

The Combined Effect of Organic and Inorganic Fertilizer on Yield and Yield Component of Cabbage (*Brassica Oleracea*) at Dedebit Central Tigray, Ethiopia

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Abstract

The use of organic fertilizer as an alternative to inorganic fertilizer increased among subsistence farmers in rural areas in meremieti. Despite the fact that, no clear recommendation exist for the application of rate of organic fertilizer on vegetable. Field experiment was conducted to evaluate the different combination of organic and inorganic fertilizer on yield and yield component of cabbage. The experiment was laid out in Randomized complete Block Design with three replications. The treatments were 1) without organic and inorganic fertilizer as a control; 2) 150 kg/ha of Urea; 3) 3.5 ton/ha of FYM; 4) 1.75ton/ha of FYM and 75kg/ha of Urea; 5) 37.5kg/ha of Urea and 2.625 ton/ha of FYM and 6) 112.5kg/ha of Urea and 0.875 ton/ha of FYM. The result indicates application of organic and inorganic fertilizer increases the yield and yield component of cabbage. The highest cabbage weight, plant height, root length and yield of cabbage was obtained when the plot was received 1.75ton/ha of FYM and 75kg/ha of Urea; and 112.5kg Urea+0.875 ton FYM followed by 150 kg Urea and plots received 37.5kg Urea+2.625 ton FYM and 3.5ton FYM shown intermediate yield. The lowest yield was recorded in control. Thus yield and yield component of cabbage was positively influenced by the different combination of organic and inorganic fertilizer. Application of fertilizer in the combination of 1.75ton/ha of FYM and 75kg/ha of Urea; and 112.5kg Urea+0.875 ton FYM leads in better yield and yield component of cabbage and hence farmers within that area should apply these appropriate combination.

Keywords: Cabbage; Farmyard Manure; Inorganic; Organic; Yield

Introduction

Cabbage is a popular cultivar of the species *Brassica oleracea* of the family Brassicaceae and is a leafy green vegetable. Cabbage (*Brassica oleracea* L.) is a member of the Cole crops, and it is important fresh and processing vegetable crop in most of the countries of the world. Cole crops are biennials, but are generally grown as annuals. Prior to cultivation and use as food, cabbage was mainly used for medicinal purposes [1]. In addition to the fresh market, cabbage is now processed into Kraut, egg rolls and cole slaws and there is the potential for other specialty markets for the various types including red, savoy and mini cabbage. Cabbage is an excellent source of Vitamin C [2]. In recent years vegetable consumption has increased. However, the productivity of cabbage per unit area is quite low as compared to the developed countries of the world [3]. Gradual deficiencies in soil organic matter and reduced yield of crop are alarming problem in Ethiopia particularly in the northern part (tigray region). As majority of farmers in this region are small scales, with low income and therefore cannot afford to purchase enough quantities of inorganic fertilizers for sustainable production of crops, as the cost of fertilizers is very high [4]. Nevertheless many researchers often disregarded farmers' knowledge and the resources at their disposal. Thus highest priority is nevertheless given for the combination of organic and inorganic fertilizers and its effect on cabbage production and the appropriate combination for maximizing the cabbage yield was not yet identified. Therefore an intervention that leads to increasing the cabbage yield through enhancing the soil fertility is paramount important. The objective of this study was: To investigate the yield and yield component of cabbage under different organic and inorganic fertilizer combination and there by proposing the appropriate combination that can enhance the yield.

Material and Methods

Description of the Study Area

Meremieti is located about 25 kilo meters south east of Mekelle at 13° 28' N latitude and 39° 32' E longitude and at an altitude of about 2300 m.a.s.l. "The area has moderately drained, acidic red soils and specifically it is comprised of 50% veriti soil, 18% black soil and the rest 32% is sandy soils. The average monthly temperature in the area ranges between 13°C and 28 °C with a mean annual temperature of 20.5°C and the rainfall averages 450 mm a year. Land-use is very intensive with a cropping adopted to maximize yield. Intercropping is practiced commonly. "Major food crops include, in order of importance, wheat, barely, teff, sorghum, from cereal crops cowpea, haricot bean (legume crops) and potato, cabbage, carrot, lettuce, tomato, onion e.t.c from vegetables.

Experimental Design

Field experiment was carried out at Meremieti Agricultural Bureau during the summer season of 2012/2013. Yield and yield component of cabbage was evaluated under different combination of Organic and in organic fertilizer. Farm Yard Manure (FYM) and Urea was used as organic and inorganic fertilizer respectively. The different combination includes; 1) without organic and inorganic fertilizer as a control; 2) 150 kg/ha of Urea; 3) 3.5 ton/ha of FYM; 4) 1.75ton/ha of FYM and 75kg/ha of Urea; 5) 37.5kg/ha of Urea and 2.625 ton/ha of FYM and 6) 112.5kg/ha of Urea and 0.875 ton/ha of FYM. Hence the experiment was comprised of 6 treatments. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The six treatments were randomly assigned to the experimental plots. The total number of experimental plot was 18 (6 treatments×3 replication).

Cabbage seed was sown in plot of three 3m rows (3 row with 3 m length) with the rows 60 cm apart and within row space of 30 cm (space between plants) and the plot size was 2m×3m. Each experimental plot was sown at depth of 12mm. All other agronomic practices were applied uniformly to all experimental plots.

Data Collection

Data were recorded on the following parameters from the sample plants during the course of experiment. Five plants were randomly selected from each unit plot for the collection of data. The plants in the outer rows and the extreme end of the middle rows were excluded from the random selection to avoid the border effect. Data on Plant height (cm), Number of leaf per plant, Root length (cm), Cabbage head weight (Kg), Days to maturity and yield (Quintal)

Data Analysis

Analysis of variance (ANOVA) was performed on all collected data with the appropriate model using Genstat version 13 and treatment mean was compared using Duncan's Multiple Range Test (DMRT).

Result and Discussion

Plant Height

Regarding plant height a significant difference ($p < 0.001$) was detected among the different combination of organic and inorganic fertilizer. It is evident that plant height was the highest with the combination and with only inorganic fertilizer than with organic and control. The highest plant height was obtained when the plots are fertilized with the combination of 75kg Urea+1.75ton FYM followed by 112.5kg Urea+0.875ton FYM and 150kg Urea. The shortest plant height was observed in control where no fertilizer was applied whereas treatments with 37.5kg Urea+2.625ton FYM and 3.5ton/ha FYM has the intermediate plant height however a significant difference was not observed between these treatments. Similar findings in the plant height of cabbage were obtained by various researchers and the application of mixed fertilizers influenced the plant height [5,6]. Sarker *et al.* (2003) reported significant increase in plant height from 27.52 cm to 43.16 cm of cabbage as the rates increased from control to combined application of N (150 kg ha⁻¹) with FYM (15 t ha⁻¹) [7]. El-Shinawy *et al.* (1999) also reported that lettuce plants treated with inorganic fertilizer were taller than plants treated with buffalo manure [8]. Moreover, Baloch *et al.* (2000) reported that increased use of nitrogen (200 kg ha⁻¹) and FYM (20 t ha⁻¹) increased plant height (47.14 cm) [9].

Root Length

Root length is an important plant character for contributing higher yield performance and it differs with the different combination of organic and inorganic fertilizer. Under the present study, root length was significantly influenced by different combination. The highest root length was indicated with the treatment of 75kg Urea+1.75ton FYM followed by 150kg Urea and 112.5kg Urea+0.875ton FYM and a significant difference was detected among the treatments. On the other hand, the lowest root length was measured with control which is significantly lower than the plots treated with 3.5 ton/ha FYM and 37.5kg Urea+2.625ton FYM. The results obtained under the present experiment were in agreement with Souza *et al.* (2008).

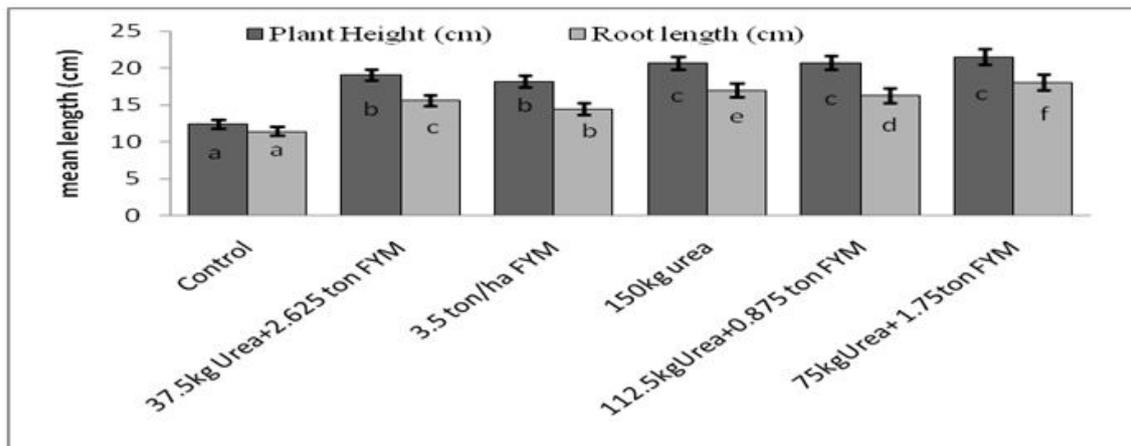


Figure 1: Effect of different combination of FYM and Urea on Plant height (cm) and root length (cm)

Number of Leaves per Plant

Significant variation was observed in the case of number of leaves plant among the different combination of organic and inorganic fertilizer (appendix Table2). The highest number of leaves per plant was recorded in treatments 112.5kg Urea+0.875ton FYM (17.5) followed by 75kg Urea+1.75ton FYM (16.65) and 150kg of Urea (16.5) although significant difference was not observed between 75kg Urea+1.75ton FYM and 150kg of Urea, while the lowest leave number was obtained in control (7.33) 3.5 ton/ha FYM (11.5), and 37.5kg Urea+2.625ton FYM (14.42) and a significant difference was observed among these treatments. The number of leaves per plant was significantly lower in control than using FYM only which is also lower than using the Urea/inorganic fertilizer. This result indicates that the number of leaves significantly increased with the application of inorganic fertilizer. Sharma (2000) found that the integrated application of organic and inorganic fertilizers significantly increased the vegetative growth [10]. Khadir *et al.* (2002) also observed that combined application of different inorganic and organic fertilizers increased both vegetative and leaf number in cabbage [11].

Days to Maturity

Analysis of variance (appendix table 4) indicates a significant difference in number of days to maturity of cabbage among the different combination of organic and inorganic fertilizer. Plots treated with 75kg Urea+1.75ton FYM resulted in reduced number of days to maturity which was significantly similar with plots treated with 150 kg of Urea followed by plants treated with 112.5kg Urea+0.875ton FYM which was statistically alike with control (Table 1). But plots treated with 3.5ton/ha FYM took the longest days to maturity followed by plots treated with 37.5kg Urea+2.625ton FYM. Chaubey *et al.* (2006) reported significantly shorter time (57.45 days) of cabbage for head initiation under the high rates of nitrogen (250 kg ha⁻¹) and farmyard manure (15 t ha⁻¹) over no fertilizer application (76.32 days). Rosen and Eliason (2005) demonstrated the importance of N for early crop growth and crop to mature earlier (104 days) starting from transplanting at the rate of 200 kg N ha⁻¹ [12]. Similarly, Sisay *et al.* (2008) reported the shortest duration of carrot to reach maturity at the highest level of N (309 kg ha⁻¹) and P (68 kg ha⁻¹) as compared to the low levels of N [13].

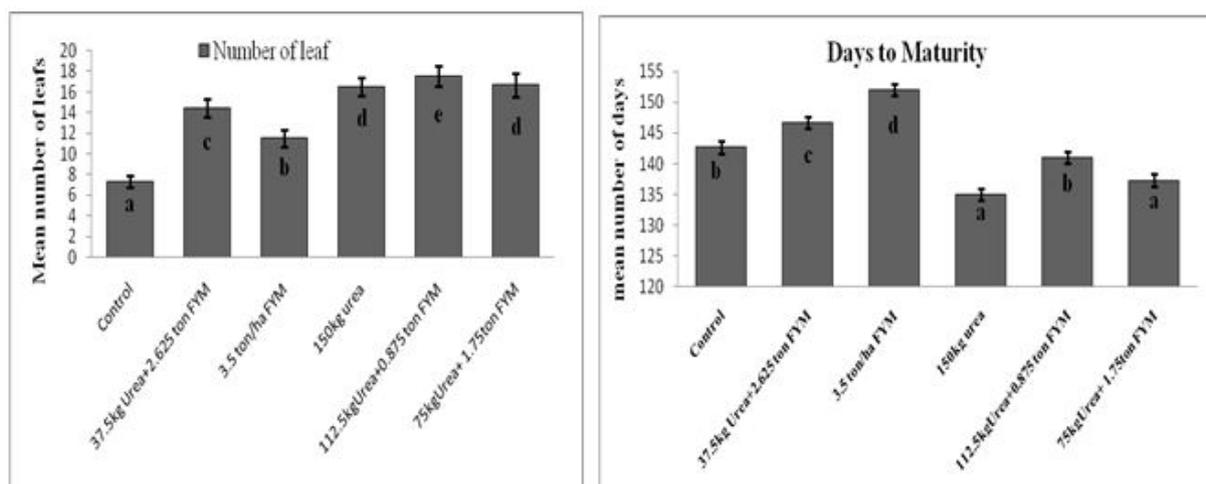


Figure 2: Effect of different combination of FYM and Urea on number of leaf (Left) and Days to maturity in the (right)

Cabbage Head Weight (Kg)

A significant difference (appendix table 5) was detected among the different combination of organic and inorganic fertilizer with regard to cabbage head weight. The highest head weight was obtained in plants treated with 75kg Urea+1.75ton FYM (3.667) which was statistically similar with 112.5kg Urea+0.875ton FYM treated plot. On the other hand the lowest cabbage head weight was shown in control followed by plants treated with 3.5ton/ha FYM. Plants treated with 37.5kg Urea+2.625ton FYM and 150 kg of Urea had resulted in intermediate cabbage head weight (2.667 and 3.367), respectively. These results are in agreement with previous reports where poultry manure and NPK had a higher head diameter compared to the control, (Haque 2012) [14]. Kedino *et al.* (2009) reported a higher head diameter in combined organic and inorganic fertilizer (FYM + NPK) applications [15]. Haque (2012) reported that the effect of the mixed fertilizer application (organic and inorganic) resulted in the highest thickness of the cabbage head [14].

Yield (quintal/ha)

Yield of cabbage was significantly influenced by the different combination of organic and inorganic fertilizer. The mean comparison for the yield indicates that plants received 75kg Urea+1.75ton FYM showed the highest yield which was statistically similar with plants received 112.5kg Urea+0.875ton FYM different which was also statistically similar with the plants treated with 3.5ton/ha FYM. However significant difference was detected between plants received 75kg Urea+1.75ton FYM and plants treated with 3.5ton/ha FYM (Table 1). Then again the lowest cabbage yield was obtained from control followed by plots treated with 37.5kg Urea+2.625ton FYM which was statistically alike with plants treated with 3.5ton/ha FYM. Improvement in growth and yield attributes of cabbage due to integration of N and FYM fertilizers could be attributed to balanced C/N ratio, higher organic matter build up, efficient microbial activity, synergistic interaction between organic manures resulting in more supply and availability of nutrients. These findings are in agreement with the reports where vermicompost or poultry manure along with inorganic fertilizer

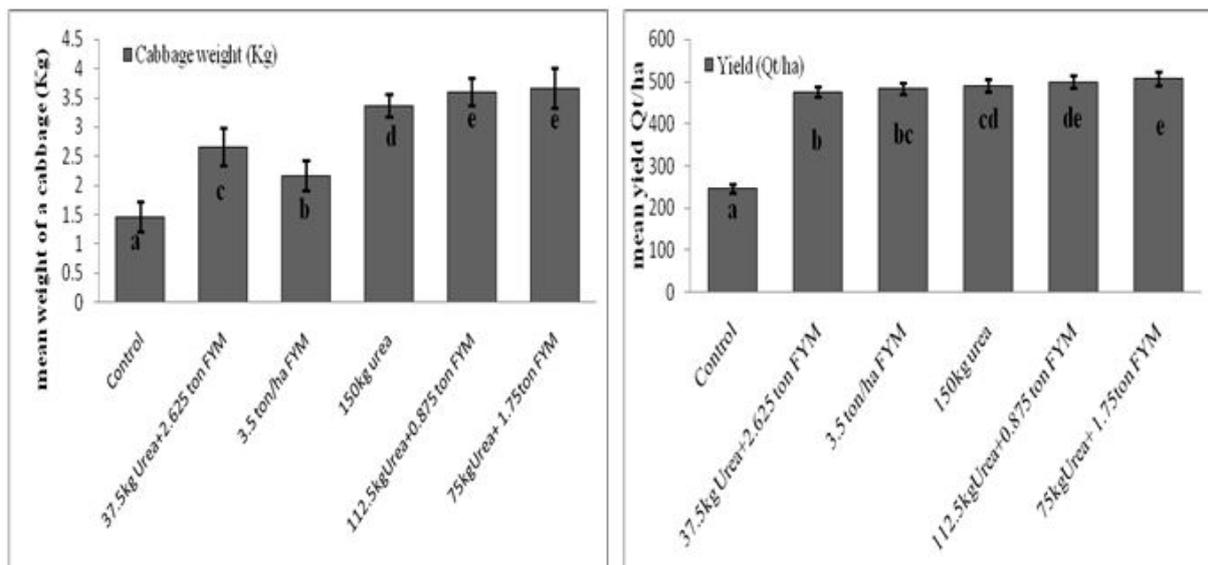


Figure 3: Effect of different combination of FYM and Urea on cabbage weight (Left) and yield (right)

| Treatment | PH | R.L | N.L | DM | C.Wt | Yield |
|----------------------------|--------|--------|--------|--------|--------|---------|
| Control | 12.4a | 11.43a | 7.33a | 142.7b | 1.463a | 247a |
| 37.5kg Urea+2.625 ton FYM | 19.13b | 15.63c | 14.42c | 146.7c | 2.667c | 476.3b |
| 3.5 ton/ha FYM | 18.17b | 14.43b | 11.5b | 152d | 2.167b | 484.7bc |
| 150kg Urea | 20.67c | 17e | 16.5d | 135a | 3.367d | 491.3cd |
| 112.5kg Urea+0.875 ton FYM | 20.77c | 16.33d | 17.5e | 141b | 3.6e | 499.3de |
| 75kg Urea+ 1.75ton FYM | 21.53c | 18.07f | 16.65d | 137.3a | 3.667e | 507e |
| CV | 3.1 | 2.1 | 3.2 | 1.0 | 4.3 | 1.1 |
| S.e | 0.335 | 0.1897 | 0.261 | 0.786 | 0.0696 | 2.74 |

CV: Coefficient of variation; S.e: Standard error of the mean Non similar letter in each column show significant difference between the different combination of organic and inorganic fertilizer at 5% probability FYM=Farm yard manure, C.Wt= Cabbage weight, PH= plant height, R.L= root length, N.L= number of leaves per plant, DM= days to maturity

Table 1: Mean estimates of yield, leaf number, head weight, plant height, days to maturity and root length of cabbage under different combination of organic and inorganic fertilizer

application yielded high plant spread [14]. Earlier reports suggest that a combined application of manures and fertilizers (integrated plant nutrient system, IPNS) increases the yield and improves the quality of vegetables [16].

Conclusion and Recommendation

From the above fact and figure it can be concluded that the different combination of organic and inorganic fertilizer significantly influenced all the parameters measured as was expected. The yield and yield component was significantly greater where 75kg Urea+1.75ton FYM was applied except for the number of leaves per plant which are highest when the plant was received 112.5kg Urea+0.875ton FYM and it was even greater compared to plants that received full organic and inorganic fertilizer. Therefore it is clear that organic fertilizer application influenced cabbage production positively and high application rates did not influence the yield and yield component negatively.

► The appropriate combination of organic and inorganic fertilizer is 75kg Urea+1.75ton FYM which results in better yield and yield component of cabbage and farmers in that area should apply this combination.

► From the result it can also be recommended that, with difficulty to access the FYM farmers should use 112.5kg Urea+0.875ton FYM.

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