Effect of Cowdung Manure and Urea on Growth and Yield of Cabbage (*Brassica oleracea* var. *capitata* L.) at Heho, Southern Shan State of Myanmar

Soe Yu Nwe[1], Soe Soe Thein[2*], Kyaw Ngwe[1], Aung Naing Oo[1], and Kyaw Kyaw Win[3]

Abstract

Two consecutive field experiments were conducted at the Farm of Heho State Agricultural Institute (SAI), Kalaw Township, Southern Shan State, Myanmar, to study the effect of cowdung manure application with urea on growth and yield of cabbage (crown variety). The first experiment was carried out in winter season and the second one was in rainy season (2015-2016). The two-factor factorial experiment comprised of 3 levels of cowdung (0, 10 and 15 t ha^{-1}) and 4 levels of N fertilizer (0, 80, 120 and 160 N kg ha^{-1}) were set as factors A and B, respectively, using randomized complete block design with four replications. The results showed that maximum marketable yield was recorded in cowdung (15 t ha^{-1}) producing of maximum plant height, and the shortest period for head initiation and for head maturity. In contrast, lowest plant growth parameters and yield components were obtained from without cowdung application. For the N effects, the result revealed that the highest fresh weight was recorded from 160 N kg ha^{-1} by producing maximum plant growth parameters and yield components. In contrast, no nitrogen fertilizer application produced minimum fresh head weight with low plant growth parameters and yield components. For the combined effect of cowdung and nitrogen fertilizer, the results revealed that combination of cowdung (15 t ha^{-1}) with 160 N kg ha^{-1} produced highest fresh weight of cabbage. After experiment I and II, bulk density values of soil decreased and increased in pH, CEC, carbon content and total nitrogen at cowdung treated soils compared to cowdung untreated soils.

Key words - cabbage, cowdung manure, urea, fresh head weight, marketable head yield

Introduction

Cabbage (*Brassica oleracea* var. *capitata* L.) is a very popular leafy vegetable. Nutritionally, it is low in calories, fat and carbohydrates, rich in protein and contains essential amino acids (Salunkhe, 1987) and glucosinolate which is anti-cancer properties (Ambrosone and Tang 2009). Cabbage is grown throughout the year in Southern Shan State, in Myanmar. In Myanmar, cabbage sown area is 31194 ha and yield per ha is 15.69 MT and 489331 MT production (MOALI 2016).

Cabbage is a heavy feeder of nutrients, and particularly N. (Din et al. 2007). If insufficient N is given, cabbage heads will not form (Knavel and herron 1981). Sufficient application of nitrogen fertilizer promotes vigorous vegetative growth and dark green colour of cabbage (Splittstoesser 1979). Manure is an important input for maintaining and enhancing soil fertility. Manure contains the three major plant nutrients, nitrogen, phosphorus and potassium, Ca, Mg, S, Zn, B, Cu, Mn, etc. (Fulhage 2000). Growth and yield of cabbage vegetable is extremely influenced by organic and inorganic nutrients (Tindall 2000). Cabbage growers are erratically using the inorganic source of nitrogenous fertilizers to increase the head yield. Excess nitrogen affects coarse and loose head, reduces keeping quality enhances the nitrate nitrogen content of head and

[1]Department of Soil and Water Science, Yezin Agricultural University
[2]ProRector, Yezin Agricultural University
[3]Department of Agronomy, Yezin Agricultural University
*Corresponding author: soesoethein1@gmail.com

above all deteriorates the soil health (Chatterjee, 2009). However combination of organic and inorganic fertilizer can increase the yield as well as keep the environment sound (Hsieh et al. 1996).

According to survey, cabbage growers in Heho, AungBan and Pindaya Township in Southern Shan State apply different rates of cowdung manure from 10 to 20 t ha^{-1} and nitrogen fertilizer about 100 to 300 kg ha^{-1}. Therefore, the proper application of cowdung manure with N fertilizer should be examined**.** Therefore, the present study was conducted with the following objectives:

- to study the effect of cow dung manure and urea on the growth and yield of cabbage.
- to study the effect of cow dung manure and urea on some physico-chemical properties of Heho State Agricultural Institute soil in Kalaw Township in Southern Shan State.

Materials and Methods

Two-season-continuous field study was conducted from October, 2015 to January 2016 (winter season) and from May to August 2016 (rainy season) at the Heho State Agricultural Institute (Heho), Kalaw Township, Southern Shan State, Myanmar. The experiment comprised of two factors: factor A: Three levels cowdung i.e, C_0 (without cowdung), C_1 (10 t ha^{-1}) and C_2 (15 t ha^{-1}) and factor B: N_0 (0 N kg ha^{-1}), N_1 (80 N kg ha^{-1}), N_2 (120 N kg ha^{-1}) and N_3 (160 N kg ha^{-1}). Well decomposed cowdung manure was applied into the plots during final land preparation. In addition, full amount of phosphorus (25 kg ha^{-1}) and potassium (80 kg ha^{-1}) were applied at the time of transplanting as basal dose. Urea fertilizer was applied with equally three times equal split at 15, 30 and 45 days after transplanting. The experiment was layout in a Randominized Complete Block (RCB) design with four replications. About 30 days old seedlings were transplanted by zigzag. The spacing was 50 cm x 50 cm and the space between two plots was 1 m. Ten sample plants were randomly selected and used to measure the growth characters, yield and yield components from each treatment plot. Plant height, plant canopy diameter and days to head initiation and head maturity, yield and yield components such as head weight, head diameter, head length were recorded at harvest time. Soil samples were taken as composite samples from 0-15 cm surface layer before the experiment. The physicochemical properties of soil samples were analyzed at Soil and Water Utilization Division, Department of Agricultural Research (DAR), Yezin, Nay Pyi Taw, Myanmar for before experiment and at JICA laboratory at Yezin Agricultural University for both after experiments. The data were analyzed by using Statistix 8 Program. Treatment means were compared by using Least Significant Difference (LSD) test at 5% probability level.

Results and Discussion

Plant height

In both seasons, plant height varied Pr<0.0001 among the cowdung and nitrogen (Table 1). The maximum plant height (28.60) and (24.25) cm was recorded from cowdung (15 t ha^{-1}) while control gave the minimum (26.30) and (21.79) cm in winter and rainy. This might be due to that plant received more nutrients by cowdung which encouraged more vegetative growth. Solomon (2015) reported that the application of cowdung manure increased the plant height. The maximum (29.50) and (24.47) cm was recorded from 160 N kg ha^{-1}whereas control gave the minimum (25.30) and (21.98) cm. This result might be due to cause of rapid release of nutrients by nitrogen fertilizer that increased taller plant height. Pramanik (2007) reported that the maximum plant height was obtained by 260 N kg ha^{-1}.The interaction between cowdung manure and nitrogen was found (Pr<0.0001) in both seasons (Table 1). The maximum plant height was obtained from cowdung manure (15 t ha^{-1}) with 160 N kg ha^{-1} and the minimum was observed from control in winter and cowdung manure (0 t ha^{-1}) with 160 N kg ha^{-1} in rainy season. Solomon (2015) reported that combined application of 200 N kg ha^{-1} with FYM (6 t ha^{-1}) gave the taller plant height compared to control.

Plant canopy diameter

In both seasons, plant canopy diameter varied Pr<0.0001 among the cowdung and nitrogen (Table 1). The maximum plant canopy diameter (61.10) and (47.19) cm was recorded from cowdung 15 t ha^{-1} while no cowdung manure application gave the minimum (57.40) and (40.78) cm in winter and

rainy. This result might be that cowdung manure is rich in micro and macronutrients which enhance plant canopy diameter (Butler et al. 2000). The maximum plant canopy diameter (63.50) and (46.32) cm was recorded by 160 N kg ha^{-1} and the minimum (54.70) and (40.01) cm in winter and rainy, respectively, was observed by no nitrogen application. Pramanik (2007) reported that the maximum plant canopy diameter was obtained by the application 260 N kg ha^{-1}as compared by control. Interaction between different rates of cowdung and nitrogen application on plant canopy diameter was observed (Pr<0.0001) and (Pr=0.0028) in winter and rainy (Table 1). The maximum plant canopy diameter was obtained from cowdung manure (15 t ha^{-1}) with 160 N kg ha^{-1}, whereas the minimum plant canopy diameter was observed from control in winter and cowdung manure (0 t ha^{-1}) with 160 N kg ha^{-1} in rainy. This result indicated that combination of cowdung manure and nitrogen application gave the maximum plant canopy diameter. Hasanuzzaman et al. (2015) reported that the maximum plant canopy diameter was obtained from cowdung (10 t ha^{-1}) with 200 N kg ha^{-1}.

Days to head initiation

In both seasons, days to head initiation varied Pr<0.0001 by cowdung manure and nitrogen (Table

Table 1. Growth and yield contributing characters of cabbage by cowdung manure and urea during 2015-2016

Treatments	Plant height (cm)		Plant canopy diameter(cm)		Days to Head Initiation		Days to Head Maturity	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Cowdung								
C_0	26.30 b	21.79 b	57.40 c	40.78 a	49.19 a	49.13 a	94.06 a	79.13 a
C_1	28.40 a	24.21 a	60.40 b	45.46 b	48.88 b	47.88 b	92.19 b	76.56 b
C_2	28.60 a	24.45 a	61.10 a	47.19 c	48.38 b	46.56 c	93.88 b	75.43 c
$LSD_{0.05}$	0.42	1.00	0.61	1.63	0.61	0.58	0.92	0.51
Nitrogen								
N_0	25.30 d	21.98 b	54.70 d	40.01 c	55.08 a	54.58 a	102.50 a	85.75 a
N_1	27.40 c	23.13 b	58.90 c	44.25 b	47.83 b	46.50 b	91.17 b	75.67 b
N_2	28.90 b	24.35 a	61.30 b	47.33 a	47.67 b	45.67 c	90.42 b	75.58 b
N_3	29.50 a	24.47 a	63.50 a	46.32 a	45.33 c	44.67 d	89.08 c	74.17 b
$LSD_{0.05}$	0.49	1.19	0.70	1.88	0.70	0.67	0.93	0.59
Pr>F								
Cowdung	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001
Nitrogen	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
C × N	<0.0001	<0.0001	<0.0001	0.0028	0.0355	0.0062	0.1689	<0.0001
CV (%)	2.13	5.94	1.41	5.14	1.74	1.68	1.20	0.92

C_0= cowdung 0 t ha^{-1}
C_1= cowdung 10 t ha^{-1}
C_2= cowdung 15 t ha^{-1}

N_0= 0 N kg ha^{-1}
N_1= 80 N kg ha^{-1}
N_2= 120 N kg ha^{-1}
N_3=160 N kg ha^{-1}

1). Cowdung (15 t ha^{-1}) took the minimum (48) and (47) days for initiation of head and the maximum (49) days was needed from no cowdung manure application in winter and rainy. From the results it was found that cowdung application declines the days for initiation of head. Solomon (2015) reported that significantly shorter time head initiation was attained in 10 t ha^{-1} farmyard manure as compared by control. In both seasons, 160 N kg ha^{-1} applications required the minimum (45) days for head initiation while the maximum (55) days was required from no nitrogen application. This result showed that the increasing the nitrogen rate decreasing the time of head initiation. Optimum nitrogen levels favored the growth of plants and it was more beneficially utilized in head formation (Solomon 2015). The interaction between cowdung and nitrogen on the days from transplanting to initiation of head was observed (Pr=0.0355) and (Pr=0.0062) in winter and rainy season (Table 1). The minimum days (45) for head initiation in both seasons were needed for cowdung manure (15 t ha^{-1}) with 160 N kg ha^{-1} whereas control required the maximum (55) and (56) days in winter and rainy. This result showed that combination of cowdung and nitrogen application earlier initiation of head. Chaubey et al. (2006) reported significantly shorter time treatment for head initiation under farmyard manure (15 t ha^{-1}) with 250 N kg ha^{-1}.

Days to head maturity

In both seasons, days to head initiation varied (Pr<0.0001) by cowdung manure and nitrogen (Table 1). Cowdung manure (15 t ha^{-1}) took the minimum (93) and (75) days for maturity of head and the maximum (94) and (79) days was needed from no cowdung manure application in winter and rainy. 160 N kg ha^{-1} applications required the minimum (89) and (74) days for maturity of cabbage while no nitrogen application took the maximum (102) and (85) days. Rosen and Eliason (2005) reported that minimum day for head maturity was required by application 200 N kg ha^{-1}. The interaction between cowdung and nitrogen on the days for maturity of cabbage was observed (Pr<0.0001) only in rainy season (Table 1). The combination of cowdung manure (15 t ha^{-1}) with 160 N kg ha^{-1} took the minimum (88) and (74) days for head maturity while control required the maximum (103) and (91) days in winter and rainy. This result showed that the combination of cowdung manure and nitrogen application enhanced the earlier cabbage maturity. Hedge and Dwivedi (1993) reported that combination of FYM (15 t ha^{-1}) with 200 N kg ha^{-1} hastens the maturity.

Head diameter

In both seasons, different levels of cowdung and nitrogen showed significant variation at Pr<0.0001 on head diameter (Table 2). Cowdung manure (15 t ha^{-1}) gave the maximum head diameter (14.65) and (15.77) cm was observed while minimum (13.88) and (13.81) cm was found in no cowdung manure application in winter and rainy. This result showed that diameter of head was increased with increased cowdung application. Haque et al. (2015) found that cowdung (12 t ha^{-1}) gave maximum head diameter compared as control. The maximum head diameter (16.96) and (15.25) cm was recorded by 160 N kg ha^{-1} and the lowest (10.01) and (13.45) cm was found from no nitrogen application in winter and rainy. This result showed that high nitrogen application gave the maximum head diameter. Westerveld et al. (2003) found that application of 170 N kg ha^{-1} gave maximum head diameter. Interaction effect between different rates of cowdung and nitrogen application was observed (Pr=0.0032) in rainy on head diameter (Table 3). The combination of cowdung manure (15 t ha^{-1}) with 160 N kg ha^{-1} took the maximum (17.97) and (17.22) cm for head diameter while control required the minimum (9.60) cm in winter and cowdung manure (0 t ha^{-1}) with 160 N kg ha^{-1} (12.28) cm in rainy.

Head length

In both seasons, different levels of cowdung and nitrogen showed at Pr<0.0001 on head length (Table 2). Cowdung manure (15 t ha^{-1}) gave the maximum head length (12.09) and (12.61) cm was observed while minimum (11.00) and (11.42) cm was found in without cowdung manure application in winter and rainy. The maximum head length (13.56) and (12.59) cm was recorded by 160 N kg ha^{-1} and the lowest (8.99) and (11.23) cm was found from no nitrogen application in winter and rainy.

This result indicated that high nitrogen application gave the maximum head length. Interaction effect between different rates of cowdung and nitrogen application on head length was observed (Pr=0.0109) only in rainy (Table 3). The combination of cowdung manure (15 t ha^{-1}) with 160 N kg ha^{-1} took the maximum (14.48) and (13.56) cm for head diameter while control required the minimum (8.58) cm in winter and cowdung manure (0 t ha^{-1}) with 160 N kg ha^{-1} (18.84) cm in rainy season.

Fresh weight of head

In both seasons, fresh weight of head varied significantly at Pr<0.0001 due to different rates of cowdung and nitrogen (Table 2). The maximum fresh weight of head (1116) and (1240) g was recorded from cowdung manure (15 t ha^{-1}) and the lowest (784) and (720) g was observed from without cowdung manure application in winter and rainy. Fresh weight of head increased with increasing cowdung. Chand et al. (2006) found that cabbage has good responsiveness on animal manure application. The maximum fresh weight of head (1487) and (1199) g was recorded from 160 N kg ha^{-1} and the lowest (339) and (661) g was found from no nitrogen application. High rate of nitrogen gave the maximum fresh weight of head. Pramanik (2007) reported that higher yields in cabbage with increased nitrogen rates. The interaction C × N was significant at Pr<0.0001 level in both seasons (Table 3). The maximum fresh weight of cabbage (1739) and (1625) g was given by cowdung manure (15 t ha^{-1}) with 160 N kg ha^{-1}, whereas control gave the lowest (324) g in winter and cowdung manure (0 t ha^{-1}) with 160 N kg ha^{-1} gave (515) g in rainy. This result showed that combination of cowdung and nitrogen application increase the fresh weight. (Solomon 2015) reported that the application of 200 N kg ha^{-1} and FYM 6 t ha^{-1} gave the higher weight of head cabbage as compared by control.

Marketable head yield

In both seasons, marketable yield varied significant at Pr<0.0001 due to different rates of cowdung and nitrogen (Table 2). The maximum marketable yield (40) and (45) t ha^{-1} was observed from cowdung manure (15 t ha^{-1}) and the minimum (28) and (26) t ha^{-1} was found in no cowdung manure application. These results showed that increasing cowdung manure application gave the higher yield of cabbage. Solomon (2015) reported that the application of cowdung 10 t ha^{-1} gave higher yield of cabbage as compared by control. The maximum marketable yield (54) and (44) t ha^{-1} was recorded from 160 N kg ha^{-1} whereas the minimum (12) and (24) t ha^{-1} was obtained by no nitrogen application. Applying nitrogen fertilizer significantly increased the marketable yield of cabbage. Parmar et al. (2009) reported that optimum nitrogen level induced optimum yields in Brassica vegetables. The interaction C × N was significant at Pr<0.0001 level in both seasons (Table 3). The maximum marketable yield (63.77) and (59.59) t ha^{-1} was given by cowdung manure (15 t ha^{-1}) with160 N kg ha^{-1}, while the lowest yield (11.89) by cowdung manure (0 t ha^{-1}) with 0 N kg ha^{-1} in winter and (18.88) t ha^{-1} was observed from cowdung manure (0 t ha^{-1}) with 160 N kg ha^{-1}. Hasanuzzaman et al. (2015) concluded that the maximum cabbage yield was obtained along with cowdung 10 t ha^{-1} and 200 N kg ha^{-1}.

Effect of cowdung manure on physicochemical properties of experimental soil

It was observed that application of cowdung manure improved some of the physical properties of experimental soil of Heho, Kalaw Township in Southern Shan State. Before the experiment, bulk density of the soil is 1.27 g cm^{-3}. After the experiment I, bulk density in cowdung treated soils decreased from 1.23 to 1.22 and 1.26 to 1.21 after the experiment II. The initial value of soil porosity is 50 %. After the experiment I, porosity in cowdung treated soils increased from 50% to 53% and 52% to 54% after the experiment II. Initial organic carbon is 1.40%. After conducting the experiment I and II, soil organic carbon contents in cowdung treated soils had increased by 1.68% to 1.93 % and 1.62% to 1.82%. After conducting the experiment I and II, cation exchange capacity had increased from 34.28 and 35.06 to 41.84 and 41.04. Initial total N is 0.28%. After experiment I and II, total N contents of cowdung treated soils increased from 0.21% and 0.19% to 0.37% and 0.26%.

Table 2. Mean effects of cowdung manure and urea on yield and yield components of cabbage during 2015-2016

Treatments	Head diameter(cm)		Head length(cm)		Fresh weight per head (g)		Marketable Yield (t ha^{-1})	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Cowdung								
C_0	13.88 b	13.81 c	11.00 b	11.42 b	784.60 b	720.10 c	28.76 b	26.40 c
C_1	14.64 a	14.77 a	12.08 a	12.24 a	1057.40 a	1121.2 b	38.80 a	41.14 b
C_2	14.65 a	15.77 a	12.09 a	12.61 a	1116.00 a	1240.1 a	40.92 a	45.47 a
$LSD_{0.05}$	0.69	0.72	0.48	0.48	74.04	62.03	2.71	2.3
Nitrogen								
N_0	10.03 d	13.45 b	8.99 d	11.23 b	339.70 d	661.7 c	12.46 d	24.26 b
N_1	14.06 c	14.99 b	11.74 c	12.33 a	863.40 c	1117.5 b	31.66 c	40.98 b
N_2	15.83 b	15.45 ab	12.68 b	12.38 a	1253.6 b	1130.2 ab	45.97 b	41.44 ab
N_3	16.96 a	15.25 a	13.56 a	12.59 a	1487.30 a	1199.3 a	54.57 a	44.01 a
$LSD_{0.05}$	0.79	0.84	0.55	0.55	85.49	71.62	3.13	2.66
Pr>F								
Cowdung	0.0006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nitrogen	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
CV %	6.73	6.86	5.65	5.54	10.44	8.40	10.43	8.49

C_0= cowdung 0 t ha^{-1} N_0= 0 N kg ha^{-1}
C_1= cowdung 10 t ha^{-1} N_1= 80 N kg ha^{-1}
C_2= cowdung 15 t ha^{-1} N_2= 120 N kg ha^{-1}
N_3=160 N kg ha^{-1}

Conclusion

According to the results from this experiment, it can be highlighted that for cabbage cultivation, for cowdung, 10 t ha^{-1}, for nitrogen, 160 N kg ha^{-1} is appropriate in both seasons, combination of cowdung manure and nitrogen (10 t ha^{-1} and 160 N kg ha^{-1}) is appropriate for cabbage cultivation in Heho in Southern Shan State. The decrease in cabbage yield in rainy season is related with received total rainfall at growth stages which leads nitrogen losses such as leaching, runoff, denitrification. (Leong et al. 2004) reported that the cabbage yield production was decreased by high total rainfall during the whole cabbage growth stages. In addition, cabbage is heavy feeder and continuous cabbage cropping reduces the soil fertility which leads to decreasing yield. After the experiment I and II, soil physicochemical properties of cowdung manure treated soil improved such as decreased bulk density, increased porosity, pH, organic carbon %, total N % and CEC compared with untreated cowdung soils. These results highlight that cowdung manure application in cabbage cultivation improved soil properties and consequently affected cabbage yield.

Acknowledgements

I gratefully acknowledge to MercyCorps - MVMVW Research Grant Program (Making Vegetable Markets Work for Smallholder in Southern Shan State) for financial support for conducting my research work. I wish to extend my gratitude to Dr. Aung Than (Pro- Rector, retired) for his valuable advice, checking for English writing and sharing his time on this manuscript.

Table 3. Combined effects of cowdung manure and urea on yield and yield components of cabbage during 2015-2016

Treatments		Head diameter(cm)		Head length(cm)		Fresh weight per head(g)		Marketable Yield (t ha^{-1})	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
C_0	N_0	9.60	13.30 de	8.58	11.02 d	324.30 f	530.00 g	11.89 f	19.43 f
	N_1	13.68	15.31 bc	11.35	12.06 bc	652.00 e	1090.00 d	23.91 e	39.97 d
	N_2	14.95	14.35 cd	12.03	11.75 cd	1039.50 cd	745.50 ef	38.12 cd	28.97 e
	N_3	15.25	12.28 e	12.05	10.84 d	1122.50 c	515.00 g	41.16 c	18.88 f
C_1	N_0	10.63	12.73 e	9.15	11.06 d	358.80 f	665.00 f	13.16 f	24.39 e
	N_1	14.08	14.53 cd	12.03	12.55 bc	925.80 d	1125.00 cd	33.95 d	41.25 cd
	N_2	16.15	15.55 bc	13.00	12.51 bc	1345.00 b	1237.50 c	49.32 b	45.38 c
	N_3	17.70	16.26 ab	14.15	12.85 ab	1600.00 a	1457.50 b	58.77 a	53.55b
C_2	N_0	9.86	14.29 cd	9.04	11.60 cd	336.00 f	790.00 e	12.32 f	28.97 d
	N_1	14.43	15.14 bc	11.85	12.39 bc	1012.50 cd	1137.50 cd	37.13 cd	41.71 cd
	N_2	16.40	16.44 ab	13.00	12.88 ab	1376.30 b	1407.50 b	50.47 b	51.61 b
	N_3	17.93	17.22 a	14.48	13.56 a	1739.30 a	1625.30 a	63.77 a	59.59 a
Pr> F		0.1967	0.0032	0.0790	0.0109	0.0002	<0.0001	0.0002	<0.0001
LSD $_{0.05}$		1.37	1.45	0.95	0.96	148.08	124.07	5.43	4.60
CV (%)		6.73	6.86	5.65	5.54	10.44	8.40	10.43	8.49

C_0= cowdung 0 t ha^{-1} N_0= 0 N kg ha^{-1}
C_1= cowdung 10 t ha^{-1} N_1= 80 N kg ha^{-1}
C_2= cowdung 15 t ha^{-1} N_2= 120 N kg ha^{-1}
N_3=160 N kg ha^{-1}

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