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# Evaluating the performance of recently released onion (*Allium cepa* L.) varieties at highland areas of West Hararghe, Ethiopia

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**Abstract**
Onion (*Allium cepa* L.) is widely produced by farmers and commercial growers throughout the year for local use and local markets as income generation by farmers and for export market by commercial growers in Ethiopia. Field experiment was conducted during 2018 to 2020 cropping season at highland areas of the west Hararghe aimed at evaluating the performance of recently released onion varieties. Treatments were composed of three released onion (*Allium cepa* L.) varieties such as Nafis; Nasik-Red & Bombay-Redar ranged in a randomized complete block design (RCBD). Onion parameter data were analyzed using R software (R 3.4.1). According to analysis of the variance, onion varieties were showed significant ($p \leq 0.01$) difference for leaf number per plant, highly significant ($p \leq 0.001$) difference for leaf length (cm), plant height (cm) and days to physiological maturity, average bulb weight (gm bulb$^{-1}$), marketable bulb yield (tha$^{-1}$) and significant ($p \leq 0.01$) difference for total bulb yield (tha$^{-1}$) but non-significant ($p \geq 0.05$) difference for unmarketable bulb yield. Hence, the highest leaf number per plant (16), leaf length (45.55 cm), plant height (59.80 cm) were recorded from variety Nafis whereas highest days to physiological maturity (127.25 days) obtained from variety Nasik-Red. In addition, the highest average bulb weight (99.31 gm bulb$^{--1}$), marketable bulb yield (20.05 tha$^{-1}$) &total bulb yield (22.58 tha$^{-1}$) were recorded from variety Nafis. Thus, the result of this study revealed that variety Nafis was superior over rest varieties tested in relation to leaf number, leaf length, plant height, average bulb weight, marketable bulb yield and total bulb yield. Hence, variety Nafis caused additional leaf number (28%), leaf length (33.8%), plant height (23.66%), average bulb weight (26.27%), marketable bulb yield (20.85%) and total bulb yield (21%) as compared to onion varieties with lowest results of these traits. Therefore, since variety Nafis was superior over rest varieties in these parameters, could be recommended for study areas to maximize productivity and production of onion.

**Keywords:** Additional bulb yield, released onion varieties, marketable bulb yield, yielding potential

## 1. Introduction
The onion (*Allium cepa* L.) cropis one of the most important vegetable crops commercially grown in the world. According to Bagali *et al*. (2012) [2], onion is originated in Central Asia between Turkmenistan and Afghanistan where some of its relatives still grow in the wild. As reported by Bassett (1986) [3], onion is belonging to family Alliaceae and widely grown herbaceous and biennial vegetable crop with cross-pollinated and monocotyledonous behavior having diploid chromosomes number 2n = 16. It is in the genus *Allium* and recent estimations accept about 750 species in the genus *Allium*, among which onion, Japanese bunching onion, leeks, and garlic are the most important edible *Allium* crops. Rabinowitch and Currah (2002) [23] reported that about 60 taxonomic groups at sub-generic, sectional and sub-sectional rank. Onion is one of the oldest cultivated vegetables which traced back to at least 5000 years and has been in cultivation for more than 4000 years.

In the worldwide, production of onion is increasing due to its wide benefits in our daily foods requirements. Opara (2003) [22] reported that onion is largely produced in the developed nations and has dominated in the international markets due to its higher quality production and longer storage life. However, the extent of the onion production varies from country to country. China is the top producer of world's onion followed by India and USA (Manna, 2014) [17]. The world's total onion production is 742.51 million tons per annum out of which China shared 205.08 million tons, India (133.72 million tons), and the USA (33.21 million tons) respectively (FAO,

2012) [10], regarding onion export, the Netherlands is the world's largest onion exporter with a total of around 220,000 Metric tons followed by India (FAO, 2012) [10].

In Africa, the status of onion production is varying spatially across the Continent. Egypt is leading country by producing 22.08 million tons of onion per year for domestic and international markets that rank as the fourth of world producer (Kulkarni *et al*., 2012) [16].

In Ethiopia, onion is economically important vegetable crop and widely produced for local market and export besides for local consumptions. It is widely cultivated as a source of income by many farmers in the country as a whole. Onion production in the country is increasing from time to time. In Ethiopia, total area on which onion planted was about 36.4 million hectares with a total production of 273,859 tons. The total production and the total cultivated land area for onion increased by 18.7% and 59.7% respectively between 2015 and 2020. Nevertheless, the productivity of onion was declined by 25.7 percent over the same production period (CSA, 2020) [6]. Similarly, according to the survey data of Central Statistical Agency (CSA) (2020) [6] from 2015 to 2020 the low yield from farmers' practices as compared to the potential yield (40,000 kg per hectare) on research stations was recorded.

Onion (*Allium cepa* L.) is a popular vegetable and its bulb is used raw, sliced for seasoning salads, and cooked with other vegetables and meat. The leaves, whole immature plants called 'salad onion' or leafy sprouts from germinating bulbs are used in the same way. In some parts of West Africa, leaves still green at bulb harvest are propounded, and then used to make sun-dried and fermented balls, which are used later for seasoning dishes. Sliced raw onions have antibiotic properties, which can reduce contamination by bacteria, protozoa or helminthes in salads (Grubben and Denton, 2004) [14]. It is grown primarily for its bulb which is used for flavoring the local stew'/wet which is considerably important in the daily diet, mostly used as seasonings or as vegetables in stews. In addition, it serves as sources of work opportunity and income generation: example; in 2013 Ethiopia exported 220,213 tons of vegetables and generated USD 438 million (Fufa, 2017) [11]. Onion is one of the richest sources of flavonoid in the human diet and flavonoid consumption has been associated with a reduced risk of cancer, heart disease and diabetes. In addition it is known for anti-bacterial, antiviral, anti-allergenic and anti-inflammatory potential (MoARD, 2009) [20].

In Ethiopia, onion can be produced twice per year both under the irrigation and rain feed conditions in different parts of the country (Belay *et al*., 2015) [6]. However, the production and productivity of the crop are far below (10.02 $tha^{-1}$) the world average (19.7$tha^{-1}$) despite to its year-round production scenarios (FAO, 2012) [10]. The low productivity and production of onion crop in Ethiopia is caused by various biotic and abiotic factors. As reported by Esheteu *et al*. (2006) [9], pests and diseases, coupled with a low level of improved agricultural technology, recurrent droughts, and decreases in soil fertility levels are some of the major contributors to the low and unstable onion bulb yields in Ethiopia.

The lower productivity of onion is resulted from various factors. Bedru *et al*. (2009) [4] reported that low productivity of onion was due to old variety, limited availability of quality seeds, disease and low adoption of recommended production package. Moreover, the low bulb yield results of onion indicate that presence of a wide gap in production and productivity in the country due to lack of improved cultivars, application of inappropriate agronomic practices and limited attention/awareness on the benefits of intensive production (FAO, 2012) [9].

Furthermore, study site of west Hararghe highlands is potential area for onion production however, its productivity and production is constrained by biotic and abiotic factors specially lack of improved onion variety suitable for the study area is the major problem that affecting productivity and production of onion crop. Therefore, objective of the experiment was to evaluate the performance of recently released onion varieties for study area of the west Hararghe highlands.

## 2. Materials and Method

### 2.1. Experimental Area Description

Field experiment was conducted during 2018 to 2020 cropping seasons at highland areas of west Hararghe. West Hararghe Zone is located at 8° 39' 59.99" N latitude and 40° 29' 59.99" E longitudes (Nigus *et al.*, 2022) [21]. Moreover, this Zone is subdivided into three major climatic Zones namely highland locally known as Dega (12.49%), midland known as Woinadega (38%) and lowland locally known as Kola (49.5%). The topography of west Hararghe is characterized by steep slopes in the highlands and mid-plains in the lowland areas. Mean monthly temperature range of west Hararghe is from 20.5-24 ºC (Nigus *et al.*, 2022) [21]. Similarly, the rainfall of west Harargheis dispersed and the year is classified in to two rainy seasons, Belg from February to April and Meher or the main season rainfall from June to September with small showers in dry months. The average annual rainfall is ranged from 600-2000 mm for higher elevations of Woinadega and Dega areas, and altitude of west Hararghe is ranged from 1200–3600 M.A.S.L. (Nigus *et al.*, 2022) [21].

### 2.2. Treatments and Experimental Procedures

A single factor field experiment was conducted during 2018 to 2020 cropping seasons aimed at evaluating the performance of recently released onion (*Allium cepa* L.) varieties. Hence, treatments were composed of three onion varieties such as Nafis, Nasik-Red& Bombay-Red and arranged in a randomized complete block design (RCBD) with four replications. Details about the onion variety treatments presented in the (Table 1).

**Table 1:** Descriptions about the released onion varieties evaluated

| Name of varieties | Day to maturity | Average fruit weight $bulb^{-1}$ (gm) | Total bulb yield (kg) Research station | Types |
|---|---|---|---|---|
| Nafis | 90-100 | 100 - 130 | 49,000 | OPV |
| Nasik-Red | 90-115 | 85 -100 | 30,000 | OPV |
| Bombay-Red | 90-100 | 85 -100 | 30,000 | OPV |

OPV = Open pollinated variety, Source: Zeleke and Derso, (2015); MoANR (2018) [25, 19].

### 2.3. Land preparation, Sowing and Transplanting

After the nursery area preparation, three level seed beds of 5m x 1m (5$m^2$) sized were prepared for the three onion varieties separately. Before sowing, the soil of seed beds was top dressed with100gm NPS fertilizer to improve nutrient content of the soil of beds. After top dressing of the NPS fertilizer, seeds were sown in rows at 15cm a part between rows and covered with light soil and then seed beds were mulched with 3cm thick dry grass.

After sowing and mulching, seed beds were watered properly using watering can and also watering operation was carried out every day and continued until the onion seeds get germinated and then done every two days and twice in a week interval. Accordingly, to get vigor seedlings, relevant activities such as weeding, hoeing, thinning and shade construction were done. Before transplanting, the experimental field was tilled and divided into four blocks and twelve (12) individual plots of 2.8 x 2m (5.6 $m^2$) sized to accommodate 18 and 126 plants per row and per plot respectively. When onion seedlings were attained transplanting height of 15-25 cm with 3-4 true leaves, carefully uprooted and transplanted to a well-prepared experimental plots at 40 cm x 10 cm inter-row and intra-row spacing respectively. Regarding fertilizer application, 200 $kgha^{-1}$ NPS and 100 k $gha^{-1}$ Urea were used: 150 kg NPS was applied at sowing, 25 kg NPS & 50 kg Urea were applied after 15 days of transplanting and the remaining 25 kg NPS & 50 kg Urea were applied after 45 days of transplanting. Fertilizer application operation was done according to procedures given by Miruts *et al*. (2021) [18].

### 2.4. Data Collection and Measuring

#### 2.4.1. Growth and Phonological Parameter Data of Onion (*Allium cepa* L.) Crop

Under this parameter, plant trait data collected were leaf number per plant, leaf length (cm), plant height (cm) and days to physiological maturity. These parameter data were collected and determined using different procedures. Hence, leaf number per plant was counted from 10 randomly selected representative plants in the middle rows of each experimental plots and then average values per plant were used for analysis.

Leaf length was measured in centimeter using meter tape from 10 randomly selected representative plants from middle rows of each experimental plots and average leaves length was taken for analysis. Plant height was determined from 10 randomly selected sample plants from middle rows of each experimental plot and measured the plant height from the base of the plant to tip of the plant using meter tape and the average values were used for analysis. Days to physiological maturity was determined by counting the actual number of days from date of sowing until 90% of the leaves of the plant senesced and attained harvest maturity from middle rows of each experimental plot and it was agreed with the procedure given by EARO (2004) [8].

#### 2.4.2. Bulb Yield and Bulb Yield Component Parameter Data of Onion (*Allium cepa* L.) Crop

This parameter encompassed onion traits like average bulb weight (gm $bulb^{-1}$), marketable bulb yield ($tha^{-1}$), unmarketable bulb yield($tha^{-1}$) and total bulb yield($tha^{-1}$) were collected and determined using different techniques and procedure. Hence, average bulb weight was determined using 10 randomly selected representative plant bulbs from middle rows of each experimental plot and weighed using sensitive balance and then the average values per bulb were taken for analysis.

Marketable bulb yield ($tha^{-1}$) was determined by taking those bulbs which were free from split, dense necked and unpleasant bulbs which harvested from the middle rows of each experimental plot, weighed using sensitive balance and it was calculated in ton basis per hectare and the average values used for analysis. Unmarketable bulb yields ($tha^{-1}$) were determined by considering under sized, contaminated, rotten, disordered, physiologically thick-necked and divided bulbs which were harvested from middle rows of each experimental plot as unmarketable bulb yields, weighed, computed in ton basis per hectare and the average values were used for analysis. Likewise, the total bulb yield ($tha^{-1}$) was determined by taking the summation of marketable and unmarketable bulb yields harvested from net area of each experimental plot were weighed using sensitive balance and computed in ton basis per hectare and the average values were used for analysis.

### 2.6. Statistical Data Analysis

All collected onion (*Allium cepa* L.) data were analyzed using R software (R 3.4.1) and least significant difference (LSD) at 5% probability level was used for mean separation when analysis of variance indicates the presence of significant difference among treatments (Gomez and Gomez, 1984) [13].

## 3. Results and Discussion

### 3.1. Growth and Phonological Parameters of Onion (*Allium cepa* L.)

#### 3.1.1. Leaf Number

The combined analysis of variance over the three years showed that onion varieties were significantly different at $p \leq 0.01$ probability level in relation to leaf number per plant (Table 2). In line with the finding of Tadese *et al*. (2022) who reported that there was significance difference ($p < 0.05$) among varieties for leaf number. Leaf number per plant results (11.5, 12 and 16) were statistically different, and they were in ranged from 11.5 - 16 leaf number per plant.

Likewise, for further comparison, the onion varieties with leaf number results were arranged in a descending order of values as variety Nafis was caused the leaf number per plant (16), Nasik-Red (12) and Bombay-Red (11.5) leaf number per plant respectively. Hence, with this arrangement, the highest (16) leaf number per plant was recorded from variety Nafis whereas the lowest (11.5) leaf number per plant obtained from variety Bombay-Red followed by Nasik-Red (12) (Table 2). However, the result was disagreed with the findings of Tadese *et al*. (2022) who reported that the lowest (8.54) leaf number per plant was obtained from variety Nafis. Regarding leaf lumber results, variety Bombay-Red and Nasik-Red were not statistically different.

The difference between maximum and minimum leaf number per plant was about 4.5. This is to show that variety Nafis was produced 28% additional leaf number over variety Bombay-Red. This also confirming the superiority of variety Nafis over Bombay-Red in relation to leaf number per plant. In addition, since the presence of more number of leaves per plant enables enhanced photosynthesis rate, an onion variety with the highest leaf number per plant could be an indication of better performance and high yielding potential and also it could be the criteria for variety selection.

#### 3.1.2. Leaf Length (cm)

The combined analysis of variance over the three years showed that leaf length was highly significantly ($p \leq 0.001$) affected by onion varieties (Table 2). In agreement with the finding of Tadese *et al*. (2022) who reported that there was significance difference ($p \leq 0.05$) among varieties for leaf length of onion. Analyzed leaf length results (30.10cm, 35.15cm & 45.55cm) were statistically different and ranged from 30.15- 45. 55cm. Moreover, leaf length results with related onion varieties were also arranged in a descending order of values: variety Nafis was attained leaf length of 45.55cm, Nasik-Red (35.10cm) and Bombay-Red (30.15cm) leaf length respectively.

This arrangement showing that the highest (45.55cm) leaf length was recorded from variety Nafis. However, the lowest (30.15cm) leaf length was caused by variety Bombay-Red. This result is on the contrary with the finding of Tadese *et al*. (2022) who reported that the lowest (34.68 cm) leaf length was obtained from variety Nafis. But regarding leaf length results, variety Bombay-Red and Nasik-Red were statistically at par.

The range between the longest and shortest leaf length was about 15.4 cm. This is showing that variety Nafis was caused 33.8% additional leaf length over Bombay-Red. Which is confirming the superiority of variety Nafis over variety Bombay-Red in leaf length. On the other hand, the differences among onion varieties in relation to leaf length might be because of genotypic variability among them

### 3.1.3. Plant Height (cm)

As indicated from analysis of variance, onion varieties were highly significantly ($p \leq 0.001$) different in relation to plant height results. It is in line with the report of Gebretsadkan *et al*. (2018) [12] who revealed that improved onion varieties were showed significant difference for plant height. Plant height results were statistically different from one another and ranged from 45.65 - 59.8cm.In disagreement with the finding of Zeleke *et al*. (2021) [26] who reported that plant height results were raged from 56.54 to 65.24 cm with a mean of 60.35 cm. In addition, plant height results with related onion varieties were expressed by arranging them in a descending order of values to compare one to another: variety Nafis caused a plant height of 59.8cm, Nasik-Red (50.40cm) and variety Bombay-Red (45.65cm) respectively.

Hence, the highest (59.8cm) plant height was recorded from variety Nafis whereas lowest (45.65cm) was obtained from variety Bombay-Red. This result is agreed with the finding of Zeleke *et al*. (2021) [26] who mentioned that the longest plant height was recorded from variety Nafis (65.24 cm).The range between maximum and minimum plant height values was 14.15cm. This is to show that variety Nafis attained the highest plant height with 23.66% increase over variety Bombay-Red. This is also confirming the superiority of variety Nafis over Bombay-Red in relation to plant height of onion.

### 3.1.4. Days to Physiological Maturity

Days to physiological maturity results of onion were significantly ($p \leq 0.001$) influenced by onion varieties (Table 2).This in in line with the finding of Zeleke *et al*. (2021) [26] who reported that the combined analysis of variance showed that improved onion varieties were significantly different in days to physiological maturity. According to report of Kahsay*et al*. (2014) who expressed that improved onion varieties showed significant differences for days to physiological maturity. Also similar idea was reported by Gebretsadkan *et al*. (2018) [12].

Analyzed days to physiological maturity results (120.75 days, 123.50 days &127.25 days) were statistically different from one another (Table 2). Accordingly, days to physiological maturity results were in range of 120.75 - 127.50 days. Based on this result, onion varieties were attain their physiological maturity in different day lengths as variety Bombay-Red was in 120.75 days, Nafis in 123.50 days & Nasik-Red in 127.25 days (Table 2). Therefore, the longest (127.25) days to physiological maturity was recorded from variety Nasik-Red (Table 2).However, the shortest (120.75) days to maturity was caused by variety Bombay-Red (Table 2). The difference between longest and shortest days physiological maturity was about 7 days. Implying that variety Nasik-Red needs additional 7 days to attain its physiological maturity as compared to variety Bombay-Red.

On the other side, the observable differences among onion varieties regarding plant height results were might be because of genotypic variability among them. In agreement with the report of Zeleke *et al*. (2021) [26] who showed that variation in maturity days among onion varieties might be due to their inherent genetic difference. The reason for the longest (127.25) days to physiological maturity with variety Nasik-Red was could be due to genetic potential of a given variety to cause longest plant height of onion while the production of the shortest (120.75) days to maturity was might be due to its narrow genetic potential to cause the shortest plant height of onion crop.

**Table 2:** Combined mean leaf number per plant, leaf length, plant height and days to physiological maturity influenced by onion variety treatments

| Variety Treatments | Leaf Number per Plant | Leaf Length(cm) | Plant Height(cm) | Days to Maturity (days) |
|---|---|---|---|---|
| Nafis | 16.00$^a$ | 45.55$^a$ | 59.80$^a$ | 123.50$^b$ |
| Nasik- Red | 12.00$^b$ | 35.10$^b$ | 50.40$^b$ | 127.25$^a$ |
| Bombay-Red | 11.50$^b$ | 30.15$^b$ | 45.65$^c$ | 120.75$^c$ |
| LSD (0.05) | 3.602 | 8.024 | 3.82 | 0.865 |
| CV% | 15.81 | 12.56 | 4.25 | 6.404 |
| Significant level | * | ** | ** | ** |

## 3.2. Bulb Yield and Bulb Yield Components of Onion (*Allium cepa* L.)

### 3.2.1. Average Bulb Weight (gmbulb$^{-1}$)

The average bulb weight is a bulb yield component of onion, and it was significantly impacted by onion varieties at $p \leq .01$ probability level (Table 3).In agreement with the finding of Tadese *et al*. (2022) who reported that there was significance difference ($p \leq 0.05$) among varieties for average bulb weight. It is also in line with the finding of Zeleke *et al*. (2021) [26] who mentioned that analysis of variance showed that significant difference between improved onion varieties in relation to average bulb weight in gm.

Thus, analyzed average bulb weight results (73.22gm, 87.88 gm & 99.31 gm) were statistically different and they were in range of 73.22 to 99.31 gm. Likely, onion varieties were caused different average bulb weight results: variety Nafis was produced average bulb weight (99.31 gm), variety Bombay-Red (87.88 gm) and variety Nasik-Red (73.22 gm) respectively (Table 3).This is showing that the highest average bulb weight (99.31gm)was recorded from variety Nafis while the lowest (73.22gm) average bulb weight was obtained from variety Nasik-Red. (Table 3). It is in agreement with the findings of Zeleke *et al*. (2021) [26] who showed that Variety Nafis was produced the maximum average bulb weight (89.68 g) followed by Bombay Red (84.72 g). But on the contrary with the finding of Tadese *et al*. (2022) who reported that the highest average bulb weight (92.79 g) was obtained from Bombay- Red.

The difference between highest and lowest average bulb weight was about 26.09 gm. This shows that variety Nafis was produced 26.27% additional average bulb weight as compared to variety Nasik-Red. As variety Nafis was produced 26.27% additional average bulb weight over variety Nasik-Red, confirming superiority of variety Nafis over variety Nasik-Red. Moreover, since an average bulb weight has direct effect on bulb yield of onion, then a variety with the highest average bulb weight is an indication of high yielding potential and better performance.

### 3.2.2. Marketable Bulb Yield ($tha^{-1}$)

Marketable bulb yield is the component of total bulb yield. According to analysis of variance, onion varieties were significantly different at *p*≤.01 probability level in relation to marketable bulb yield (Table 3). This is in line with the finding of Tadese *et al*. (2022) who reported that there was significance difference (*p*≤ 0.05) among varieties for marketable bulb yield. It is also in agreement with the finding of Zeleke *et al*. (2021) [26] who mentioned that the combined. Similarly, Gebretsadkan *et al.* (2018) [12] reported that improved onion varieties were showed significant difference for marketable bulb yield $tha^{-1}$.

Marketable bulb yield results (15.87 $tha^{-1}$, 17.64 $tha^{-1}$ & 20.05 $tha^{-1}$) were statistically different and also ranged from 15.87-20.05 $tha^{-1}$ (Table 3). Moreover, onion varieties were found to show different marketable bulb yield results. Variety Nafis was produced the marketable bulb yield of 20.05$tha^{-1}$, variety Bombay-Red (17.64$tha^{-1}$) and variety Nasik-Red (15.87$tha^{-1}$) respectively. Hence, the highest (20.05$tha^{-1}$) marketable bulb yield was produced by variety Nafis whereas the lowest (15.87$tha^{-1}$) marketable bulb yield obtained from variety Nasik-Red (Table 3). This result is in agreement with the finding of Miruts *et al*. (2021) [18] who reported that the highest mean bulb yield was recorded from Nafis with a 45 percent yield increment over Bombay-Red. However, marketable bulb yield obtained from Nasik-Redwas on the contrary with the report of Bedru *et al*. (2009) [4] who mentioned that bulb yield increment was caused byvariety Nasik-Red as compared to Bombay-Red. It was alsoin disagreement with the findings of Tadesse *et al*. (2022) who explained that the highest bulb yield was obtained from variety Bombay red followed by the varieties Melkam.

Variety Nasik-Red and Bombay-Red were not statistically different from each other in relation to marketable bulb yield (Table 3). The range between maximum and minimum marketable bulb yield was about4.18$tha^{-1}$.This is to show that variety Nafis was produced the highest marketable bulb yield with 20.85% increase over variety Nasik-Red. The observable differences among onion varieties in marketable bulb yield could be due to genetic variability among them. In line with the idea of Zeleke *et al*. (2021) [26] who reported that the differences in marketable bulb yield might be due to genetic variation among onion varieties. The reason for variability among onion varieties in relation to marketable bulb yield might be because of genetic potential differences among them.

Furthermore, onion variety with highest marketable bulb yield is an indication of best performance and yielding potential and also these characteristics could be because of genotypic variability among varieties and then could be the main criteria for the variety selection.

### 3.2.3. Total Bulb Yield ($tha^{-1}$)

Total bulb yield is summation of marketable and unmarketable bulb yield. The combined total bulb yield results were significantly (*p*≤.01) affected by onion varieties (Table 3). In disagreement with the finding of Zeleke *et al*. (2021) [26] who expressed that analysis of variance showed that improved onion varieties were non-significantly different in total bulb yield in $tha^{-1}$. Similarly, in disagreement with the report of Addis (2020) [1] who revealed that improved onion varieties were showed non-significant difference for total bulb yield.

With this, analyzed total bulb yield results (17.84$tha^{-1}$, 21.62$tha^{-1}$& 22.58$tha^{-1}$) were statistically different from one another and ranged from 17.84-22.58$tha^{-1}$.The analysis of variance showed that onion varieties were caused different average bulb weight results as variety Nafis (22.58 $tha^{-1}$), variety Bombay-Red (21.62$tha^{-1}$) and Nasik-Red (17.84 $tha^{-1}$) respectively (Table 3).

Hence, leading highest (22.58 $tha^{-1}$) total bulb yield was recorded from variety Nafis followed by variety Bombay-Red (21.62$tha^{-1}$) whereas the lowest (17.84 $tha^{-1}$) total bulb yield was obtained from variety Nasik- Red. However, variety Nafis and Bombay-Red were statistically at par in total bulb yield. The difference between leading highest and lowest total bulb yield was 4.74 $tha^{-1}$. Which is indicating that variety Nafis was produced21% additional total bulb yield over variety Nasik-Red. The reason for variability among onion varieties in relation to total bulb yield might be because of genetic potential variations among them.

**Table 3:** Combined mean bulb weight, marketable bulb yield, unmarketable bulb yield and total bulb yield influenced by onion variety treatments

| Treatments | Bulb weight (gm $bulb^{-1}$) | Marketable bulb yield ($tha^{-1}$) | Un-marketable bulb yield ($tha^{-1}$) | Total bulb yield ($tha^{-1}$) |
|---|---|---|---|---|
| Nafis | $99.31^{a}$ | $20.05^{a}$ | 2.53 | $22.58^{a}$ |
| Nasik- Red | $73.22^{c}$ | $15.87^{b}$ | 1.97 | $17.84^{b}$ |
| Bombay-Red | $87.88^{b}$ | $17.64^{b}$ | 3.99 | $21.62^{a}$ |
| LSD(0.05) | 10.34 | 1.95 | 2.27 | 3.03 |
| CV% | 6.88 | 6.31 | 26.49 | 8.46 |
| Significant level | ** | ** | NS | * |

## 4. Conclusion and Recommendations

Field experiment was conducted during 2018 to 2020 cropping season at onion potential areas of west Hararghe highlands using three recently released onion varieties (Nafis, Nasik-Red & Bombay-Red) under supplementary irrigation conditions. West Hararghe highlands of study site is potential area for onion production. At west Hararghe highlands of study area, farmers have been producing onion crop for consumption and market purposes since right now, however, its productivity and production is very low due to lack of improved onion varieties suitable for the study site, and then farmers obliged to use local onion variety which is low yielder. Hence, the productivity and production of onion could be maximized using improved onion varieties suitable for the study area. Based on result of this study, variety Nafis showed best performance in bulb yield and bulb yield components over rest onion varieties evaluated. Therefore, variety Nafis could maximize productivity and production of onion crop and recommended for the study site.

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