

Research Article

Evaluation of Improved Exotic Head Cabbage Varieties at Bale high Lands, South Eastern Ethiopia

Gemechu Ejigu*

Oromia Agricultural Research Institute, Sinana
Agricultural Research, Robe Bale, Ethiopia***Corresponding author: Gemechu Ejigu**Oromia Agricultural Research Institute, Sinana
Agricultural Research, Robe Bale, Ethiopia.
Email: gemechuejigu55@gmail.com**Received:** July 29, 2024**Accepted:** August 22, 2024**Published:** August 29, 2024**Abstract**

Evaluation of exotic head cabbage varieties was conducted to select the most adaptable variety which was/were high yielder, disease and insect tolerant and best fit for the study area. The field experiment was conducted during the 2021 and 2022 rainy season at three locations. Randomized complete block design with three replications were used; each plot consisted of six rows and seven plants per row having spacing of 40cm x 50cm (intra and inter row) respectively, on a plot size of 2.8m x 3m (Width and length respectively). Cabbage varieties those were commercially available on the market Rossen, Royal, Monarch, Green and Delta was used in the study. Widely cultivated variety Bakker brother was included as check. From this experiment the combined analysis over locations and years indicated that almost all phenological, growth, yield and yield components of cabbage are significantly influenced due to varieties. From the ANOVA analysis the longest days to head initiation [70.93] was recorded for Delta seed variety, while the minimum [63.13] was attained by Monarch seed variety. In terms of days to 90 % head maturity the highest record [110] was recorded from Delta seed variety, while the lowest [105.5] was from royal seed varieties. The maximum gross head yield [118.11 ton/ha] was recorded from the variety green seed followed by Monarch seed variety [111.21 ton/ha], while the smallest number [88.72 ton/ha] was from Bakker brothers' variety. Similarly, the highest marketable yield [94.15 ton/ha] was green seed variety, the next also from monarch seed variety [85.42 ton/ha] and the minimum record [61.57 ton/ha] was from Bakker brothers' variety. Finally, from this experiment we get the result that green seed and Monarch seed variety showed best performance in almost all tested agronomic parameters over the tested varieties, therefore these two exotic head cabbage varieties were recommended for the study area and similar agro-ecologies.

Keywords: Exotic head cabbage varieties; Gross head yield; Marketable yield; Parameters

Abbreviations: RCBD: Randomized Complete Block Design; ANOVA: Analysis of Variance.

Introduction

Vegetables are substantial sources of vitamins, fiber, minerals, anti-oxidant and plant proteins in human diet which are useful for ordinary functioning of body systems and avoidance of cancer. Vegetable farming is becoming expensive due to the rising use of purchased inputs such as pesticides, herbicides and fertilizers to withstand production levels [13]. It was first originated in Northern Europe, the Baltic Sea coast and the Mediterranean region, where it has been produced for more than three thousand years and is well adapted to cool moist conditions [14].

Cabbage (*Brassica oleracea* var. *capitata* L.) is a critical Cole crops which is a member of the family Cruciferae or Brassicaceae with $2n=2x=18$ chromosome number. This family includes broccoli, Brussels sprouts, cauliflower, kale, mustard (greens), and collards. Communally, these crops are mentioned to as cole crops or crucifers Cabbage is assumed to have originated in Western Europe and it was the first cole crop to be grown [5]. Prior to growing and use as for consumptions, cabbage was principally used for medicinal purposes. In addition to the marketed fresh, cabbage is also processed into Kraut, egg rolls, and

there is the option for other specialty markets for the numerous types comprising of red, savoy and mini cabbage [8].

Cabbage is an admirable source of Vitamin C. In addition to having some B vitamins, cabbage provides some potassium and calcium to the nutrition. Two hundred fifty millilitres of raw cabbage contain twenty one kilocalories [12]. Cabbage (containing several varieties of Brassica oleracea) is a leafy green, red (purple), or white (pale green) biennial plant produced as an annual vegetable crop for its condensed-leaved heads. Plants are 40–60 cm tall at the matured vegetative stage [10]. According to [4], cabbage (*Brassica oleracea* L.) ranks second in terms of production among the vegetables in Ethiopia behind red pepper (*Capsicum* spp.). A latest estimate shows that Africa has about one million hectares planted with head cabbage [7]. Commercial seed sales indicate that at least 40,000 ha of white-headed cabbage are grown in Kenya, Uganda and Tanzania; 10,000 ha in Malawi, Zambia, and Zimbabwe; 4,000 ha in Ethiopia; and 3000 ha in Cameroon. Ethiopia has substantial agro-ecological variability that shapes crop production areas across the country [2].

In Ethiopia, a total of 38 thousand hectares of land are used for its cultivation, yielding almost three hundred ninety-five thousand tons per hectare under irrigation and rain-fed conditions. As a compared to the world average, Ethiopia's cabbage production is very low [10.4 t ha^{-1}] [6]. In terms of cabbage productivity, Japan and the Republic of Korea are the top two producers of cabbage in the world with 71.2 and 67.6 t ha^{-1} , respectively [9].

In recent decades, head cabbage has become increasingly important in tropical and subtropical regions. Africa has been estimated to have 1 00,000 hectares planted with head cabbage [1]. At least 40,000 ha of white-headed cabbage is grown in Kenya, Uganda and Tanzania; 10,000 ha in Malawi, Zambia and Zimbabwe; 4000 ha in Ethiopia; and 3000 ha in Cameroon [3]. Several reports have shown that vegetables can be planted throughout the year as long as there is enough moisture in the soil. Smallholder farmers in Kenya grow cabbage for food, income, and it is one of the most important vegetables.

The average cabbage head weighs between 0.5 and 4 kilograms, and it can be green, purple, or white. There are many types of green cabbage, but the most common are those with smooth and firm leaves. Savoy cabbages with smooth leaves and those with crinkle leaves are both uncommon. During the summer, high northern latitudes can experience extended sunny days that encourage cabbages to grow large. Cabbages can be consumed in many ways; they can be soured, fermented, steamed, parboiled, deep-fried, braised, or eaten raw [11].

Conducting cabbage adaptation will be helpful for breeders, seed companies, and farmers to evaluate varieties for adapta-

Table 1: Mean value of Days to head initiation and maturity, Plant height and number of leaves.

S. No	Varieties	DHI	DHM	PH	NL
1	Rossen Seed Variety	69.07ab	106.1b	33.27	14.82b
2	Monarch Seed Variety	63.13a	100.9a	31.79	16.29a
3	Royal Seed Variety	69.93ab	105.5b	33.25	14.47b
4	Green Seed Variety	66.40b	106.1b	32.53	16.53a
5	Delta Seed Variety	70.93c	110c	34.57	14.23b
6	Bakker Brothers Variety	70.40c	109c	33.31	14.20b
	Mean	68.31	106.09	33.12	15.091
	Lsd	2.719	2.34	NS	0.63
	CV	4.4	7		5.7

Means within the same column followed by the same letter (s) are not significantly different at 5% level of significance; LSD: Least Significant Difference; NS: Not Significant; CV: Coefficient of Variation; DHI: Days to Head Initiation; DHM: Days to Maturity, NL: Number of Leaves; PH: Plant Height.

tion to environment and yield, so they can select varieties that are best suited to the local environment and market. The high lands of Bale area have high potential for cabbage production. Improved cabbage cultivars are not yet adequately put under production and majority of the areas in the Bale zone are using unknown variety from unknown source; as a result, the production is resulted in low yield due to the lack of high yielding and disease/insect pest resistant variety/ies and scarcity of improved varieties and low access. Therefore, conducting evaluation of exotic head cabbage varieties is very important to solve these problems and increase income of the farmer.

Material and Methods

Description of the Study Area

The field experiment was conducted during 2021 and 2022 main cropping season at Sinana, Agarfa, and Gobba (Alloshe) locations of Bale zone. Sinana is located 463 Km southeast of Finfinne (Addis Ababa) and it has an altitude of 2400 m above sea level. It is located at 07007'N latitude and 40010'E longitude respectively. The periodic rainfall varies from 346 to 861 mm during the first rainy season (March to July) and 353 to 894 mm during the main season (August to December). The mean temperatures are 9.5 and 21°C (annual min and max respectively). Agarfa is situated at 7° 16' 12.32"N and 39° 49' 28.09"E latitude and longitude respectively and it has 362 km distance from Addis Ababa. Agarfa has Average minimum and maximum temperatures of 80C-230C and 86.34 millimetres average rainfall. Gobba is located about 446 km southeast of Addis Ababa; it has a latitude and longitude of 7°0'N 39°59'E respectively and an elevation of 2,743 meters above sea level. Gobba has average temperature of 8.60C-22.60C, and average rainfall of 1272mm per year. The majority of these woredas population livelihood relies on crop production and livestock production.

Treatments and Experimental Design

For the experiment RCBD with three replications were used. The spacing between plants and rows were 40cm x 50cm respectively, having plot size of 2.8m x 3m (Length and width respectively), each plot was consisted of six rows and seven plants

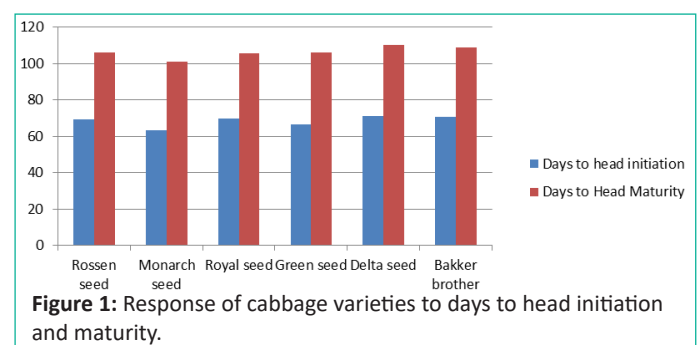


Figure 1: Response of cabbage varieties to days to head initiation and maturity.

Table 2: Mean value of head height and diameter, trimmed and untrimmed head weight, Gross and Marketable yield.

S. No	Varieties	HH	DH	FWUH (gm)	FWTH (gm)	GHY (ton/ha)	MY (ton/ha)
1	Rossen Seed Variety	20.72b	20.25a	2677c	2013c	87.44d	60.03d
2	Monarch Seed Variety	21.67a	21.38ab	3227b	2648b	111.21b	85.42b
3	Royal Seed Variety	20.26bc	18.81c	2700c	2066c	93.28c	65.96cd
4	Green Seed Variety	22.26a	22.08a	3512a	2880a	118.11a	94.15a
5	Delta Seed Variety	19.49c	18.95c	2653c	2093c	91.07cd	64.81c
6	Bakker Brothers Variety	20.19bc	19.63c	2749c	2230c	88.72cd	61.57cd
	Mean	20.76	20.18	2920	2322	98.31	71.99
	Lsd	0.929	1.571	156.8	224.2	5.01	4.88
	CV	6.1	10.7	7.3	13.2	7	9.3

Means within the same column followed by the same letter (s) are not significantly different at 5% level of significance; LSD: Least Significant Difference; CV: Coefficient of Variation; HH: Height of Head; DH: Diameter of Head; FWUH: Fresh Weight of Untrimmed Head; FWTH: Fresh Weight of Trimmed Head; GHY: Gross Head Yield; MY: Marketable Yield

per row. Cabbage varieties those were commercially available on the market Rossen, Royal, Monarch, Green and Delta was used in the study. A widely grown variety Bakker brother was included as check. Cabbage seedlings was raised on bed for one month and then transplanted. The trial was conducted during rainy season and all agronomic practices were applied to all varieties according to recommendations.

Data Management

Data was collected for phenological parameters (Days to head initiation, head maturity), Growth parameters (Plant height, number of expanded leaves per plant), and yield and yield components (Height of head, Diameter of head, Fresh weight of untrimmed and trimmed head, Gross head yield and Marketable yield).

Statistical Data Analysis

All the measured parameters were subjected to analysis of variance (ANOVA) appropriate to factorial experiment in RCBD according to the General Linear Model (GLM) of Gen Stat 15th edition [GenStat, 2012], then the data was subjected to Analysis of Variance (ANOVA) using SAS 9.3 and the interpretations were made following the procedure described by Gomez and Gomez (1984). Least Significance Difference (LSD) test at 5% probability level was used for treatment mean comparison when the ANOVA showed significant differences (Statistical Analytical System, [2003]).

Results and Discussions

Phenological and Growth Parameters of Head Cabbage

The Combined over location analysis from two consecutive years indicated that Days to 50 % head initiation, Days to 90 % maturity, diameter of head and height of head were high significantly [$P < 0.01$] influenced by variety.

From the ANOVA analysis the result indicated that the highest number of days to head initiation [70.93] was recorded for Delta seed variety, while the minimum (63.13) was attained by Monarch seed variety [Table 1]. In terms of days to 90 % head maturity the longest days to head maturity [110] and [109] was recorded from Delta seed and Bakker brothers variety, while the shortest [105.5 and 106.1] was from royal seed and Green seed varieties respectively. In case of number of leaves per plant the highest record [16.53] was from Green seed variety followed by monarch seed variety [16.29], and the lowest [14.20, 14.23, 14.47 and 14.82] was from Bakker brother, Delta seed, Royal seed and Rossen seed varieties respectively. In case of plant height there was no significant difference [$P < 0.05$] among varieties.

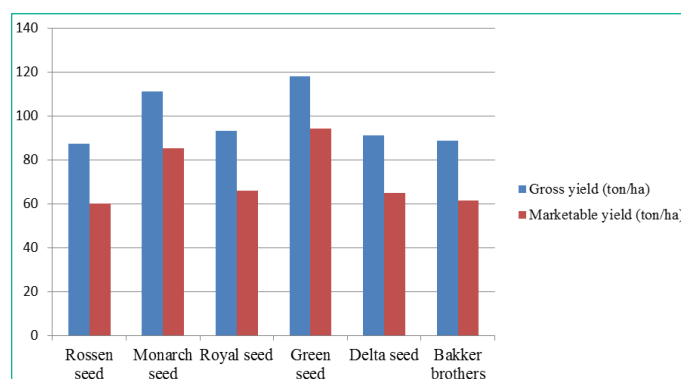


Figure 2: Response of exotic head cabbage varieties to Gross and marketable head yield.

Yield and Yield Components of Head Cabbage

The combined over location and year ANOVA result also showed that different varieties of cabbage had significant [$P < 0.05$] effect on Diameter of head, height of head, fresh weight of trimmed and untrimmed head [Table 2].

The longest head height [22.26] was recorded by green seed variety followed by monarch variety [21.67], while the lowest [19.49] from Delta seed variety. Similarly, the largest diameter of head [22.08] was from green seed variety and the smallest [18.81] from royal seed variety. This result showed that genetic variation among the varieties can influence the growth characteristics of the crop that can have direct positive or negative influence on yield per hectare and its acceptance on the market [Table 2].

On the other hand, ANOVA result showed that these varieties of cabbage had high significantly affect [$P < 0.01$] gross head yield and marketable head yield. The maximum gross head yield [118.11 t/ha] was recorded from the green seed variety and the next from monarch variety [111.21 t/ha] while the lowest [61.57 t/ha] gross head yield per hectare was recorded from Bakker bothers variety [Table 2].

Summary and Recommendation

Head Cabbage is increasingly becoming important vegetable produced for domestic markets. Farmers in the study area were practicing production of cabbage. However, they were not using well adapted and improved seed from known source. In the local market the seed of cabbage sold with small packed materials which have no direction for sowing which means unknown variety from unknown source. Due to these and other agronomic practices production and productivity per hectare was very low. In order to solve problems related to Lack of improved varieties and proper management practice's introduction and adaptation of high yielding varieties with proper agronomic practices are very important. Therefore, this experiment was initiated with

the objective to select varieties those are high yielding, resistant/tolerant to major diseases and insects. To minimize cabbage production constraints, we conduct this experiment using one widely cultivated variety with five improved exotic cabbage varieties at Agarfa, Sinana and Gobba locations of Bale zone, south eastern Ethiopia for two consecutive years by using Randomized complete block design with three replications having plot size of 2.8m x 3m for one experimental unit (plot).

From this study the combined analysis over locations and years indicated that almost all phenological, growth, yield and yield components of cabbage are significantly influenced due to varieties. The maximum gross head yield [118.11 ton/ha] was recorded from the variety green seed followed by Monarch seed variety [111.21 ton/ha], while the smallest number [88.72 ton/ha] was from Bakker brother's variety. Similarly, the highest marketable yield [94.15 ton/ha] was green seed variety, the next also from monarch seed variety [85.42 ton/ha] and the minimum record [61.57 ton/ha] was from Bakker brother's variety.

Generally, from this experiment we get the result that green seed and Monarch seed variety showed best performance in almost all tested agronomic parameters over the tested varieties. Therefore, as the Recommendation, Head cabbage growers at study area and similar agro ecologies should grow green seed and Monarch seed varieties for their short maturity period, good head height and diameter, and best marketable yield that distinguish them from other tested varieties.

Author Statements

Acknowledgement

We thank Oromia Agricultural Research Institute (OARI) for financing this experiment. We also thank the staff of Sinana Agricultural Research Center (SARC) for supplying all logistics during the conducting of the trial. We also acknowledge all Horticulture team of Sinana Agricultural Research Center for data collection and management of the trial.

References

- Adeniji OT, Swai I, Oluoch MO, Tanyongana R, Aloyce A. Evaluation of head yield and participatory selection of horticultural characters in cabbage (*Brassica oleracea* var. *capitata*). *Journal of Plant Breeding and Crop Science*. 2010; 2: 243-250.
- Ahmed MH, Lemma Z, Endrias G. Technical efficiency of maize producing farmers in Arsi Negelle, Central Rift valley of Ethiopia: Stochastic frontier approach. *Poljoprivreda i Sumarstvo*. 2014; 60: 157.
- Aktaş Z, Bakkalbaşı E. Effect of Widely Used Thermal Processes on Surface Color, Total Phenolic Content and Antioxidant Activity of White Cabbage. *Yuzuncu Yil University Journal of Agricultural Sciences*. 2016; 26: 505-511.
- Alamerie K, Ketema M, Gelaw F. Risks in vegetables production from the perspective of smallholder farmers: The case of Kombolcha Woreda, Oromia region, Ethiopia. *Agriculture, Forestry and Fisheries*. 2014; 3: 1-5.
- Bekele A, Kassa B, Legesse B, Lemma T. Effects of crop commercial orientation on productivity of smallholder farmers in drought-prone areas of the Central Rift Valley of Ethiopia. *Ethiopian Journal of Agricultural Sciences*. 2011; 21: 16-34.
- Daniel KAM, Muindi EMD, Muti SMD. Cabbage (*Brassica oleracea*) Production in Kenya: A Review of its Economic Importance, Ecological Requirement and Production Constraints. *International Journal of Plant & Soil Science*. 2023; 35: 245-254.
- Gary TL, Baptiste-Roberts K, Gregg EW, Williams DE, Beckles GL, Miller 3rd EJ, et al. Fruit, vegetable and fat intake in a population-based sample of African Americans. *Journal of the National Medical Association*. 2004; 96: 1599-1605.
- Hussain J, Rehman N, Al-Harrasi A, Ali L, Ullah R, Mabood F, et al. Nutritional prospects and mineral compositions of selected vegetables from Dhoda Sharif-Kohat. *J Med Plants Res*. 2011; 5: 6509-6514.
- Jaskani MJ, Khan IA. *Horticulture: An Overview*. University of Agriculture Faisalabad. 2021.
- Lundberg JO, Feelisch M, Björne H, Jansson EÅ, Weitzberg E. Cardioprotective effects of vegetables: is nitrate the answer?. *Nitric Oxide*. 2006; 15: 359-362.
- Mason AS, Nelson MN, Takahira J, Cowling WA, Alves GM, Chaudhuri A, et al. The fate of chromosomes and alleles in an allohexaploid *Brassica* population. *Genetics*. 2014; 197: 273-283.
- Monteiro A, Lunn T. Trends and perspectives of vegetable *Brassica* breeding world-wide. In *WCHR-World Conference on Horticultural Research*. 1998; 495: 273-280.
- Shah MM, Hassan A, Mahmood Q, Akbar K, Khan MS. Assessment of pesticide residues on selected vegetables of Pakistan. *Journal of the Chemical Society of Pakistan*. 2011; 33: 816.
- Thompson MD, Thompson HJ. Botanical diversity in vegetable and fruit intake: Potential health benefits. In *Bioactive Foods in Promoting Health*. Academic Press. 2010: 1-17.