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Evaluation of Head Cabbage Varieties (*Brassica oleraceae var. capitata L.*) on Different Rates of Nitrogen Fertilizer in the Condition of Lemo Area at Hadiya Zone, Southern Ethiopia

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ABSTRACT

Cabbage is an important food and cash vegetable in many parts of Southern Ethiopia. But, its production and productivity is low owing to a number of constraints. Disorganized agronomic practices, such as low rates of Nitrogen fertilizers and lack of improved varieties are among the major problems. This experiment was conducted during the summer cropping season of 2019/2020 at Wachemo University, Southern Ethiopia. To evaluate the effect of Nitrogen fertilizer rates on three varieties of head cabbage yield and yield components. Nitrogen rates (0,34.5, 69 and 103.5 kgNha^{-1}) with three varieties (Rossen, Royal and Delta) were used and laid out by randomized complete block design in a factorial arrangement replicated three times. The results revealed that, most of yield components were significantly (P<0.05) influenced by the interaction effect of Variety and Nitrogen fertilizer. Specifically, highest head weight (4.07 Kg plant^{-1}), highest marketable head yield (40.69 t ha^{-1}) and highest total head yield (48.27 t ha^{-1}) were recorded from Rossen variety at 103.5 kgNha^{-1}. While, the lowest performance in each parameters was from Delta variety at control treatment. However, the highest marginal rate of return (11,666.67%) with its optimum net benefit value of (512,275.00 ETB ha^{-1}) was recorded at rate of 69 kg N ha^{-1} Rossen variety. Yet, application of 69 kgNha^{-1} at the same variety (Rossen) had also resulted higher MRR (7,908.06%) and highest net benefit (598,275.00 ETB ha^{-1}). Therefore, these two can be alternatively used. Besides, as the study was done at only one location in a single season, it is recommended to repeat the study for more than one season at different locations.

Keywords: Cabbage; Nitrogen; Varieties; Yield.

Introduction

Head cabbage (*Brassica oleraceae var. Capitata L.*) belongs to the Brassicaceae family and which is closely related to the broccoli, cauliflower and brussels leaves. It is a leafy vegetable that grows close to the ground. The leavens may be loose or firmly compacted, ranging in colour from pale green to purple. The crop is one of the most important vegetable crops under cultivation. According to recent, there are more than two million hectares of cabbage in production globally, with an average yield of 29 tonnes per hectare [1]. Its productivity per unit area in Ethiopia is quite low (15 t ha^{-1} per unit area) when compared to the developed countries of the world [2]. Several factors such soil nutrient management, irrigation, variety, plant population per unit area, are involved for better growth of cabbage. Among the factors, suitable variety of the crop and optimum nutrient supply are the vital inputs for recognizing better growth and higher yield [3].

The cabbage has been ranked by the FAO among the top twenty vegetable crops grown, establishing it as an important food source, globally [4]. The crop is a rich source of water, calcium, Iron, vitamin A and vitamin C, in addition to containing some B vitamins [5]. It also contains significant amounts of glutamine, an amino acid and antioxidants which has anti- inflammatory properties [6,7]. It is used mainly in salads, as a fresh food item, but is also cooked with

other foods [8]. The crop's head may be flat, round or pointed, with variations among these shapes [9].

It is a cool season crop which grows best under cool, moist weather conditions [10]. This leafy vegetable can grow well on a wide range of soil types provided adequate moisture and fertilizer is supplied. During the summer months the cabbage is more susceptible to pests. The length of the growing period is shorter during the cooler season (November to March), between 90 and 100 days, while summer cabbages can take up to 140 days to mature. High yielding variety requires more nutrients than the local or wild variety [11,12]. The requirement of these plants nutrients can be provided by applying Nitrogen fertilizer. The application of Nitrogen fertilizer is known to increase the yield of leafy vegetables [13,14].

Globally, the role of vegetables has been known in solving the problem of food and nutritional security. However, the production of vegetables like head cabbage is confronted with numerous constraints. Among those, high cost of inputs pesticides and fertilizers and attack by pests and diseases and low rate use of fertilizers and lack of improved varieties are the main issues.

Also, farmers in Lemo area have limited awareness on the use of improved variety and optimum Nitrogen fertilizer application for head cabbage production. Even though, the blanket recommendations are available regards to those practices in the country. Yet, site specific recommendations on variety selection and Nitrogen fertilizer use rate are not available and no more trials were conducted in this regard particularly at Lemo area condition in Hadiya zone. And also there is no practice of producing this vegetable crop in the University; the present study provides information's on how to enhance the production and availability of the produce for the communities of the study area and student's cafeteria and this requires a serious attention for its wider production to meet the desired goal.

Therefore, by considering the potential for head cabbage production to improve for the food security, evaluating its varieties at different rates of Nitrogen fertilizer is the main issue and this might help to tackle its production problems in the future; since the crop has high economic importance to fulfill both the nutritional and food security problems. Therefore, this study is initiated with the objectives to evaluate the growth and yield performance of three cabbage varieties on different rates of Nitrogen fertilizer for the growing conditions of Lemo area; and to determine economic and agronomic feasible type of head cabbage variety and Nitrogen fertilizer for the study area conditions.

Materials and Methods

Description of the area

This experiment was conducted in 2020 on Wachemo university college of Agriculture experimental research field site and which is Located in the Hadiya zone of the SNNPR about 232 km away from Addis Ababa at altitude of 2250 m.a.s.l. The annual mean rainfall is about 1800 mm. About 70% of the total annual rainfall is received during winter, which lasts from the end of March to early August and average annual temperature is about 14.5°C at Latitude of 7° 57' 0 N, Longitude of 39° 7' 60 E. The soil type of study area is sandy loam.

Experimental design

Three improved varieties of head cabbage (Rosen, Royal and Delta) and four rates of Nitrogen fertilizer was laid out in 3 × 4 factorial arrangements using Randomized Complete Block Design (RCBD) with three replications.

Experimental procedures

The seeds of varieties were sown on the nursery bed and raised as the seedlings for about 40-45 days. Phosphorus was applied in the form of TSP fertilizer during planting time and Nitrogen through urea was applied in a split, *i.e.* half was first banded at a time of transplanting and second half was side dressed after full establishment of the transplanted seedlings at different rates.

Data collection

Days to 50% head initiation; Days to 75% maturity, Plant height (cm), number of leaves per plant, head diameter (cm), head weight (kg), marketable unmarketable yield (t ha-1), unmarketable yield (t ha-1) and total yield (t ha-1) were collected as required.

Data analysis

The collected data's were subjected to Analysis of Variance (ANOVA) of RCBD in factorial arrangements by using the general linear model of SAS statistical package updated version 9.3 independently (SAS Institute Inc. Cary NC, 2008). Treatment means that exhibited significant differences was separated using Least Significance Difference (LSD) at 5% level of significance.

Economic or partial budget analysis

Partial budget analysis of selected treatments was done according to CIMMYT, (1988). The average total head yield data produced by each treatment was calculated over the planted head cabbage. And this average total yield was adjusted down by 10 percent to minimize plot management variation. The field price of 1 Kg of head cabbage yield during harvest was estimated as 12.50 Ethiopian birr (ETB kg^{-1}) and 100 gram of the seeds is 100 Ethiopian Birr (ETB) g^{-1} during sowing season and the required amount is about 350 to 400 g ha^{-1}. The average price of Urea fertilizer was 13.50 Ethiopian birr (ETB kg^{-1}) as the estimation based on the cost at the time of purchasing. The gross benefit was calculated as average adjusted total head yield (kg ha^{-1}) × field price of a crop was about 12.5 (ETB kg^{-1}). Net benefit was also be calculated by subtracting total variable cost from the gross benefit. The Marginal Rate of Return (MRR) was calculated as:

$$MRR=\frac{\text{Change in net benefit}}{\text{Total variable cost}}\times 100 \text{ i.e } MRR=\frac{\Delta NB}{\Delta TVC}\times 100$$

Results and Discussion

Phonological parameters

Days to 50% head initiation

In this experiment the days to attain 50% heading of cabbage was influenced by the main effect of variety and Nitrogen fertilizer rates and at which the delayed performance (79.34) days was obtained from the variety of Delta (V3) while the faster number of days (65.73) to attain 50% head initiation was from Rossen variety (V1) of head cabbage. This might be due to the genetic variations among the varieties. And also the result of the present study was in line with the finding of that which they reported that different varieties of the head cabbage has difference in the performance of head initiation [7].

Similarly, the head intuition of cabbage crop was influenced with the increased application of Nitrogen fertilizer and the delayed mean days of (75.29) was obtained in the increased treatment of 103.5 $KgNha^{-1}$, whereas early heading days (69.78) was observed at control (Table 1). That shows the extended number of days to attain 50% heading was recorded in the increased delayance might be due to the role of Nitrogen fertilizer to extend the vegetative growth of crop. And the current result was in agreement with the finding of reported that the growth of the head cabbages has influenced by the effect of application of different rates of Nitrogen fertilizer effect [14].

Days to 75% maturity

The analysis of variance indicated that the main effects of variety and Nitrogen fertilizer had significant ($p<0.05$) effect on days to 75% maturity. Therefore, the maturity of cabbage was delayed due to the variety effect. Accordingly the delayed days (134.79) to attain 75% physiological maturity were recorded from the Delta variety (V3) while, the faster growth or the shorter days (117.56) were obtained from Rosen variety (Table 1). This might be due to the varietal difference of the crop.

Similarly, the maturity of the head cabbage was also influenced with the increased application of Nitrogen fertilizer. In this experiment, the faster physiological maturity to attain 75% physiological maturity were obtained from the 34.5 Kg N ha^{-1}, while the delayed days to attain 75% maturity were recorded from the increased application of (103.5) Kg N ha^{-1} (Table 1). This delayance with increased application might be due to the role of Nitrogen fertilizer on plant maturity where it is known to further prolong the vegetative growth of the crop. The result of the current study was in agreement with the findings of who reported that maturity of head cabbage was influenced with the increased application of Nitrogen fertilizer [2].

Growth and yield parameters

Plant height (cm)

The result of the present study revealed that, the tallest plant height of (29.81) cm was obtained from Rossen variety and the shortest plant height of (24.95) cm was recorded from Delta variety at the stage of physiological maturity. This difference in the height of the crop might be due to the genetic variations among the varieties to perform differently. This study was in agreement with the finding of Haque (2005) who reported that plant height was influenced by the varietal difference of the crop.

Plant height was also significantly affected by the application of different rates of Nitrogen fertilizer under the present study (Table 1). The longest plant height (30.62) cm was obtained from increased rates (103.5 Kg N) ha^{-1} fertilizer application on head cabbage while the shortest plant height of (24.02) cm was recorded from the control treatment. This result might be due to the effect of Nitrogen fertilizer for plant height because it is known that a crop which grows in the increased application of Nitrogen fertilizer has an elongated growth and cell expansion. The current finding was in line with the findings of who reported that cabbage plant height was highly influenced by the application of Nitrogen fertilizer [9].

Main effect	Days to 50% head initiation	Days to 75% maturity	Plant height (cm)	Number of leaves per plant

Number of leaves per plant

The ANOVA value table (Analysis of variance) has revealed that, number of leaves per plant was highly influenced by the main effect of variety, Nitrogen fertilizer. In this experiment, the increased leaves number per plant (21.92) was recorded from the Rossen variety (V1) while the reduced number of leaves per plant (16.92) was obtained from the Royal variety (V3) of head cabbage. These results might be due to the difference in genetical characters of cultivars that might allow the performance difference on the number of leaves. And also, the report in the findings of was in agreement with findings of the current study where the number of leaves per plant of the cabbage was influenced by the genetic potential difference [7].

Correspondingly, the number of leaves per plant of cabbage crop was influenced by the increased application of Nitrogen fertilizer. In this study, the highest number of leaves per plant of (21.56) was obtained in the increased application rate of 103.5 $KgNha^{-1}$ while the lowest amount of leaves per plant (16.89) was obtained from the control treatment (Table 1). The present result was in agreement with the findings of [2,9,13] who reported an increase in the number of leaves per plant with the application of inorganic fertilizers.

Table 1: The days to 50% head initiation, days to 75% physiological maturity, plant height and number of leaves per plant has influenced with the main effect of variety and N fertilizer rates at Lemo area in Hadiya Zone, at cropping season of 2012.

Main effect	Days to 50% head initiation	Days to 75% maturity	Plant height (cm)	Number of leaves per plant
Variety				
Rossen (V1)	65.73c	117.56c	29.81a	21.92a
Royal (V2)	70.97b	125.75b	27.62b	18.92b
Delta (V3)	79.34a	134.78a	24.95c	16.91c
LSD (0.05)	1.3	0.74	0.59	0.39
N (kg N ha-1)				
0	70.58c	125.17c	24.02d	16.89d
34.5	69.78c	121.45d	26.40c	
69	72.39b	127.57b	28.81b	20.22b
103.5	75.29a	129.94a	30.62a	21.56a
LSD (0.05)	1.5	0.85	0.68	0.45
CV	2.14	6.69	2.54	2.39
Mean	72.01	126.03	27.46	29.25
Whereas, LSD=Least significance difference, CV=Coefficient of variation, cm=centimeter, N=Nitrogen fertilizer and V=variety				

Head diameter

Diameter of head is a measurement of the size of actual cabbage shape which indicates the yield amount and/or market value. In this study, Variety and Nitrogen fertilizer has a very highly significantly (P<0.01) increased the head diameter. Consequently the head diameter of cabbage was highly increased (P<0.01) with the main effect of variety and the Nitrogen fertilizer and also with the interaction effect of variety and Nitrogen fertilizer rates (Table 2).

Table 2: The interaction effect of variety and nitrogen fertilizer on head diameter and Head weight of cabbage crop in the cropping season of 2012.

Variety	Nitrogen fertilizer rate (kgNha^{-1})							
	Head diameter (cm plant^{-1})				Head weight (Kg plant^{-1})			
	0	34.5	69	103.5	0	34.5	69	103.5
Rossen (V1)	16.86^{hg}	18.19^{ef}	20.22^{b}	22.26^{a}	1.64^{gh}	2.28^{ef}	3.14^{b}	4.07a
Royal (V2)	16.42^{h}	17.51^{fg}	19.06^{cd}	19.79^{bc}	1.53^{g}	2.12^{g}	2.58^{c}	2.98b
Delta (V3)	14.86^{i}	15.51^{i}	16.85^{gh}	18.39^{de}	1.30^{i}	1.75^{g}	2.33^{de}	2.48cd
LSD(0.05)	0.84				0.17			
CV (%)	5.77				4.36			
Mean	17.99				2.35			
Whereas, LSD =Least significance difference, CV=Coefficient of variation, cm=centimeter and V=variety								

In this study, the highest head diameter of (22.26) cm head-1 was obtained from the Rossen variety with the increased application rate of Nitrogen (103.5 KgNha^{-1}) while the lowest head diameter (14.86) cm head^{-1} was recorded from Delta variety in the control treatment. The present study was in agreement with the findings of who reported that different cultivars has resulted a significant variations in the performance of the head diameter. This difference in the performance of the diameter of the head cabbage crop in the current study area might be due to the difference in the genetic potential of each variety to respond at different with the different rates of Nitrogen fertilizer even in the same soil condition [13].

Head weight (Kg)

The head weight of cabbage was highly increased (P<0.01) with the interaction effect of variety and Nitrogen fertilizer rates (Table 2).

The results revealed that the highest plant head weight (4.07 kg plant^{-1}) was from Rossen variety with the interaction of increased application rate of (103.5 KgNha^{-1}) whereas the lowest head weight of (1.30 Kg plant^{-1}) was obtained from the Royal variety (V3) under control treatment (Table 2). This difference or enlargement in the weight of the head cabbage crop in the increased application of Nitrogen fertilizer and the difference in genetic makeup of the varieties; since Nitrogen fertilizer is one of a critical nutrient in determining head enlargement of different varieties of cabbage at differently. This might be attributed due to the activated or enhanced metabolic role for head enlargement of the varieties at increased rate of Nitrogen fertilizer. And this was supported with the findings of who reported that the head weight of plant observed in different varieties are different in their performance [15,16].

ANOVA table result revealed that, marketable yield of the crop was significantly (P<0.01) affected by the interaction effect of different varieties and nitrogen fertilizer rates (Table 3).

Table 3: The interaction effect of varieties and nitrogen fertilizer marketable and unmarketable yield of head cabbage at Lemo condition during 2012 cropping season.

Variety (V)	Nitrogen fertilizer rate (kg N ha^{-1})							
	0	34.5	69	103.5	0	34.5	69	103.5
	Marketable head yield (t ha^{-1})				Unmarketable head yield (t ha^{-1})			
Rossen (V1)	27.04f	32.90d	40.77b	40.69a	1.46f	1.81bc	1.67cde	1.58def
Royal (V2)	24.99g	29.12e	33.46d	39.49c	2.11a	1.86b	1.71bcd	1.64cdef
Delta (V3)	23.24h	25.23g	27.37f	28.61e	2.20a	1.86b	1.75bcd	1.50ef
LSD(0.05)	1.23				1.18			

CV (%)	2.31				6.06			
Mean	31.58				1.76			
Whereas, LSD=Least significance difference, CV=Coefficient of variation, cm=centimeter and V=variety								

Hereby, the highest marketable yield (40.69 t ha^{-1}) was obtained from Rossen variety (V1) with the combined effect of the higher rates of Nitrogen fertilizer of (103.5 Kg ha^{-1}) while the least amount of marketable yield (23.24) t ha-1 was recorded from Delta variety (V3) with the with no application of Nitrogen fertilizer. This difference in the performance of marketable yield of head cabbage might be due to their yielding potential or genetic characters of the varieties with the combined effect of Nitrogen fertilizer to contribute for tuber formation and enlargement. The current result was supported by the findings of reported that the cabbage crop has shown high response and an increment in almost all parameters due to varietal differences and difference in fertilizer rates [12,16].

In addition to the above facts, the finding is in agreement with those of who reported marketable yields has shown an increase with the increased application rates of Nitrogen from 0 to 120 kg/ha, respectively. This was possibly due to higher synthesis of carbohydrate and their translocation to the sink, that is; cabbage head which subsequently helped in the formation of larger and comparatively broader head of the cabbage [13,17].

Unmarketable yield (t ha^{-1})

The unmarketable yield of cabbage was highly increased ($P<0.01$) with the main effect of variety and the Nitrogen fertilizer and also with the interaction effect of variety and nitrogen fertilizer rates. The highest unmarketable yield (2.20 t ha^{-1}) was obtained from Royal variety (V3) from the control treatment or with no application of Nitrogen fertilizer and which is far lower than the yields which were observed from the increased rates of fertilizer while the variety while, Rossen variety (V1) on the same treatment or in control treatment has shown the lowest unmarketable yield (1.46 t ha^{-1}) which was statistically different from others varieties on different rates of nitrogen fertilizer (Table 3). This difference in the unmarketable yield of head cabbage might be due to the yielding potential difference or genetic characters of the varieties.

The results achieved by were no similar to the present study as they found that the higher unmarketable yield from the Copenhagen variety [18].

This increment in the unmarketable yield on Royal variety of a head cabbage crop with no application of Urea fertilizer or under control treatment might be due to the weak performance of the variety and deficiency of the nutrient to provide better growing conditions and head enlargement for the crop than the rest varieties [19].

Total yield (t ha^{-1})

The interaction effect of varieties and Nitrogen fertilizer rates has significant ($P<0.05$) influence on the total yield of cabbage crop in this study. The highest total yield (48.27 t ha^{-1}) was obtained from Rossen variety (V1) with the combined effect of the increased application rate of Nitrogen fertilizer (103.5 Kg N ha^{-1}). However, the variety Rosen with no application of Nitrogen fertilizer or in control treatment has shown the a little increment than the rest rates, But the least total yield (25.45 t ha^{-1}) was obtained from the Royal variety (V3) in the control treatment and which was statistically different from others varieties. This difference in the performance of total yield of head cabbage might be due to the yielding potential difference of the varieties and the role of Nitrogen fertilizer which might help in determining yield of cabbage crop by enhancing the physiological and metabolic activities of the crop [20].

The results were no in agreement with the findings of who reported that variation in the total yield of the crop was influenced because of the variety effect and different yields were observed at each varieties [5,17].

Partial budget analysis

The primary objective of producers in choosing appropriate variety and applying optimum rate of fertilizer by providing the others recommended management practices is to make profit at the end. The extent to which the use of appropriate variety and optimum fertilizers contributes to this objective depends not only upon the amounts of fertilizer they apply, but also upon the variety type and cost of fertilizer. In this experiment, the results of economic analysis revealed that there were higher marginal rate of returns due to difference in variety and Nitrogen fertilizers rates had been calculated as CIMMYT, 1988 and presented on Table 4. The results of partial budget analysis data revealed that the highest marginal rate of return (11,666.67%) with its net benefit value of (512,275.00 ETB ha^{-1}) was recorded

Table 4: The total yield of head cabbage as influenced by the interaction effect of varieties and Nitrogen fertilizer at the 2012 cropping season in Lemo condition.

Variety (V)	Nitrogen fertilizer rate (kg N ha-1)			
	0	34.5	69	103.5
Rossen (V1)	28.50ef	34.71cd	42.44b	48.27a
Royal (V2)	27.10ef	30.98de	35.17cd	35.80c
Delta (V3)	25.45f	27.09ef	29.12ef	30.11e
LSD(0.05)	4.39			
CV (%)	7.89			
Mean	32.89			
Whereas, LSD=Least significance difference, CV=Coefficient of variation, cm=centimeter and V=variety				

at application of N rate of 69 kg urea ha^{-1} from the Rossen variety. Nevertheless, application of 103.5 kg N ha^{-1} on the same Rossen variety had also resulted higher MRR (7,908.06%) and maximum net benefit (598,275.00 ETB ha^{-1}). While, the least net benefit (282,462.00 ETB) was obtained from Delta variety which is treated no fertilizer application or in the control treatment. From this result, it is advisable to apply fertilizer for cabbage production with the application of the increased rates on N rate of 69 kg and 103.5 $KgNha^{-1}$ at Rossen variety and this could be more effective. This reveals that application of both rates (69 and 103.5) $KgNha^{-1}$ on Rossen variety of cabbage seems to increase the production of the crop and these rates might be economically feasible when compared to the production of cabbage without the application of fertilizer in the study area (Table 5).

Table 5: Partial budget analysis of the treatment effect on head cabbage production.

Variety	N fertilizer Kg ha^{-1}	AV.TY(t ha^{-1})	Adj. TY (t ha^{-1})	GB. Of TY (ETB)	CST (ETB)	CNF (ETB)	TVC (ETB)	NB (ETB)	MRR (%)
	0	28.5	25.65	3,20,625.0	4000	0	4000	3,16,625.0	-
	34.5	34.71	31.239	3,90,487.50	4000	1087.5	5087.5	3,85,400.00	6,324.14
V1	69	42.44	38.196	5,27,450.00	4000	2175	6175	5,12,275.00	11,666.67
	103.5	48.27	43.443	6,05,537.50	4000	3262.5	7262.5	5,98,275.00	7,908.06
	0	27.1	24.39	3,04,875.00	3900	0	3900	3,00,975.00	D
V2	34.5	30.98	27.882	3,48,525.00	3900	1087.5	4987.5	3,43,537.50	3,913.79
	69	35.17	31.653	3,90,662.50	3900	2175	6075	3,84,587.00	3,774.71
	103.5	35.8	35.22	4,40,250.00	3900	3262.5	7162.5	4,33,087.50	4,459.77
	0	25.45	22.905	2,86,312.50	3850	0	3850	2,82,462.0	D
V3	34.5	27.09	24.383	3,04,787.5		34.5	27.09	24.383	3,04,787.5
	69	29.12	26.208	3,27,600.0		69	29.12	26.208	3,27,600.0
	103.5s	30.11	27.099	3,38,737.5		103.5s	30.11	27.099	3,38,737.5

*C=control, Av. TY=Average head yield, Adj. TY=Adjusted tuber yield GB=Gross benefit of total head yield, CST (ETB)=Cost of cabbage seed, CNF=Cost of Nitrogen fertilizer, TVC=Total variable cost, NBT=Net benefit, MRR=Marginal rate of return, t ha-1=Tone per hectare and ETB=Ethiopian Birr, D=Dominated alternative, V1=Variety Rossen, V2=Variety Royal and V3=Variety Delta of head cabbage.

Conclusion

The maximum yield attainment by a given crop can rely on the use of an appropriate varieties and application of the required level of nutrients. In addition, selection of appropriate variety and adequate level of nutrients are so critical for the better yield production of the crops. Consequently, the current study was designed to evaluate the performance of varieties of head cabbage with the application of different rates of Nitrogen fertilizers. Thus, three different varieties of head cabbages were evaluate by applying different rates of nitrogen fertilizer at lemo condition in hadiya zone,

Southern Ethiopia. Laid out in 3 X 4 factorial arrangements using randomized complete block design with three replications. Cultivation aspects such as varieties selection and nutrient requirements were provided as required.

Main effect of variety and nitrogen fertilizer has revealed significant influence ($P<0.05$) on days to 50% head initiation, days to 75% physiological maturity, Plant height and number of leaves per plant. However, the head diameter, head weight, marketable yield, unmarketable yield and total yield of the crop were influenced by the interaction effect of variety and the nitrogen fertilizer rates.

More specifically, the highest marketable yield (40.69 t ha^{-1}) was obtained from the Rosen variety with the application of the increased rate of 103.5 Kg nitrogen fertilizer ha-1 while the lower marketable yield (23.24 t ha^{-1}) was obtained from the Royal variety with no application of nitrogen fertilizer. And also the highest total yields (48.27 t ha-1) of head cabbage was obtained from the Rosen variety with the increased application of nitrogen to 103.5 $KgNha^{-1}$ but the Royal variety has revealed the least performance of total yield (25.45 t ha^{-1}) in the control treatment with no application of nitrogen fertilizer.

The partial budget analysis result revealed that, the highest marginal rate of return (11,666.67%) with its optimum net benefit value of (512,275.00 ETB ha^{-1}) was recorded at rate of 69 kg N ha^{-1} Rossen variety. Yet, application of 69 $kgNha^{-1}$ at the same variety (Rossen) had also resulted higher MRR (7,908.06%) and highest net benefit (598,275.00 ETB ha^{-1}). Therefore, application of increased rate of both (69 and 103.5) $NKgha^{-1}$ on the same Rosen variety has an economically feasible effect on the production of the cabbage crop at Lemo condition. However, to perform the conclusive recommendation, this might requires further investigation on more than one location and seasons in those varieties.

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