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Evaluation of the Off-season Production of Bulb Onion (*Allium cepa* L.) in Mongar

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ABSTRACT

Bulb onion is one of the important commercial crops cultivated by the farmers in all the districts, and onion has been identified as one of the mandatory vegetable crops in Bhutan. The crop requires about five to six-month growing period from sowing till harvest. The harvest season coincides with the onset of the monsoon season and post-harvest losses due to high humidity and poor post-harvest management are high. With steady demand for the crop throughout the year and low domestic production, the current production cannot meet the market demand. Hence, substantial quantities of bulb onion are imported. Promotion of off-season bulb onion production with the harvest season during the dry season could minimize post-harvest losses and make it available in the market all year round. The objective of this experiment was to evaluate two bulb onion varieties, namely Pune Red and Pink onion 1358 for off-season production. The experiment was conducted at Lingmethang (600 masl) and Wengkhar (1650 masl) in the 2022 cropping season in a Randomized Complete Block Design (RCBD) with three replications and two treatments. The results indicate a significant difference ($P < 0.05$) in bulb height, weight, plant height, and neck diameter but no significant difference in bulb width. The maximum bulb weight 306.7 g was recorded at the Lingmethang station in the Pink 1358 variety. The yield obtained was 18.68 MT/acre for Pink 1358, 19.20 MT/acre for Pune Red at Lingmethang station, and 13.35 MT/acre for Pink 1358, 13.08 MT/acre for Pune Red at Wengkhar station. However, there was no significant difference ($P >0.05$) in yield in both stations. This study found that bulb onion production is feasible between August to March months in the mid-elevations upto 1650 masl. However, the best location for bulb onion production would be in the lower elevation where the yields are higher compared to the mid-elevation.

Keywords: *Bulb onion; Variety; Bulb characteristics; Yield*

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1 Introduction

Onion (*Allium cepa* L.) which is also called bulb onion belongs to the Amaryllidaceae family and most widely cultivated species of this genus. The crop is believed to have originated from Central Asia and it is a widely grown and consumed vegetable in the world (Saxena & Kumar, 2023). Bulb onions have gained importance due to its cash crop value and high export potential. Onion is mostly used as a spice during the preparation of different dishes such as meat, vegetables, and dal. It is also consumed as fresh salad and used in preparation of pickles. It is characterized by its distinctive flavour and pungency which is due to Allylpropyl disulphide, a sulphur-containing compound found in the scales of the bulb. And the outer skin colour which is red and yellow is due to the presence of anthocyanin and quercetin (Choudhary, 2018). It is also a good source of carbohydrates, fat, protein, vitamins, minerals, and high antioxidants that have several health benefits (Bhaskar, Tailor, Sharma, Singh, & Gupta, 2018).

Onion is a cool-season vegetable that requires and grows well under mild climates without extreme heat or cold or excessive rainfall. The optimum temperature for vegetative growth is 13°C to 24°C and bulb formation is 20°C to 25°C. For vegetative growth lower temperature combined with a short photoperiod is required whereas a relatively higher temperature along with a longer photoperiod is required for bulb development and maturity (Choudhary, 2018).

In Bhutan, bulb onion is one of the important commercial crops cultivated by the farmers in all the *Dzongkhags* (Districts). Bulb onion has been identified as one of the mandatory vegetable crops in the country and farmers are encouraged to take up cultivation on a large scale. The highest bulb onion production in a *Dzongkhag* in 2022 was Punakha with 28.03 MT, followed by Dagana with 27.56 and Tsirang with 27.01 MT. Overall production in 2022 in the country was 264.80 MT from 288.28 acres of harvested area (NSB, 2022).

With steady demand for the crop throughout the year and low domestic production, the crop cannot meet the domestic market demand. The domestic production yield per acre for the last three years was about 1067 kg/acre in 2020, 1008 kg/acre in 2021, and 920 kg/acre in 2022, and in the year 2022 bulb onion production was the lowest compared to other major vegetables (NSB, 2022). To meet the consumer demand, Bhutan imported about 6329.70 MT of onions and shallots in 2022 (DRC, 2022).

The Department of Agriculture thus far has released six bulb onion varieties for cultivation in the country (DoA, 2023). The most popular variety that has been cultivated by the farmers are

Bombay and Pune Red bulb onions and recently a new variety Pink 1358 has been released for cultivation.

Bulb onion production was encouraged after the cultivation of paddy in the paddy fields. The cultivation season begins from October to November for sowing, nursery raising, and harvesting in the May-June months (Phuntsho, Tshering, & Tamang, 2018; Tomiyasu et al., 2018). The crop requires about a five to six-month long growing period from sowing till harvest. The harvest season coincides with the onset of the monsoon season and post-harvest losses due to high humidity and poor post-harvest management are high. Post-harvest losses are due to rotting, sprouting, physiological loss in weight, and moisture evaporation from bulbs which results in serious losses with more than 50 percent of the harvest depending upon the variety and the storage conditions (Sharma & Chauhan, 2022).

To promote bulb onion in the country, promotion of off-season bulb onion production is encouraged as an alternative to have the crop for year-round available in the market. It also aims to harvest the bulbs during the dry season which could minimize post-harvest losses. In India, bulb onions are grown throughout the country in three seasons, *Kharif* (July-December), late *kharif* (October-March), and *rabi* (December-May) season but the major production is during the *rabi* season (Sable, Saras, & Patel, 2023). In our context, onion production is usually done once a year, where the nursery raising is carried out from October to November and harvested in the May to June months. To study and explore the feasibility of bulb onion production in other seasons of the year, this experiment was designed and planted in the off-season with the expected harvest during February and March months. Two existing onion varieties Pune Red and Pink onion 1358 was used in this experiment with the primary objective to evaluate the varieties for off-season production.

2 Materials and Method

The experiments were conducted at the Agriculture Research and Development Center, Wengkhar (27°16'12.42" N and 91°16'20.06" E) at 1650 meters above mean sea level (masl), and at the Agriculture Research and Development Sub-Center, Lingmethang (27° 15' 39.43" N and 91° 10' 46.13" E) at 650 masl. Two varieties of onion Pink 1358 and Pune Red were used for the experiment. Nursery at Lingmethang was raised on 2nd August 2022 and transplantation was carried out on 22nd September 2022. At Wengkhar the nursery was raised on 10th August 2022 and transplantation was carried out on 4th October 2022. The experiment was established in a Randomized Complete Block Design (RCBD) for two treatments (Treatment 1 Pink 1358

and Treatment 2 Pune Red) with three replications each in both stations. Each experimental plot was established measuring a plot size of 3 m² (3 m in length and 1 m in width) and 15 cm in bed height. About 30 kg of well-decomposed Farm Yard Manure (FYM) was applied to all the experiment plots and incorporated into the soil. The seedlings were transplanted at a distance of 20 cm row to row and 10 cm plant to plant after 52 days of sowing at Lingmethang and 70 days at Wengkhar. The seedlings were irrigated immediately after the transplanting and the crops were then irrigated when the soil moisture was dry. Standard crop management practices through nursery till harvest were followed in both stations. Data collection and monitoring of the crop were carried out timely. The crop was harvested on 27th February 2023 at Lingmethang and on 15th March 2023 at Wengkhar when more than 50% of bulb necks were fallen.

Data such as plant height, bulb height, bulb diameter, bulb weight, yield, pest, and diseases were collected from the experiment. Plant height was measured by a one-meter scale. Bulb weight and yield were measured using a digital weighing balance (Tanita KD-320) and bulb diameter and height were measured using a digital Vernier caliper (UYUSTOOLS, Stainless CLD 006). Pests and diseases were identified visually according to the manual. The data were statistically analyzed for both stations using the Statistical Tool for Agricultural Research (STAR) version 2.0.1. Analysis of variance (ANOVA) and Post Hoc test were carried out at a significance level of 0.05.

3 Results and Discussion

3.1 Bulb characteristics

The bulb characteristics as shown in Table 1, indicate a significant difference *($P < 0.05$)* in bulb height and weight but no significant difference in bulb width. The maximum bulb weight 306.70 g was recorded at the Lingmethang station in the Pink 1358 variety. Bulb height was also recorded highest in the Pink 1358 variety at Lingmethang station. Similar results were reported in the study conducted in Nepal, the interaction between the transplantation time and varieties showed no significant difference in the bulb diameter of the onion (Gautam, Khatri, & Paudel, 2006). However, the larger bulb onion plants produced larger bulbs, as the onion plant height, sheath diameter, and leaf number were positively correlated with average bulb weights (Nourbakhsh & Cramer, 2022).

Significant difference was observed in the plant height and bulb neck diameter *($P < 0.05$)*. The variety Pink 1358 was taller in both stations. A thick bulb neck was also found in the Pink 1358

variety compared to the Pune Red in both stations. The thickness of the bulb onion neck is an important characteristic that needs to be considered for the bulb storage. Onions with a thin neck diameter store better than those with a thick diameter (Gautam et al., 2006), and for the longer duration storage Pune Red will have an advantage over Pink 1358 due to its thin neck compared to the Pink 1358. A thick bulb neck also takes a longer duration to dry the bulb after harvesting and has a high risk of infection during postharvest storage (Ratan, Gowda, & Pandey, 2017).

Table 1. Bulb onion characteristics

Station	Variety	Mean				
		Bulb Height (mm)	**Bulb Width (mm)**	**Bulb Weight (g)**	**Plant Height (cm)**	**Neck Diameter (cm)**
Lingmethang	Pink	90a	83.69	306.7a	51.1a	2.84a
	Pune	63.75b	78.02	179.9b	39.4b	2.16b
	CV %	6.17	13.25	32.64	14.27	11.53
Wengkhar	Pink	79.5	76.7a	164.57a	50.8a	2.75a
	Pune	53.2	68.2b	210.57b	39.7b	2.13b
	CV %	12.42	7.3	26.82	12.66	13.59

Means in the column with different letters are significantly different at (P <0.05)

3.2 Yield

The yield obtained indicates that there was no significant difference *(P >0.05)* in both stations as shown in Figure 1. The yield was higher at Lingmethang station which is 17.33 kg/3m² plot for Pink 1358 and 19.65 kg/3m² for Pune Red compared to Wengkhar which has 9.9 kg/3m² for Pink 1348 and 9.7 kg/3m² for Pune Red variety. This indicates that the bulb onion production from August to March month could be better in the lower elevations compared to mid-elevation at Wengkhar which has an altitude of 1650 masl. This could be because onions require higher temperatures during bulb formation while it prefers low temperatures at an early stage, and long days are favorable for production as they enhance leaf development and bulb formation which is directly related to bulb size (Khade, Thangasamy, & Gorrepati, 2019).

Although there was no significant difference *(P >0.05)* in yield in both stations, the Pink 1358 onion yield was lower compared to the Pune red at Lingmethang condition while there was no significant difference at Wengkhar condition. Similar results were also reported in the studies

carried out on bulb onion varieties during the summer season in India (Sharma & Chauhan, 2022).

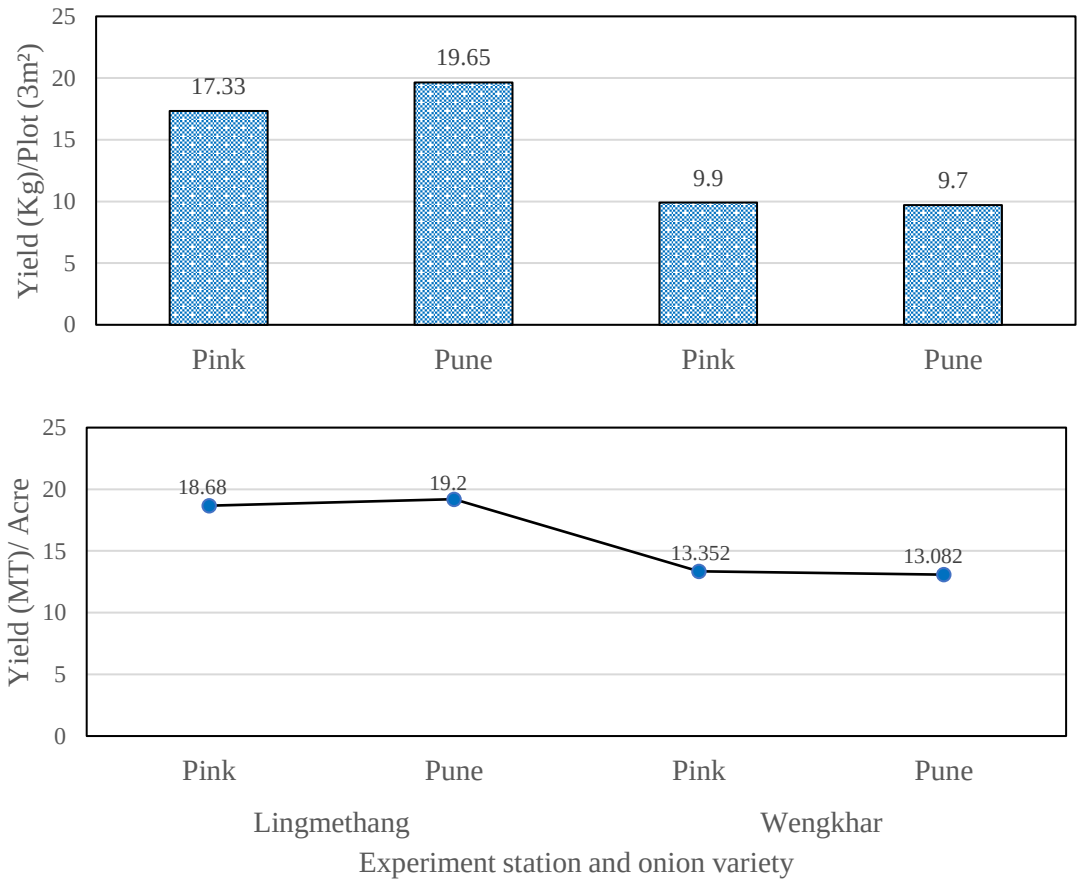

Figure 1. Statistical comparison of the yield of bulb onion across two stations

The mean yield at Lingmethang station ranged from 17.33 kg to 19.65 kg/ 3 m² equivalent to 18-19 MT/acre while at Wengkhar station the mean yield ranged from 9.7 kg to 9.9 kg/ 3 m² equivalent to 13 MT/acre. Similar results were also reported by Sable et al. (2023) in their study on the assessment of rabi onion varieties for the region of north Gujarat of five varieties of onion. The performance of the onion varieties was significantly influenced by the location, soil types, rainfall, and other climatic conditions (Tignegre et al., 2022). Practices of standard management during the bulb onion cultivation period contribute to the higher yield and increased bulb sizes and weight over the farmers' practices in the field (Srivastva, Meena, Tiwari, Singh, & Behera, 2022). The difference between the two bulb onion varieties in its bulb

characteristics and yield could be also due to the genetic makeup of the variety and suitability under different climatic and soil conditions (Gupta, Bhargav, & Dixit, 2020).

The mean yield comparison between the normal and off-season production showed that there was no significant difference *(P >0.05)* between the two seasons although the mean yield was slightly higher in the off-season production as shown in Table 2. This indicates that the off-season bulb onion production could be feasible and will have production comparable to the normal season production. If the recommended management practices are followed, the yields could be even higher than normal season. The normal bulb onion season production starts with planting during October-November and harvested during May-June. The off-season or summer production starts with nursery sowing and transplantation carried out in August, and harvested in early spring from February to March which similar to Indian bulb onion production seasonality (NHRDF, 2023).

Table 2. Bulb onion yield comparison

Season	**Mean Yield (MT/acre)**
Normal	12.2a
Off-season	13.22a

Means in the column with different letters are significantly different at (P <0.05)

4 Conclusion

Bulb onion is an important crop that is used as a spice for the preparation of different Bhutanese dishes and consumed daily by majority of the Bhutanese. To meet the demand there is a need increase the production by exploring other alternatives technologies and supplement the production from the normal season. This study found that bulb onion production is feasible between August to March months in the mid-elevations upto 1650 masl. In this study, the variety Pink 1358 produced 18.68 MT/acre and Pune Red 19.20 MT/acre at Lingmithang and Pink 1358 13.35 MT/acre and Pune Red 13.08 MT/acre at Wengkhar. The yields from the both the experimental sites were not statistically significant *(P >0.05)*. However, the best location for bulb onion production would be in the lower elevation where the yields are higher compared to the mid-elevation. The comparison of mean yield between the normal and off-season cultivation showed no significant difference between the two seasons although the mean yield was slightly higher in the off-season production (13.22 MT/acre). Encouraging the production of bulb onion in different seasons could ensure the availability all year round. Other than the production season, good storage structures and additional varieties need to be explored that are

suitable for both summer and winter productions which will give higher yield and has a good storage quality, so that the growers would have a choice of variety. Sharma & Chauhan, (2022) reported that the variety Agrifound Dark Red which is the popular and most cultivated variety in India is suitable for summer season production, and Khade, Gorrepati, & Thangasamy, (2017) reported that varieties such as Bhima Raj and Bhima Red can be grown in all the seasons. These varieties could be evaluated in the Bhutanese growing conditions to have a choice and suitable variety both for the summer and winter production of bulb onion in the country.

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