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Assessment of *rabi* onion varieties for the region of North Gujarat

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Abstract
Demonstration was conducted during *rabi* (December, 2020–April, 2021) on the horticulture farm at Krishi Vigyan Kendra, Sardarkrushinagar Dantiwada Agricultural University, Khedbrahma, Sabarkantha, Gujarat, India to study the impact of improved varieties with integrated crop management (ICM) in onion and scientific temperament of farmers of North Gujarat part. The demonstration was conducted in four plots (replications) consists of five varieties (treatments). About 55 days old seedlings of onion were transplanted in flat beds at a spacing of 15 x 10 cm. Four improved varieties of *rabi* onion are compared with local variety. The varieties (treatments) are symbolized as T_1- Agrifound Light Red, T_2 - NHRDF Red2, T_3 - NHRDF Red3, T_4 - NHRDF Red 4 and T_5 – Local of Sabarkantha region of Gujarat (Farmer's seed). The parameter wise data (yield parameter like bulb yield, quality parameter like bolting percent and visual appearance of bulb) of four plots (replications) and five varieties (treatments) was recorded to assess the impact of KVK interventions on onion yield and economics and analyzed in randomized block design (RBD). All these four improved varieties of *rabi* onion under demonstration had significant impact on bulb yield, bulb quality, bolting per cent and economic as compared to the local variety. Significantly higher bulb yield and net return, superior bulb quality and lower bolting per cent was recorded in improved onion varieties as compared to the local.

Keywords: Onion, varieties, assessment, bulb yield

1. Introduction
Onion (*Allium cepa* L.) is one of the most important commercial vegetable crop used as raw as salad, vegetable and spice all over the world (Tripathy *et al*., 2013a; Ganie *et al*., 2019a) [36, 6]. It is also referred as queen of kitchen (Meghana *et al*., 2021a; Ganie *et al*., 2019b). The pungency in onion is due to the presence of ally propyl disulphide (Mohanty and Prusti, 2001) [19]. Onion belongs to the family *Alliaceae* (Shinde *et al*., 2021a; Sable *et al*., 2013a; Hirave *et al*., 2015) [33, 23, 30] having chromosome number 2n = 16 (Meghana *et al*., 2021b) [16]. It ranks second in value after tomatoes on the list of cultivated vegetable crops worldwide. It is an important bulb crop throughout the world and is commercially cultivated in more than hundred countries (Nayak *et al*., 2022a) [20]. The major onion growing states are Maharashtra, Madhya Pradesh, Karnataka, Gujarat, Rajasthan, Bihar etc. In India onion is grown in an area of 1.62 mh with a total production of 26.64 mt (Anonymous, 2022) [1] and productivity is 16.40 t ha^{-1}. India is second largest onion producing country in the world after China (Dhar *et al*., 2019a). Onion is grown all over the country in three seasons i.e. *kharif*, late *kharif* and *rabi*. It is predominantly cultivated during *rabi* season (Tripathy *et al*., 2013b; Ganie *et al*., 2019c) [37, 8]. Hence, average productivity of Indian onion depends on the *rabi* onion. Many varieties of onion have been released by the public and private but information on their performance is lacking (Sharma *et al*., 2014a) [31]. Therefore, identification of specific cultivars suitable for specific season is an indispensible step towards increase in production and productivity of onion (Nayak *et al*., 2022b; Shinde *et al*., 2021b; Tripathy *et al*., 2013c; Dhar *et al*., 2019b; Dikshit *et al*., 2020; Meghana *et al*., 2021c; Wablepatil, 2023a; Warade *et al*., 2015a; Kumar and Prasad, 2015a; Ganie, Ganie *et al*., 2019d) [21, 34, 38, 3, 5, 147, 40, 12, 9]. Identification of the variety suitable for the area and technological gap to enhance the onion production with quality bulb produce is the need of time. Apart from improved *rabi* onion varieties and integrated crop management (ICM) in onion, scientific temperament of the onion grower is very important for achieving the quality bulb produce. The main mandate of the KVKs are to plan and carry out demonstration on Krishi Vigyan Kendra farms as well as farmer's field to verify, assess, validate and refine location-specific technologies developed by National Agricultural Research System.

In this location the farmers were facing the problems in onion cultivation like low yield, low quality bulb produce, bolting, etc. due to lack in knowledge regarding location specific varieties selection and inadequate integrated crop management (ICM). Considering the aforementioned facts, the Krishi Vigyan Kendra scientist's emphasized on demonstration on Horticulture farm at Krishi Vigyan Kendra as an educational activity in a systematic manner to show the impact of improved varieties and ICM during the farmers visit to Krishi Vigyan Kendra and farmers-scientist interactions. Impact of the demonstration plots on horticulture farm at Krishi Vigyan Kendra has been seen on the scientific temperament of onion growers of this region after exposure to demonstration. After this exposure farmers of this region are demanding the seedlings of improved onion varieties from the Krishi Vigyan Kendra and Krishi Vigyan Kendra is providing technical backstopping with critical inputs like seedlings to the farmers as on farm testing (OFT) on farmer's field. Farmers is getting higher yield with quality bulb produce and income from improved *rabi* onion varieties as compared to the local of this region.

2. Materials and Methods

Demonstration was conducted during *rabi* (December, 2020–April, 2021) on the horticulture farm at KVK, Sardarkrushinagar Dantiwada Agricultural University, Khedbrahma, Sabarkantha, Gujarat, India. The net plot size was 2.7 m × 2.6 m. The demonstration was laid out in Randomized Block Design (RBD) with five varieties (treatments) with four plots (replications). Four improved varieties of *rabi* onion are compared with local. The varieties (treatments) are symbolized as T_1- Agrifound Light Red, T_2- NHRDF Red 2, T_3- NHRDF Red 3, T_4- NHRDF Red 4 and T_5-Local of Sabarkantha region of Gujarat (Farmer's seed).Improved varieties seed was purchased from NHRDF office, Mahuva, Dist. Bhavnagar, Gujarat and local varieties seedlings was purchased from vegetable seedling's local seller of Khedbrahma. The parameter wise data like bolting per cent, yield and visual appearance of four plots (replications) and five varieties (treatments) was recorded to assess the impact of KVK interventions (Varietal assessment) on onion yield and economics. About 60 days old seedlings are transplanted at 15 cm × 10 cm spacing (Dhar *et al*., 2019c) [4]. One third top portion of the seedlings is cut at the time of transplanting. Onion seedling's root dipped into solution of fungicide carbendazim 1 g L^{-1} of water and insecticide carbosulfan 2 ml L^{-1} of water before transplanting to control sucking pests and fungal diseases. The dose of manures and fertilizer depends upon the soil health and nutrients content so it may be changed as per soil test report. Farm yard manure (FYM) 25 t ha^{-1} was applied at the time of final land preparation. Neem cake 250 kg $ha^{-1}$was applied in soil before transplanting as preventive measure against nematode infestation. Fertilizer dose of 100:50:50 kg N:P_2O_5:K_2O ha^{-1} was applied(Shinde *et al*., 2021c). Half dose of N and full dose of P_2O_5 and K_2O was applied as basal dose. The remaining dose of N was applied in two equal splits at 30 and 45 DAT (Sable *et al*., 2021b and Wablepatil, 2023b) [16, 41]. Sulphur 16 kg $ha^{-1}$was applied before transplanting as basal. *Azotobacter* 5 kg, *Phosphorus Solubilizing Bacteria* (PSB) 5 kg, *Trichoderma* 1.25 kg (Sable *et al*., 2021c) [28] and *Pseudomonas fluorescens* 2.5 kg ha^{-1} was applied with 125 kg vermicompost (one week enriched) after one week of basal RDF application. Micronutrients, Grade-IV (Zn 6%, Fe 4%, Mn 1%, Cu 0.5% and B 0.5%) 2 g L^{-1} of water was sprayed at 30 and 45 days after transplanting along with silicon spreader (Sable *et al*., 2021c) [28]. Weed was controlled effectively by spraying oxyfluorfen 23.5% EC @ 1 ml L^{-1} of water on 5th after transplanting followed by one hand weeding (HW) at 30 DAT (Sable *et al*., 2021d; Sable *et al*., 2013b; Sable *et al*., 2013c) [29, 24, 25]. Mancozeb 2.5 g + fipronil 1 ml L^{-1} of water at appearance of pest and disease, propiconazole 1 ml + carbosulfan 2 ml L^{-1} of water at 45 DAT and copper oxychloride 2.5 g + profenofos 1 ml L^{-1} of water along with sticker at 60 DAT were sprayed to manage thrips and blight (*Cholototrichum* blight and purple blotch) (Patil and Nargund, 2017) [22]. The variety wise fresh bulb yield was recorded from each plot at harvest. The bolting per cent was recorded when the bolting observed in the plot. Sprouting was observed after six month of storage at room temperature. Variety wise visually bulb quality like colour and appearance also observed.

3. Results and Discussion

Significantly wide variation was observed among the *rabi* onion varieties in the demonstration for yield as compared to the local variety of Sabarkantha region of Gujarat (farmer's seed) and are presented in Table 1. It was observed from the demonstration data that, the improved varieties of *rabi* onion *viz*. Agrifound Light Red, NHRDF Red 4, NHRDF Red 3 and NHRDF Red 2 recorded the significant higher bulb yield as compared to the local variety. Significantly higher bulb yield per plot and hectare was obtained in variety Agrifound Light Red (58.17 t ha^{-1}) which was at par with variety NHRDF Red 4 (51.69 t ha^{-1}), while, it was significantly lower in local (30.00 t ha^{-1}).These type of differences among different varieties may be due to genetic makeup of different varieties and adaptability under different climaticconditions also reported by Tripathy *et al*.,2013 [36], Sharma *et al*., 2014 [31], Sarkar *et al*., 2015 [30], Jalaja *et al*., 2016 [11], Gosai *et al*., 2018 b. Thus, yield increase over control in Agrifound Light Red, NHRDF Red 4, NHRDF Red 3, NHRDF Red 2 of 93.90, 72.30, 51.83, 49.76% respectively was recorded. This difference among the varieties may be due to genetic makeup of the varieties and their adaptability to different climatic condition (Meghana *et al*., 2021b) [16]. Lower yield from local variety (farmer's seed) may be due to transplanting from seedlings sown by using seed produced by conventional method without following proper isolation distance. Isolation distance is important for quality seed crop. Off types and rogues influences the quality of seed and genetic purity by contamination. Seed produced by conventional method by farmers having possibilities of reduced genetic purity of seed due to inadequate isolation distance adapted by farmers during seed production. While, improved varieties seed is to be harvested from field's having prescribed field standards and processing standards certified by the certification agency. The variety local of this region recorded significantly higher bolting per cent (60%). While, minimum bolting of bulb was recorded in NHRDF Red3 (0.13%) followed by NHRDF Red 4 (0.21%). The varieties NHRDF Red 2, Agrifound Light Red recorded bolting per cent 0.39, 1.03, respectively. It may be due to varietal characters, genetic makeup of varieties and their adaptability to different climatic condition. Vibhute and Singh (2019) stated that bolting per cent in onion varies as per variety. Similar results were reported by Warade *et al*. (2015)

and Kumar and Prasad (2015) [12]. With respect to the bulb colour of *rabi* onion varieties, local was mixture of dark red, violet and white with inferior quality and small bulbs as compared to improved varieties *viz*. NHRDF Red 4, NHRDF Red 3, NHRDF Red 2 and Agrifound Light Red. Varieties NHRDF Red 4 and NHRDF Red 3 were dark red and visually more attractive, while that of, Agrifound Light Red and NHRDF Red-2 were light red. The local variety bulb produce showed sprouting after six months of harvest at room temperature storage.

Table 1: Response of *rabi* onion varieties demonstration for yield

Treatment symbol	Varieties	Yield (t ha^{-1})	Yield plot^{-1} (kg)	Yield increase over local (%)
T_1	Agrifound Light Red	58.17	40.83	93.90
T_2	NHRDF Red 2	44.93	31.53	49.76
T_3	NHRDF Red 3	45.55	31.97	51.83
T_4	NHRDF Red 4	51.69	36.28	72.30
T_5	Local (Farmer's seed)	30.00	21.06	00.00
	S.Em±	2.18	1.48	
	CD	6.50	4.40	

Table 2: Response of *rabi* onion varieties demonstration for quality

Treat. symbol	Treatment (Varieties)	Bolting (%)	Sprouting observed	Visual appearance of bulb
T_1	Agrifound Light Red	1.03	No	Attractive, light red colour
T_2	NHRDF Red 2	0.39	No	Attractive, light red colour
T_3	NHRDF Red 3	0.13	No	Very attractive, dark red colour
T_4	NHRDF Red 4	0.21	No	Very attractive, dark red colour
T_5	Local	60.0	Yes	Very less attractive, mixture of different colours

Sprouting after six months of harvest at room temperature storage condition

Fig 1: Different onion varieties showing bulb quality

Fig 2: Sprouting in local variety's bulb after six months of harvest at room temperature storage

3.1 Economics

It was revealed from the economic data that maximum net return (₹538458 ha^{-1}) and cost benefit ratio 1:5.03 was noted in T_4 (Onion CV. NHRDF Red 4) followed by T_3 (Onion CV. NHRDF Red 3) (Net return ₹458606 ha^{-1} and cost benefit ratio 1:4.43). Though per hectare bulb yield was recorded maximum in T_1 (Onion CV. Agrifound Light Red) but T_4 (Onion CV. NHRDF Red 4) and T_3 (Onion CV. NHRDF Red 3) fetched more market bulb price due to attractive colour as compared to the T_1 (Onion CV. Agrifound Light Red). However, the lowest net return (₹315746 ha^{-1}) and cost benefit ratio 1:3.36 was noted in T_2 (Onion CV. NHRDF Red 2) and T_5 (Local/ Farmer's seed) (Net return ₹316458 ha^{-1} and cost benefit ratio 1:3.36). Bulbs market price was fluctuated as per consumer's preference. Fresh bulb produce of varieties $T_1 - T_4$ was sold at a onetime immediately after harvest in the market. However, bulb produce of T_5 was shelled after two months storage when the shortage was in the market at ₹ 15 kg^{-1}.

Table 3: Economics of different treatments (varieties)

Treat. symbol	Treatment (Varieties)	Gross return (₹ ha^{-1})	Cost (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
T_1	Agrifound Light Red	581709	133542	448167	4.36
T_2	NHRDF Red 2	449288	133542	315746	3.36
T_3	NHRDF Red 3	592148	133542	458606	4.43
T_4	NHRDF Red 4	672000	133542	538458	5.03
T_5	Local (Farmer's seed)	450000	133542	316458	3.36

Shelling price of fresh bulb produce of Agrifound Light Red and NHRDF Red 2 was ₹ 10 kg^{-1}, NHRDF Red 3 and NHRDF Red 4 ₹ 13 kg^{-1}.

4. Conclusion

The improved production technology of *rabi* onion with varieties *viz*. NHRDF Red 4, NHRDF Red 3 and Agrifound Light Red has found more productive and profitable as compared to existing local variety (farmer's seed). For getting higher *rabi* onion yield and income in Sabarkantha and Aravalli region of North Gujarat improved dark red attractive varieties *viz*. NHRDF Red 4, NHRDF Red 3 and light Agrifound Light Red instead of local existing variety may be recommended.

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