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COLLEGE OF AGRICULTURE AND NATURAL RESOURCE

DEPARTMENT OF HORTICULTURE

Effect of Different Rates of NPS Fertilizer on the Yield Components of Cabbage (*Brassica oleracea*var. *capitate*s.)

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ABSTRACT

Cabbage is known for its nutritional importance and it is rich in minerals and vitamins like A, B1, B2, and C. Among different factors application of fertilizer in different rata was affecting the productivity of cabbage. Therefore, field experiment was conducted in 2011 at Wolkite University at demonstration site with the objective of to evaluate the effect of different rate of NPS on yield and yield component of head cabbage. Filed experiment was conducted by RCBD design with three replication of the following treatment 0kg,60kg,120kg,180kg,240kgand 300 kg/ha|) of .Copen Hagen market variety of cabbage was used for the experiment. To analysis the effect of NPS rate the following data's were taken and analiyised by manual scientific calculate. Application of different rate of NPS was a significant ($p<0.05$) on the yield component of cabbage. From the result the higher plant height (25.6 & 30.53, days of 50% headinitiation(54 and 56.33), Days of 90% head maturity(65 and 67.33), head height(12.8 and 14.47) , head weight(0.933 and 1.06kg/ha), head circumference(30.15 and 30.18) and head diameter(12.16 and 12.06) was recorded at the rate of 300kg/ha and 180kg/ha respectively and intermediate result was recorded at the rate of 60kg/ha 120kg/ha and 240kg/ha whereas the lower yield attributer was recorded sole cropping.. From the result increasing the rate of NPS fertilizer was increase the yield attribute of cabbage and recommended to the local farmer to use 180kg/ha. However further investigation may be suggested to carried out on different soil types ,different location to come up with precise and comprehensive recommendation

Key Word, NPS cabbage, yield attribute

1. INTRODUCTION

Cabbage (*Brassica oleraceavar. capitata L.)* belongs to the family cruciferea and it is biennial crop with a very short stem supporting a mass of overlapping leaves to form a compact head or loose head. It originated from wild non-headed type 'Cole wart' (*Crambecordifolias*) from Western Europe and northern shore of Mediterranean (Semuli, 2005). It has been domesticated and used for human consumption since the earliest antiquity. It is cool season crop that is popular with gardeners and commercial producers.

Cabbage is known for its nutritional importance and it is rich in minerals and vitamins like A, B1, B2, and C. It is also known for it is cooling effect being appetizer; it aids digestion thereby preventing constipation. It also protects against cancers (Ruzawlah*et al.*, 2002) because the vegetable cabbage is a store house of phyto –chemicals like thiocyanate, indole-3- carbinol, lateinzea-xant and others.

Cabbage can grow easily under wide range of environmental condition in both temperate and tropical, but cool temperature is the most suitable (Rai and Asati, 2005). Optimum growth occurs at a mean daily temperature of about 17 degree centigrade with daily maximum of 24 degree centigrade and minimum of 10 degree centigrade. Mean relative humidity should be in the range of 60 and 90 percent (FAO, 2012). It prefers a well-drained sandy loam soil with good organic matter content and a Phbetween 6.0 to 6.5 (Yano *et al*., 1999). Cabbage seeds germinate in about two weeks in soil with temperature as low as 10 degree centigrade' which allows for early planting in cooler regions (Smith, 1995).Depending on the variety, cabbage requires 60 to100 days from sowing to ready for harvesting as cabbage produce.

Cabbage is grown for its head in more than ninety countries throughout the world (Meena*et al.*, 2010). The major cabbage growing countries of the world are China, India, South Korea, Germany, Japan and South Africa (Sarker, 2002). Cabbage ranks fifth among the vegetable crops of the world. In 2009 area planted by cabbage was about 2.5 million hectare in Asia, 0.5 million hectare in Europe, 80,000 hectare in America and 120,000 hectare in Africa (Nina, 2011). The five cabbage producer African countries are Kenya, Egypt, Ethiopia, Niger and South Africa.

Cabbage is one of a vegetable crop grown in the south gurage zone in rainfied and irrigation but the yield of the cabbage is low because of:-fertility statuses of the soil is low, prevalence of diseases and insects, input supply problems, poor infrastructures, improper agronomic practices including crop protection, inappropriate uses of artificial fertilizer. Even if 180 kg NPS /ha is nationally recommended (ARARI, 2005) but it can be varied with the statuses of soil fertility, climate, soil type

Although the amount of fertilizer required depend on the fertility statues of the soil (Bok et al .,2006),cabbage growers in Ethiopia including the study area use recommendation of200kg DAP ha^{-h} and 100kg ha^{-h} urea in split application is recommended as asourse of phosphorus and nitrogen ,respectively, which not satisfy the nutrient requirement of cabbage plants (arari,2005;manrs,2011).recently ,the ministry of Agriculture introduced a new fertilizer (NPS) that contains not only nitrogen and phosphorus but also sulfur with the concentration of 19%N,38%P_2O_5,7%S.morever,the government of Ethiopia has plan to substitute dap with NPS in the near future .However its application rate for the production of cabbage in Ethiopia is not known

NPS levels have to obtain high yield from cabbage thus, knowledge on this factor is helpful to optimize cabbage yield through efficient use of rate of fertilizer. In Gurage zone, there is need by farmers to increase productivity of cabbage to maximize their profit from small plot of land they have. However, farmers of this area who grow cabbage frequently give less attention to NPS application rate. Moreover, information on cabbage NPS application rate of optimum yield and other agronomic practices are limited. Since most of the farmers on this area has small plot of land and the yield obtained from this is very low. So it is important to increase the yield of cabbage from this plot of land to improve the income of the farmers around this area by recommending the appropriate NPS fertilizer rate after our research result proved. Therefore the objective of the experiment would be:

To evaluate the effect of NPS fertilizer rate on the yield and yield components of cabbage.

2. LITERATURE REVIEW

2.1 Description and Origin of Cabbage

Cabbage (*Brassica oeracea,* var. *capitata* L.) is also known as Cole crops. It belongs to family Brassicaceae (or Cruciferae) and generally referred as Brassicas. It is important groups of crop worldwide. It is originated from Western Europe and northern shore of Mediterranean region where it has been grown for more than 3000 years. It has chromosome number 2n=2x=18. It is dicotyledonous biennial crop, but it is grown as annual. In the first season growth it produces the head and in the second it produces seed. Cabbage form several different head shapes: painted, conical or oblong, round or drummed shaped. Cabbage generally classified as headed which is round, oval or flat. Chinese head cabbage is oval and flat; moreover it is loosely formed and light a weight. Head formation in cabbage is quantitative trait controlled additively with low dominance effect. It is only head cabbage that changes in leaf shape becoming wider because at the shorter petiole length with increasing leaf position and thus cabbage acquired the developmental change in leaves. Cabbage has been domesticated and used for human consumption since the earliest antiquity (Semuli, 2005). The genus Brassica include about 100 species majority at which are native to Mediterranean region. The crop is attributed to the Mediterranean center of origin (Rai and Asati, 2005). It is widely grown as cool – season crop and is very popular with gardeners.

2.2 Importance of cabbage

Cabbage is grown for its leaves and commonly used as vegetable. Cabbage is an excellent source of mineral such as calcium, iron, sodium, and potassium and phosphorous. It has substantial amount of beta-carotene, ascorbic acid and other. It has calories (27 %), fat (0.1 %) and carbohydrate (4.6 %), it is good source of protein (1.3%) which contain all essential amino acids, particularly sulfur containing amino acids (Rai and Asati, 2005). The only part of the cabbage plant that is normally eaten by human being is the leafy head, more precisely, the spherical cluster of immature leaves, excluding the partially unfold outer leaves.

Cabbage is used us raw in salad such as coleslaw, as a cooked vegetable, or reserved in pickle or saver kraut. Flavor in cabbage is due to the glycosides sinigrin (Rai and Asati, 2005). A 100g edible portion of cabbage contain 1.8 mg protein, 0.1 mg fat, 4.6 mg carbohydrate, 0.6 g mineral, 0.8 mg iron and 14.1 mg sodium (Singh and Naik, 1996).

2.3 Cabbage Production in Ethiopia

Ethiopia has a variety of vegetable crops grown in Different agro –ecological zones by small farmers, mainly as a source of income and food. Commercial producers are also involved in the production, processing and marketing of vegetable. These crops are produced under rain fed and irrigation conditions. It is produced both in cereals based cropping system and in monoculture. Largely cabbage is produced by irrigation rather than rain fed. At present commercially in different parts of the country. But most of the production is by small holder. Cabbage production in Ethiopia is scattered in the high lands but the larger production is found at the central high lands of the country. In Ethiopia, land holders living near urban center largely practice vegetable farming. Most vegetables are not commonly practiced by the rural peasant holders (Fekadu and Dendena, 2006). Most of the vegetables produced in Ethiopia include cabbage are grown from imported seeds from various countries except limited once such as shallot, garlic, hot pepper and kale, which has been traditionally produced.

2.4 Nutritional requirement and their management

The quantity of fertilizer requirement in cabbage defends on fertility status of the soil. Cabbage requires large amount of fertilizer. As it benefit from higher levels of organic matter, it is suggested that animal manure be the basis for the program. The most important nutrient for cabbage is nitrogen, phosphorus and sulfer. In cabbage fertilizers (especially nitrogen) promote rapid growth, high yield and high quality. High value crops such as cabbage, proper nutrition is important in order to produce a high yield and good quality. There is a correlation between amount of nitrogen applied and quality of cabbage. Cabbage head will not form if there is shortage of nitrogen. On the other hand, excess nitrogen may cause the formation of loose heads with internal decay. The demand for phosphorus is greater during head formation and shortage will result in purple leaves. Potassium deficiency can cause cracked heads. Cabbage also requires

sulfur, magnesium, and boron. High temperature causes nutrients, especially nitrogen, to be available to the growing plants much quicker and will result in high quality yields (Semuli, 2005). Aside dressing of nitrogen is desirable after the heads has formed to about half the size to maturity.

2.5Effect of fertilizer on the yield component of cabbege

Cabbage is a heavy feeder and requires supplement fertilizer in the form of compost or manure and in organic fertilizer. The application of fertilizer should be determined based on fertility status of the soil . However such practice is not common in Ethiopia. fertilizers mostly applied based on recommendation rate which are implemented for all types of soil .according to ARARI (2005), the rate of nitrogen and phosphorus required for the production of cabbage in Ethiopia is categorized based on the fertility of the soil .About 150 kg DAP and 100kg urea is recommended for fertile while 200kg of DAP AND100 kg of urea is recommended for non –fertile soils . half of the urea and the whole DAP is applied at the time of planting and remaining half of the urea will be applied 30 days after transplanting (ARARI, 2005).

Fertilizer usage plays a major role to increase food production and to meet the demands of the growing world population. The extent to which fertilizers are used still differs considerably between various regions of the world (Mengel and Kirkby, 1996). The quantity of fertilizer nutrients required to optimize crop production depends on the inherent capacity of the soil to supply adequate levels of nutrients to growing plants (Sanchez 1976; Baligar and Bennett, 1986), the yield potential of the crop variety grown (Amsal Tarekegne et at., 1995, 1997a; Tilahun et at., 1996), the availability and cost of fertilizers (Gezahegn and Tekalign, 1995), and climatic conditions prevailing during the crop growing season (Baligar and Bennett, 1986).

Crop species differ in their nutrient requirements depending on their stages of development and high requirement for nitrogen while large amounts of potassium are a requisite for good growth of marketable part is the underground organs like sweet potato and Irish potato (Preece and Read, 2005) takes up high amounts of nutrients especially nitrogen and potassium (Hemy, 1984; Salunkhe et al., 1987). Prasad et al. (2009) maximum number of outer leaves, head length, head width, total and net head weight and total yield were obtained with the application of 120kg N/ha

and 100kg P/ha. Whereas the maximum plant height, plant spread, leaf area and head diameter were recorded with the application of 140kg N/ha and 120kg P/ha. Application of 120kg nitrogen and 100kg phosphorous ha-1also gave the best yield of Chinese cabbage in the Gangetic plains of West Bengal (Prasad et al., 2009). In the research from Westerveld et al. (2003), cabbages received the highest nitrogen rates were larger and had a darker green color compared to those received the lowest nitrogen rates.

An experiment carried out at Bangladesh Agricultural University farm, the maximum marketable yield of cabbage was obtained from the application of 336 kg ha-1 nitrogen (Farooque and Mondal, 1978). They also observed increased plant height, number of loose leaves, head size, marketable and total yield of cabbage with increased nitrogen level. In the study conducted by Khokhar et al. (1970) in Taskent Region of Russia, application of 200 kg ha-1 of nitrogen increased the growth and development of cabbage and thus increased the yield. White and Forbes (1977) reported that cabbage responded positively to nitrogen application up to the level of 308 kg ha-1 in Florida, USA. The higher rates reduced generally the proportion of bigger cabbage heads.

Singh and Naik (1988) conducted an experiment on the nitrogen requirements of cabbage at Ranchi, India. They observed that the head weight, number of marketable heads and total yield were maximum at the rate of 180 kg ha-1nitrogen. Similarly, Khadir et al. (1989) studied the effects of three levels of nitrogen (0, 138, and 376 kg ha-1) and found the highest mean leaf number, head weight and head yield at the maximum rate of nitrogen.

Not only nitrogen and phosphorous but also other macro and micronutrients affect the growth and development of crops including cabbage. Din et al. (2007) reported that the maximum head yield was recorded in treatment receiving NPK level of 120-90-60 kg ha-1 in cabbage. The minimum values of these parameters were recorded in control plants where no fertilizer was applied. Rankov and Belichki(1980) also found that the highest yield of cabbage was obtained when N: P2O5: K 2O was applied at the rate of 450:150:300 kg ha-1.

Similarly Hossain (2011) reported that maximum marketable yield of cabbage (87.09 t ha-1) was recorded from plants which were received in receiving 240 kg N, 45 kg P, 180 kg K and 45 kg S ha-1. Application of fertilizer above these concentrations reduced the marketable yield of

cabbage. The increased marketable yield was expressed in terms of increased diameter and thickness of heads and less number of loose leaves.

Organic fertilizers such as compost are also important in crop production including cabbage. They not only add nutrients to the soil, but also improve the structure of the soil and the availability of nutrients to plants and thus they improve the efficiency of the applied inorganic fertilizers. In this regard Sarker et al. (2002) who observed a significant effect of fertilization on maturity of cabbage heads where fertilizer application reduced the date of maturity compared to without fertilization and reported that highest marketable yield of cabbage (86.68 t ha-1) was obtained from treatment combination of 60 cm x 45 cm plant spacing with organic and inorganic fertilizers. In the study of Anonymous (1991), application of 240kg N, 60 kg P and 120 kg K ha-1along with cow dung @ 5 t ha-1 produced the highest cabbage head yield (75 t ha-1).
Farmyard manure release nutrients slowly and steadily and activates soil microbial biomass (Ayuso et al., 1996; Belay et al., 2001). Organic manures can sustain cropping systems through better nutrient recycling and improvement of soil physical attributes (El-Shakweer, 1998). The use of inorganic fertilizer has not been helpful under intensive agriculture because of its high cost and it is often associated with reduced crop yields, soil degradation, nutrient imbalance and acidity (Kang and Juo, 1980; Obi and Ebo, 1995).

The effects of fertilizers on growth and development of crops including cabbages are affected by the stage of development of the crop and the moisture content of the soil. In three years fertilizer trails conducted on alluvial meadow soils (Radov and Turkmenbaen, 1973) found that use of 180 kg nitrogen ha-1 applied in three splits of equal doses produced the highest head yield of cabbage. Similarly, Vleck and Polack (1964) obtained the highest cabbage yields by application of 75 kg N ha-1 three times during the growing season based on the stages of plant development. Application of full dose of nitrogen at the time of planting in most cases results nitrogen deficiency at late stage of crop development including cabbage because of leaching through irrigation water. Application of nitrogen late in the growing season of cabbage may solve deficiencies without yield loss. The pre plant applications may lead to losses or immobilization before plant uptake, thus greatly affecting N use efficiency (NUE). To avoid nitrogen losses as a result of leaching and volatilization, split application is needed. Pre-plant applied N is subject to

leaching and prone to Dentrifications or immobilization before plant uptake, thus affecting N use efficiency (Subedi et al., 2007).

Soil moisture also affects the effects of applied fertilizers on growth and development of crops including cabbage. In this regard, Sammis et al. (1988) found that head size, yield and quality of lettuce and cabbage were significantly decreased as soil moisture reduced. In another experiment, Sammis and Wu (1989) found that marketable yield of cabbage was decreased linearly with decreasing water application. In an experiment from Dragland (1976) the yield of cabbage was gradually increased when the nitrogen supply was raised up to 380 kg ha-1. However application of 470 kg ha-1 didn't showed any yield advantage if moisture tension was kept below 0.4 bars.

As indicated above the increase in fertilizer application increased the growth and development of cabbage. However, excess nitrogen may adversely affects the head quality by producing coarse and loose head, reduces keeping quality, and enhances the nitrate nitrogen content of head (Chatterjee, 2009). In various studies similarly, high rates of nitrogen delayed maturity, decrease storage life, and increase the incidence of disorders (Peck, 1981; Locascio, 1984; Berard, 1990). In contrast to this, Zebarth et al. (1991) observed no quality deterioration in cabbage with application of high rates of nitrogen.

Although high nitrogen rates and closer row spacing increased total yield, such condition also delayed maturity of cabbage as indicated by White and Forbes (1976). In similar experiment from Csizinszkys and Schuster (1985) high plant density reduced head size and head weight of individual cabbage, but greater number of heads per unit area obtained from closer row spacing increased total yield of cabbage. In contrary to this, an increase in spacing results in increasing in percent marketable cabbage and the average weight of individual heads (Stepanović et al., 2000).

The complementary use of organic and inorganic fertilizers has been recommended for sustenance of long term cropping in the tropics (Ipimoroti et al., 2002). Fuchs et al. (1970) reported that nutrients from mineral fertilizers enhance the establishment of crops while those from mineralization of organic manures promoted yield when both fertilizers were combined.

3. MATERIALS AND METHODS

3.1 Description of the Study Area

The experiment was conducted under field condition at Wolkite university ,college of Agriculture and Natural Resource, Department of Horticulture. The experiment is located at about 158 km from Addis Abeba at 8^{o} 11'60.0'' north latitude and 37^{o} 47' 60.0'' east longitude. The altitude of the site ranges from about 1900-3000m above sea level. Rain fall is seasonal, varying in depth, space and time. The mean maximum and minimum temperature of the area is about 24^{o}c and 14^{o}c, respectively. The mean annual rainfall in the area is about 1294mm and it is erratic and uneven in distribution (NMSA, 2009).

3.2. Experimental Design

The experiment was carried out in Randomize complete block design (RCBD)with six treatments and three replications. Both the spacing between rows and plant was 50 and 30cm, respectively. The experiment plot size was 2m x2.1m ($4.2m^2$). The space between blocks and plot was1m and 0.5m respectively. There are 4 rows per plot with 28 plants per plot. Thus the total experimental area of land was 16.1x9m ($144.9m^2$)

3.3. The Experimental Materials and Treatments

The experimental materials that used during the experiment was Copenhagen cabbage varieties and NPS fertilizer was used. The experiment was contains the following treatments with different rates of NPS(19:38:7respectively).0kg/ha (Control) 60 kg/ha, 120kg/ha,180kg/ha,240kg/ha and 300kg/ha.

3.4 Experimental procedures

Experimental site was selected ,cleared to remove unwanted material, digging ,leveled and smoothed the soil and nursery was established and Seed bed were prepared. The cabbage seed was sown (February 25/06/2011) in the prepared bed and urea were applied. After sowing, the seed was covered by straw mulch and other cultural practices were carried out until the seedling

become ready for transplanting. The permanent bed was prepared and the layout was arranged appropriately. The bed was watered sufficiently before seedling was transplanted to make the soil suitable for them. Total experimental area was divided into three blocks then blocks were divided into plots equal to the number of treatments. The plots were watered before planting .After the seedling raised for 3or 4 week, they were transplanted (march 26/07/2011) to 30cmx50cm spacing. Six different levels of NPS was randomly allotted to each plot. Beds watered twice per day once in the morning and afternoon and watered once a day afternoon after second week of transplanting. Weed management and other cultural practices were applied as per recommendation for the cabbage.

3.5 Data collected

To evaluate the effect of different rate of NPS on yield and yield components, five plants were randomly sampled from the middle rows and tagged were taken within the interval of a week. Data related to growth parameters and yield as follow:-

- **Days of 50% head initiation**:-days of 50% head initiation was recorded when half of the plants in a net plot form heads.
- **Days of 90% head maturity**:-days of 90% head maturity was recorded from the date of transplanting to when 90% of the heads from the net plot reaches maturity.
- **Plant height**:-the height of the plant was measured by placing meter scale from the ground level to the top of the outer longest leaf of an individual plant at the time of 90% days of head maturity
- **Head diameter**:-five heads were taken randomly from middle plot were cut vertically at their middle position with a sharp knife and measured the diameter of the head by caliper.
- **Height of the head**: head height (cm) was obtained from five representative plants by caliper.
- **Head circumference**: five heads were taken from the middle plot and measured the head by caliper.
- **Head weight**: the head of five randomly selected plants from the nets plot are were harvested and weighing using weighing scale and the mean value were calculated and used for further analysis.

3.6 Data Analysis

The collected data was subjected to analysis of variance (ANOVA). The data for the characters under study was statically analyzed and differences among treatment means were adjusted by least significant difference test (LSD) at 5% probability level

4. RESULT AND DICUSSION

4.1.1 Plant height

The result revealed that plant height was significantly ($p<0.05$) affected by different level of NPS fertilizer rate (Appendix table 1). The higher plant height (30.56 cm) was obtained from the application of NPS at the rate of 240 kg/ha followed by 120kg/ha, 180kg/ha and 300kg/ha which is 23.86cm, 28.26cm and 25.6cm respectively whereas the shortest plant height was recorded in T1 at the rate of kg/ha (10.93cm) (Table 1) which was not supplied with NPS fertilizer. application of NPS was not significant at the rate of 180,240, and 300kg/ha (Table 1).The result was in agreement with the finding of Thapa and Prasad (2011) who has reported that maximum plant height (32.57cm) at the rate of 120 kg/ha nitrogen and 100 kg/ha phosphorus perhectar.

4.1.2 Days of 50% head initiation

The analysis of variance revealed that different levels of NPS had highly significant ($p<0.01$) (appendix table 2). Early head initiation was observed application of NPS an the rate of 300kg/ha followed by 240kg/ha and 180kg/ha which is 54 ,56.33 and 56.33 where plants not supplied (T1) with whereas relatively longer time to initiate head (68 days) was recorded at the rate of 0kg/ha (Table 1) . The result was in agreement with the finding of Hossan et al.(2011) who has reported that earliest head initiation (53 days) was observed on cabbage plants which were supplied with nitrogen : phosphorus and sulfur with the ratio of 240:180:45kg per hectare respectively.

4.1.3Effect of NPS on Days of 90% head maturity

The analysis of variance indicated that different NPS fertilizer rate had highly significant ($p<0.01$) effect on days required for head maturity (Appendix Table 3).The earliest 90% head maturity (65 days) was observed in at the rate of 300kg/ha ,followed by 240kg/ha, 180kg/ha with the mean values of 65 ,67.33 and 67.33 days respectively where as late 90% head maturity was observed at control which is 78 days. Application of NPS at the rate of 0,60 and 120kg/ha is not significant and also application of NPS at the rate of 180kg/ha and 240kg/ha is not significant(

Table 1) .These result was in agreement with Sarker et al. (2002) who was reported that different rate of fertilization had an effect on maturity of cabbage heads e date of maturity .

4.14 Effect of NPS on Head height

The analysis of variance indicated the head height was significantly($p<0.01$) different levels of NPS fertilizer (Appendix table 4).The higher head height (14.47cm) was obtained in 180kg/ha Followed by 240kg/ha and 300kg/ha with the mean values12.6and 12.8 respectively, whereas The lower head height (8.6 cm) was recorded in control plants (Table 1).in the result in line with the work of Hossan et al.(2011) who has reported the maximum average head height (16.5 cm) was found with the apply of 240:180:45 kg /ha while the minimum head height (8.6 cm) was recorded from control plants ,without NPS fertilizer.

Treatment	Plant height(cm)	Days of 50% head initiation	Days of 90% head initiation	Head height(kg)	Head weight(cm)	Head circumference (cm)	Head diameter(cm)
0kg	10.93^{d}	68a	78^{a}	8.6^{de}	0.56^{cd}	23^{c}	7.64^{cd}
60kg/ha	23.3^{bc}	63.33^{a}	73.66^{a}	9.66^{cd}	0.57^{bc}	22.916^{cd}	8.66^{bc}
120kg/ha	$23.86a^{b}$	58.66^{a}	69.6^{a}	11.133^{bc}	0.653^{ab}	26.29^{b}	9.33^{ab}
180kg/ha	28.26^{a}	56.33^{ab}	67.33^{b}	14.47^{a}	1.06^{a}	30.18^{a}	12.06^{a}
240kg/ha	30.53^{a}	56.33^{ab}	67.33^{b}	$12.6a^{b}$	0.86^{a}	29.19^{a}	10.7^{a}
300kg/ha	25.6^{a}	54^{cd}	65^{c}	12.8^{a}	0.933^{a}	30.15^{a}	12.16^{a}
LSD 5%	6.187	10.5	10.2	1.78	0.272	1.61	1.66
CV	14.67	12.5	6.14	8.46	19.4	7.34	9.03

Means with same letter within a column was not significant

4.1.5 .Effect of NPS on Head weight

The analysis of variance revealed that head weight was significantly (P<0.01) different in rate of NPS fertilizer (Appendix Table 4). The highest weight of head (1.06kg) was obtained from plants at the rate of 180kg/ha followed by the heads obtained from 300kg/ha with the mean values of 0.933kg. The lowest average head weight (0.5266 kg) was recorded from control plant. Application of NPS at the rate of 180kg/ha, 240kg/ha and 300kg/ha is not significant effect(Table1).similar results are observed by Prasad *et a*l (2009) who reported that the combined application of 120 kg/ha and100kg/ha of nitrogen and phosphorus, respectively, give the maximum head weight of cabbage.

4.1.6 Effect of NPS on Head circumference

The result showed that application of NPS in different rate was significant (p<0.01) (Appendix Table 6).The highest head circumference of cabbage was obtained from at the rate of 180kg/ha and 300kg/ha|(30.18cm and 30.15 respetively) followed by240kg/ha whereas the minimum head circumference (23cm) was recorded in control (Table 1). The result was inline with the work of Prasad et al. (2009) who has reported the maximum average head circumference (33.2cm) was found with the application of 120kg N/ha and 100kg /ha. Where as The minimum head diameter (24.4cm) was recorded from control

4.1.7 Effect of NPS on Head diameter

The analysis of variance revealed that head diameter was significant in different rate of NPS application (p<0.01) (Appendix Table 7). The maximum head diameter was recorded at the rate of 300kg/ha and 180kg/ha which is 12.16 cm and 12.06 |respectively followed by at the rate of 240kg/ha whereas the lowere head diameter (7.64cm|) was recorded in control . The result was not significant at the rate 300kg/ha, 240kg/ha and 180kg/ha Table 1. The result was in agreement with Hossain et al. (2011|) who has reported the maximum average head diameter

(17.2cm) was found with the application of 240,45,180:,45 $kgha^{-1}$ of NPK and S. The minimum head diameter (8.0 cm) was recorded from control plants,

5. Conclusion and Recommendation

Cabbage (*Brassica oleraceavar.capitata L.)* belongs to the family cruciferea and it is biennial crop with a very short stem supporting a mass of overlapping leaves to form a compact head or loose head. It originated from wild non-headed type 'Cole wart' (*Crambecordifolias*) from Western Europe and northern shore of Mediterranean (Semuli, 2005).

Application of different rate of NPS was a significant ($p<0.05$) on the yield component of cabbage. From the result the higher plant height (25.6 & 30.53, days of 50% headinitiation(54 and 56.33), Days of 90% head maturity(65 and 67.33), head height(12.8 and 14.47) , head weight(0.933 and 1.06kg/ha), head circumference(30.15 and 30.18) and head diameter(12.16 and 12.06) was recorded at the rate of 300kg/ha and 180kg/ha respectively and intermediate result was recorded at the rate of 60kg/ha 120kg/ha and 240kg/ha whereas the lower yield attributer was recorded sole cropping.. From the result increasing the rate of NPS fertilizer was increase the yield attribute of cabbage and recommended to the local farmer to use 180kg/ha.

Cabbage production in the study is indicated thus huge potential in the production cabbage with NPS fertilizer. However, cabbage production in the area does not implement the recommended agronomic practice such as fertilizer rate, plant spacing and watering in the production of cabbage which are necessary to increase the production of cabbage.

One of the major constraint in the study area the occurrences of disease and insect pest especially aphid attack cabbage. Therefore, the farmers must be know the occurrences, the spread and the control methods to prevent disease and insect should be provide awareness for the farmers for the future to produce high quantity and quality of cabbage.

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Appendix

Table 1: Analysis of variance on plant height

Source of variation	DF	SS	MS	Fcal	Ftab at 5%	Ftab at 1%
Block	2	6.52	3.26	0.28	4.10	8.86
Treatment	5	591.86	118.372	10.24**	3.33	5.64
Error	10	115.56	11.556			
Total	17					

Table 2: Analysis of variance on days of 50% head initiation

Source of variation	DF	SS	MS	Fcal	Ftab at 5%	Ftab at 1%
Block	2	340.8	170.44	5.2	4.10	8.86
Treatment	5	1623.12	324.63	9.74**	3.33	5.64
Error	10	333.58	33.358			
Total	17	2297.58				

Table 3: Analysis of variance on days of 90% head maturity

Source of variation	DF	SS	MS	Fcal	Ftab at 5%	Ftab at 1%
Block	2	278.43	139.215	4.59	4.10	8.86
Treatnent	5	817.17	163.434	5.38**	3.33	5.64
Error	10	303.93	30.393			
Total	17	1399.53				

Table 4: Analysis of variance on head height

Source of variation	DF	SS	MS	Fcal	P value at 5%	P value at 1%
Block	2	0.48	0.24	0.25	4.10	8.86
Treatnent	5	70.78	14.156	14.8**	3.33	5.64
Error	10	9.56	0.956			
Total	17	80.82				

Table 5: Analysis of variance on head weight

Source of variation	DF	SS	MS	Fcal	P value at 5%	P value at 1%
Block	2	0.0816	0.041	1.84	4.10	8.86
Treatnent	5	0.7064	0.142	6.34**	3.33	5.64
Error	10	0.2236	0.0224			
Total	17	1.0116				

Table 6: Analysis of variance on head circumference

Source of variation	DF	SS	MS	Fcal	P value at 5%	P value at 1%
Block	2	21.23	10.625	0.55	4.10	8.86
Treatnent	5	173.99	34.798	4.48**	3.33	5.64
Error	10	38.86	3.9			
Total	17	234.1				

Table 7: Analysis of variance on head diameter

Source of variation	DF	SS	MS	Fcal	P value at 5%	P value at 1%
Block	2	2.13	1.065	4.10	4.10	8.86
Treatment	5	51.8	10.36	12.44**	3.33	5.64
Error	10	8.33	0.833			
Total	17	62.26				