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Participatory Onion Variety Evaluation at Fogera District of South Gondar Zone, Ethiopia

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Abstract

Participatory onion variety evaluation was conducted for two dry seasons at Fogera district of South Gondar zone of Ethiopia. Five onion varieties were laid in a randomized complete block design with three replications. Farmers, development agents and agricultural experts of the district agriculture office and researchers from Fogera National Rice Research Center evaluated the varieties at different growth stages using numerous criteria. Variety Nasik red followed by Nafis and Adama red were preferred to others because of their vigorous vegetative growth with little symptoms of disease attack. The dark red bulb color of varieties Nasik red and Nafis with good bulb firmness, tight outer skin and good storability were among desirable characteristics for attracting good market price. Disease scores also showed that varieties Nafis, Adama red and Nasik red were the least attacked. Moreover, the total soluble solid (TSS) assessment indicated that varieties Nafis (14.46%) and Nasik red (13.69%) had higher TSS values in their bulbs. In general, farmers preferred varieties Nasik red and Nafis for their good vegetative growth, disease tolerance, dark red bulb color, firmness of the bulb and tight outer skin although bulb yields of these varieties were less than Bombay red - a familiar variety with the farmer and known for its high yield and earliness in maturity, but susceptible to foliar diseases and bulb rotting with poor storability. It is therefore recommended to multiply seeds and further demonstrate varieties Nasik red and Nafis on farmers' plots with active participation of all actors.

Keywords: Bulb, color, disease, pungent, seed, storability

Onion (Allium cepa L.) is a bulbous vegetable crop widely grown all over the world. It is used for flavoring and seasoning of a variety of dishes, and is commonly known as "Queen of the kitchen" (Pareek, et. al, 2018). Without onion many of the popular dishes would lack the flavor and character that make them favorites (Hodges, 2011). Onion has volatile oil with sulfur containing compounds that are responsible for the strong odor, its distinctive flavor and pungency as well as for its health benefits. Both the green leaves and bulbs of onion can be eaten raw, cooked, or in soups and salads. It is also reported by Pareek, et. al (2018) that onion is used throughout the year, for example in curries, in the form of spices, in salads, as a condiment, or cooked with other vegetables, such as boiled or baked. It is further used in different forms of processed food, e.g. pickles, powder, paste, and flakes. It is also reiterated that onion has an important role as a medicinal herb in many communities, and is claimed to minimize high blood pressure and other heart diseases due to its favorable action on the elasticity of blood vessels (Sani & Jaliya, Szalay, 2017). Onion is used as remedy for catarrhal diseases (flu, angina, lung inflammation, catarrh and cough), for the treatment of bronchial asthma and diabetes and is reputed to lower blood sugar and reduce blood coagulation, and to prevent from prostatic hypertrophy, atherosclerotic plaques and other cardiovascular diseases. It is further reported that one onion bulb can have the same effect as cardio aspirin; onion improves kidney function and absorbs nitrogen from blood, has an anticarcinogenic effect, stimulates digestion and regulates bowels function removing active microorganisms (Kumar, et. al 2010).

Onion production in the dry season using irrigation is widely practiced in many parts of Ethiopia. In many areas in the country, onion production has become a major cash source for farmers; and other actors involved in the value chain including retailers, middlemen, transporters and wholesalers are also benefitting from this venture. Dera, Fogera and Libokmkem districts of the South Gondar zone are among the major growing areas of onion in the Amhara Region. Availability of limited number of improved varieties and production practices are however among the major challenges of onion production system contributing towards low productivity and poor quality bulb. In addition, sustainability of onion production and its profitability is further constrained by absence of healthy, pure and reliable seeds and other planting materials supply of improved onion varieties, buildup of various diseases and insect pests, and high postharvest losses and marketing problems (Hunde, 2017).

Bombay red is a widely cultivated improved variety in Fogera and its surrounding districts of South and North Gondar zones. Nikus and Mulugeta (2010) reported that Bombay red is the most widely grown onion variety under irrigation in Ethiopia due to its higher bulb yield and earliness. Despite its high yielding potential and earliness, Bombay red is susceptible to foliar diseases and bulb rotting. It is difficult to store its harvested bulbs without significant deterioration. Moreover, the light red bulb color of Bombay red is not attracting good price on

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the market (personal discussion). Lemma and Shimelis (2003) also indicated that fresh market red colored and highly pungent types have high acceptance in the local market. Bombay red is not also suitable for production under rain fed as it easily rots in the field if encounters rain during maturity stage (Nikus and Mulugeta, 2010). Due to these undesirable qualities of variety Bombay red, farmers are usually compelled to sell bulbs immediately after harvest whether the market price is attractive or not. It was also difficult to keep bulbs of their own harvest for the next planting season to use as planting material for the production of seeds. Consequently, they were forced to buy bulbs for seed production with high price from other distant areas such as Shewa Robit in North Shoa. Farmers have therefore been requesting for alternative improved varieties of onion which could be used to substitute Bombay red. Accordingly, a participatory variety evaluation was initiated to study the adaptation and performance of recently released onion varieties with the ultimate target to supply alternative onion varieties to the Fogera areas.

Materials and Methods

Description of the study area

Field experiments were conducted for two consecutive seasons in 2016/17 and 2017/18 in Woreta Zuria and Quar Mikael 'kebeles', respectively, of Fogera district in South Gondar zone of the Amhara Region. These two 'kebeles' are found in the vicinity of Fogera National Rice Research and Training Center at the outskirt of Woreta town. Woreta lies at 11° 58′ N latitude and 37° 41′ E longitude. It has an altitude of 1819 m above sea level and receives average annual rainfall of 1230 mm. Mean minimum and maximum temperatures of the area is 120C and 280C, respectively. Soil of the site is red clay (vertisol) with a pH of 5.48.

Plant material and seedling care

Seeds of five improved onion varieties, namely, Adama red, Bombay red, Nasik red, Nafis and Melkam were obtained from Melkassa Agricultural Research Center (MARC) of the Ethiopian Institute of Agricultural Research. Seed beds were thoroughly prepared at Fogera center, and seeds of these five onion varieties were separately sown on 5m x 1m thoroughly prepared adjacent beds, 5 cm raised from the surface. Seeds were drilled on rows with 10cm inter-row spacing and it was covered lightly with fine soil and mulched with eucalyptus leaves until emergence. Weeding was accomplished as deemed necessary. Water was regularly applied to seedling beds (seeds till emergence and thereafter seedlings) using watering can. Seedlings were thinned at first true leaf stage to allow 1-2cm distance within plants (intra-raw spacing). Seedlings generally attained transplantable size in six to eight weeks. Healthy, vigorous and uniform seedlings of pencil size were transplanted in the field.

Treatment and field management

The five released varieties were evaluated on farmers' fields at Wortea zuria kebele in 2016/17, while four varieties excluding Melkam were compared at Quar Michael kebele in 2017/18 because variety Melkam is an old variety which has been out of production. Varieties were laid out in a randomized complete block design with three replications. A total plot size used for a treatment was 10.8m2 (3.6m*3m), while an effective plot size of 7.2m2 (2.4mx3m) was used to harvest bulb yields and measure other yield and quality parameters.

Experimental field was thoroughly plowed and leveled, and ridges were prepared on sides of which transplanting was done. Following research recommendations of MARC and packages of Ministry of agriculture, spacing used was 40cm*20cm*7cm between furrows, rows and plants, respectively. Inorganic fertilizers in the form of Urea (46:0:0) (100kg/ha) and Nitrate phosphate sulfur (NPS) (19:38:7) (242kg/ha) were applied. NPS was applied at transplanting while urea was applied in two splits, the first at seedling establishment (1-2 weeks after transplanting) and the second one and half months after transplanting. Weeding and cultivation were performed as deemed essential during the growing season following standard field management practices. Furrow irrigation once in a week starting at transplanting until two to three weeks before harvest was practiced during the dry seasons of 2016/17 and 2017/18. Transplanting was done on 15th December 2016 and 13th December 2017 for the first and second experiments, respectively, while harvesting ranged from 10th to 30th April 2017 and 2018 depending on maturity period of varieties compared.

Data collection

Feedbacks from participatory variety evaluation by the farmers and development agents of the Woreta zuria and Quar Mikael kebeles and the agricultural experts of the Fogera district agriculture offices were gathered. Criteria considered for vegetative evaluation include symptoms of disease and/or insect attack, plant height and vigor, plot cover, leaf color, width, thickness and length, bolting and maturity time whereas criteria for bulb evaluation included, bulb color, size, firmness, smell, strength of outer skins (cover) and storability of bulbs.

Data was collected on disease and insect attacks, plant height, leaf number, neck thickness, bolting and days to maturity. Disease and insect attacks were regularly observed and recorded using one to five score where five refers to 100% attack, all leaves and plants developing severe symptoms (Kiran et. al, 2013). Onion bulbs were harvested at 50% defoliation. Harvested bulbs with foliage were cured for 10 to 15 days before neck removal. Drying and curing of onion bulbs was done on wire-mesh and wooden shelves in a simple ventilated storage constructed from poles, wire meshes and sheets of corrugated iron roofing. Bulbs were categorized into marketable and non-marketable based on size, visible damages and rotting. Marketable bulbs are those with average size and above, and are free from visible damages due to diseases, rotting and bruises. Marketable bulbs were counted and weighed whereas non-marketable bulbs were counted and sorted out based on their respective causes, i.e., disease, rotting, bruise or undersized bulbs. The TSS and size of bulbs of different varieties of onion were recorded. Data was subjected to analysis of variance using SAS software version 9.2 (SAS Institute, 2008), and least significance difference (LSD) was used to compare treatment means at $P<0.05$ significant level of difference.

Results and Discussion

Over all vegetative evaluation indicated that variety Nasik red was a preferred variety followed by Nafis and Adama red (Tables 1 and 2). This is because an overall vigorous growth was observed for Naisk red and Nafis with less symptoms of disease attacks. Likewise, bulbs of Nasik red and Nafis with good firmness, dark red color, absence of significant bruises and good storability were found superior than the rest.

Table 1. Rank of onion varieties by different groups of evaluators in 2017

	Evaluation at vegetative stage Rank			Bulb evaluation		
Variety	Female farmers (9)	Male farmers (18)	Agricultural experts (15)	Female farmers (12)	Male farmers (25)	Agricultural experts (20)
Adama red	4	3	5	2	4	5
Bombay red	5	5	4	4	3	3
Nasik red	2	1	2	1	1	2
Nafis	1	2	1	3	2	1
Melkam	3	4	3	5	5	4

Table 2. Rank of onion varieties by different groups of evaluators in 2018

	Evaluation at vegetative stage Rank			Bulb evaluation		
Variety	Female farmers (12)	Male farmers (20)	Agricultural experts (25)	Female farmers (15)	Male farmers (23)	Agricultural experts (25)
Adama red	3	3	3	3	3	4
Bombay red	4	4	4	4	4	3
Nasik red	1	1	1	1	2	1
Nafis	2	2	2	2	1	2

Key: 1 is the most preferred variety and in parenthesis are number of participants in the evaluation

The largest bulb length in 2017 was recorded from varieties Malkam (5.26cm) and Nafis (5.20cm) while the highest bulb width (5.03cm) was recorded for variety Bombay red (Table 3). Maturity period ranged from 101 for variety Bombay red to 111 days after transplanting for variety Nasik red (Table 3). On the other hand, maturity period in 2018 ranged from 109 for variety Bombay red to 121 days after transplanting for variety Nafis (Table 4). In the same year, bulb length was large for variety Nafis while the highest bulb width was recorded for variety Bombay red.

Plant height varied from 54.27 cm for variety Bombay red to 61.07 cm for variety Nafis in 2017 while leaf number ranged from 10.05 to 11.23 and neck thickness varied from 1.22 to 1.62cm (Table 3). In 2018, plant height ranged from 60.5 to 63.13 cm, leaf number from 11.1 to 16.9 and neck thickness from 1.83 to 2.15 (Table. 4). Highest bolting percentage in 2017 was recorded from variety Nasik red (30.29%) while the lowest was from variety Adama red (8.09%). Moreover, the highest bolting percentage in 2018 was however recorded from variety Bombay red (39.46%) and the lowest was from variety Nasik red (5.79%). This could be attributable to differences in climatic and soil conditions from different seasons and locations.

Table 3.Vegetative performance, days to maturity and bulb size of onion varieties in 2017

Variety	Days to maturity	Height cm	Leaf number	Neck (cm) thickness	Bulb length cm	Bulb width cm	Bolting %
Adama red	106	57.25	10.05	1.57	5.10	4.43	8.09
Bombay red	101	54.27	11.23	1.22	4.92	5.03	20.44
Nasik red	111	59.92	10.83	1.62	4.94	4.82	30.29
Nafis	109.7	61.07	10.67	1.62	5.20	4.58	11.78
Melkam	105	56.27	10.80	1.4	5.26	4.69	15.14
LSD (0.05)	4.15	7.19	0.55	0.41	0.63	0.51	
CV%	2.07	6.69	2.72	14.72	6.59	5.71	

Table 4.Vegetative performance, days to maturity and bulb size of varieties in 2018

Variety	Days to maturity	Height cm	Leaf number	Neck (cm) thickness	Bulb (cm) length	Bulb width cm	Bolting %
Adama red	119.7	60.5	11.7	1.95	4.83	5.40	13.68
Bombay red	109	63.07	13.03	1.92	4.93	6.06	39.46
Nasik red	118	62.1	16.9	2.15	4.57	5.74	5.79
Nafis	121.3	63.13	11.1	1.83	4.95	5.31	14.44
LSD (0.05)	3.72	3.92	1.16	0.19	0.32	0.64	12.67
CV%	1.59	3.16	4.41	4.84	3.36	5.73	34.57

The highest cured bulb yield was obtained from variety Bombay red both in 2017 (34.815 t/ha) and 2018 (31.875 t/ha). The second highest yielder was variety Nasik red (29.858 t/ha) in 2017 and variety Nafis (27.292 t/ha) in 2018 (Table 5). Whereas the lowest percentage non marketable bulb yield was recorded from Variety Bombay red both in 2017 (11.36%) and 2018 (8.18%), the highest percentage non marketable bulb yield was from Variety Nafis (20.12%) in 2017 and Nasik red (18.74%) in 2018. The highest percentage TSS (14.46%) was recorded from variety Nafis followed by Nasik red and Adam red. Varieties Nafis, Adam red and Nasik red were least attacked by disease particularly downy mildew and purple blotch. Furthermore, bulb color of varieties Nafis, Nasik red and Adama red was dark red which is a preferred color in local market. On the other hand, bulb color of variety Bombay red was light and that of variety Melkam was the lightest in bulb color (Table 6).

High overall mean yield was obtained from variety Bombay red while the lowest was from variety Adama red. Farmers were however looking for varieties with disease tolerance, lower percentage of bolting, good red bulb color, longer storability and high pungency. Lemma and Shimelis (2003) also indicated a strong local preference for red bulb color, long shelf life and high pungent type. According to Kim, et al (2007), bulb color in onions is an important trait whose complex inheritance mechanism involves epistatic interactions among major color-related loci. These desirable traits are lacking in Bombay red but found in varieties Nasik red and Nafis. Furthermore, Bombay red has already been in the production system for many years, and farmers stated that, in addition to its susceptibility to disease and bulb rotting, plots of this variety has been resulted in very poor performance from season to season, despite increasing application of inputs such as fertilizers and field management practices. As compared to varieties with dark red bulb color, variety Bombay red with light red bulb color is not attracting good market price, and it has poor storability. This is inconformity with the report of Nikus and Mulugeta (2010) that Bombay red easily rots and is not suitable for production under rain fed.

It was further reported by Lemma and Shimelis (2003) that Bombay red is with light red bulb color, light pungent, susceptible to purple blotch disease, high proportion of split bulbs and is short storing compared to Adama red. As a result, farmers are usually compelled to sell bulbs immediately after harvest whether the market price is attractive or not. It is also difficult to keep bulbs of their own harvest for next season planting to produce seeds. They are thus forced to buy bulbs for seed production with high price from other distant areas such as Shewa Robit in the North Shoa zone of the Amhara Region. Alternative variety with desirable characteristics has therefore been the question of farmers, and was partly addressed in these experiments. The dark red bulb color of varieties Nasik red and Nafis with good bulb firmness, tight outer skin and good storability were among desirable characteristics for attracting good market price.

Table 5. Onion cured bulb yield in 2017 (Woreta zuria) and 2018 (Quar Michael) dry seasons using irrigation

Varieties	Marketable yield in t/ha		Nonmarketable yield %	
	2017	2018	2017	2018
Adama red	23.519	22.986	18.76	13.78
Bombay red	34.815	31.875	11.36	8.18
Nasik red	29.858	22.361	14.00	18.74
Nafis	26.358	27.292	20.12	13.02
Melkam	29.692		14.86	
LSD0.05	13.013	7.859		
CV%	23.96	15.06		

Table 6. Results of evaluation of varieties for bulb color, TSS, and scores for disease and insect attacks

	2018		2017	
Variety	TSS %	Insect score*	Disease Score*	Color
Adama red	13.16	2.5	1.0	1.3 DR
Bombay red	12.24	2.5	2.0	2.0 R
Nasik red	13.69	2.0	1.17	1.3 DR
Nafis	14.46	2.3	1.0	1.0 DR*
Melkam			1.33	3.0 LR
LSD (0.05)	2.53	1.04	0.74	0.73
CV%	9.45	22.3	30.2	22.34

R=red, LR= light red, DR= dark red, DR*= very dark red *1=least attacked and 5= severe attack

Conclusion and recommendation

Farmers preferred varieties Nasik red and Nafis for their good vegetative growth, disease tolerance, dark red bulb color and firmness of the bulb, although bulb yield of these varieties was lower than Bombay red. The result also revealed that these two varieties have desirable physical, chemical and organoleptic attributes with firm bulb, tight outer skin and good storability to attract good market price and keep in a store with insignificant bulb deterioration. Farmers could therefore be able to save their own bulb harvest for seed production thereby assisting them to reduce cost of production. We suggest that varieties Nasik red and Nafis should therefore be largely demonstrated on farmers' fields with active participation of all actors including farmers (male and female), development agents, agricultural experts and researchers. Further increasing productivity and improving quality through the use optimal inputs such as fertilizer, disease and insect management practices and post-harvest handling practices are essential. We also suggest to developing research based recommendations of inputs considering agro-ecology and edaphic requirements of specific locations.

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