar in forage quality.
Cultivar Giza gave slightly higher protein content. The lower crude protein of cultivar Mugtama was probably due to high plant population for this cultivar which leads to consequently resulted in lower protein.

Although fertilization treatments effects were not significant for crude protein. The treated plants gave slightly higher protein content. This slightly increase is due to the role played by nitrogen in the protein synthesis. The increase in crude protein content due to nitrogen fertilizers application was concided with the finding many investigation (Rai, 1965; Parsad, 1979; Desia and Deor, 1983; Khandaker and Islam, 1988; Singh *et al.* , 1992).
Crude fibre was not affected by the fertilization treatments. This result was not expected since nitrogen fertilization was reported to reduce crude fibre content (Tomar, 1969, Sharma *et al*., 1969; Sandhu *et a*l., 1976). However, the results are in conformity with that of Primost (1964) who reported no significant effect of nitrogen on crude fibre content. This contradiction in the results my be due to factors other than the treatments, which offset the effects of the fertilization treatments on crude fibre. These may include environmental factors and soil fertility factors. Also the age of the crop at harvest may be anther factor since forage quality is always affected by maturity regardless of the treatments used.

Conclusion

The results revealed that cultivar Giza-2 exceed cultivar Mugtama-45 in plan height, number of leaves per plant and produced thicker stem diameter with the best result in leaf area index in all growth stages. The results showed that fertilizer application affected growth parameters. Cattle and chicken manure in combination with urea gave taller plants, thicker stem diameter; higher number of leaves and leaf are index compared to the other treatments. Organic fertilization with high nitrogen and phosphorus content enhances growth and progressively

increase forage yield in maize. Additions of organic manure in combination with urea or alone are very important for improvement maize forage yield.

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