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Studies on the Performance of Onion (*Allium cepa* L.) varieties Intercropping in Pre-bearing Kinnow (*Citrus reticulata* Blanco) Orchard

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ABSTRACT: The present investigation was carried out in Kinnow orchard during the year 2019-20 at the Main Experiment Station, Department of Fruit Science, Acharya Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya, in Randomized Block Design (RBD) with four treatments, comprised of onion varieties Pusa Madhavi, Puna Fursungi, N-53 and Agrifound Light Red with four replications of each treatment. Observations were recorded on Plant height, leaf length, leaves per plant, neck length, neck diameter, bulb height, bulb diameter, days of maturity, moisture content in bulb, total soluble solids of bulb and yield. From the findings of present investigation, it can be inferred that the highest plant height, leaf length, neck length, neck diameter, bulb height, bulb diameter, days of maturity and dry matter content were found in Agrifound Light Red and maximum leaves per plant, neck diameter, moisture content, bulb weight and yield were found in N-53. The highest total soluble solids was found in Poona Fursungi.It can be concluded that N-53 variety of onion can be cultivated in pre-bearing Kinnow orchard as intercropping for maximum return.

Keywords: Intercropping, Kinnow, Onion, N-53, Pusa Madhavi, Puna Fursungi, Agrifound Light Red, *Citrus reticulata* Blanco, Citrus.

INTRODUCTION

Kinnow is a member of the 'Mandarin' family of citrus fruits and is widely produced in India and Pakistan. In early 1940, Kinnow was introduced in India after being created in 1935 at the university of California citrus experiment station. It is a cross between the 'King' (*Citrus nobilis*) and 'Willow Leaf' mandarin (*Citrus deliciosa*). It is grown in parts of Punjab, Rajasthan, Himachal Pradesh, Haryana, Uttarakhand and Jammu & Kashmir in India, where it has a total production area of 0.33 million ha and production of 3.34 million ton . The prevailing climatic conditions during the winter contribute to this abundant production I there states, helping to further improve the sweetness index along with the unique tested. Punjab is Indie's leading kinnow producer. It is a country that accounts for 29% of the total national production (1.1 MT per year on an area of 0.048 mha). The Fazilka district of Punjab covers 55% area of the cultivated area and accounts for 58% of the total production (Mahawar *et al.,* 2020) so the orchard of Kinnow in these states can be better utilized for the intercropping of some seasonal vegetables such as onion etc. (Das *et al.,* 2008; Abouziena *et al.,* 2010) which increase the overall return of the orchard.

The onion (*Allium cepa* L.) is a very important vegetable during *Rabi* season and belongs to Alliaceae family. Its genus is *Allium* and species *cepa*. This crop is native to Central Asia. Onion is popularly known as 'Queen of the kitchen''. In addition, onion is used as salad and pickles. Recently onion is being employed by mean of processing enterprises to a greater volume for getting ready dehydrated onion forms like powder and flakes. Onion is grown throughout the entire world with some major producing countries like China, India, USA, Turkey, Pakistan, Iran, Japan, Spain and Brazil (Young *et al.,* 2004). In the world, India stands first in area (1293 Mha) and ranks second in production (23610 MT) after China. In India it is mostly cultivated in the state of Maharashtra, Madhya Pradesh, Karnataka, Gujarat, Bihar, Rajasthan, Haryana and Andhra Pradesh. In India, Maharashtra is that the leading state with 471.66 thousand hectare area and 6773.08 thousand metric tons production followed by Karnataka (195.54 thousand hectare area and 2767.98 thousand metric tons production). Uttar Pradesh covers 41.61 thousand MT production and 4.08 thousand hectare area. India contribute 12 percent of total world export of onion. It is more than 75 percent of foreign exchange that comes

from export fresh vegetable. Per capita availability of onion in Netherlands (32.99 kg/year) is the highest followed by Turkey (29.82 kg/year). In India, the availability of onion per capita is 3.94 kg/year.

Intercropping is an antique and established agronomic technique that, when used appropriately, can significantly reduce insect issues and increase revenue in bearing orchard. Intercropping can be explained as a system where two or more crop species are grown in the same field at the same time during a growing season. It is a simple and inexpensive strategy and has been recognized as a potentially befitted technology to increase crop production due to its substantial yield advantage than sole cropping (Sarker *et al.,* 2007). Fruit plants can be intercropped with other crops to increase employment and revenue for farmers while having no negative effects on orchard (Das *et al.,* 1995; Abdel-Aziz *et al.,* 2008).

MATERIALS AND METHODS

The experiment was carried out during 2019-20 in the Kinnow orchard at Main Experiment Station, Department of Fruit Science, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh. Which is situated beside Ayodhya-Raibarelli Road about 42 km away from Ayodhya headquarter and lies geographically at 26.47°N latitude, 82.12°E longitude and at altitude of 113.0 meter above mean sea level. The soil was alluvial with good drainage and moderate water holding capacity.

Pusa Madhavi: Developed in New Delhi at the Indian Agricultural Research Institute. Bulbs range in size frome medium to large, have a light red colour and have a flattish spherical form. After being transplanted, the plant matures 130-140 day later and bulbs have good storage qualities. The average yield potential is 30 t/ha. Recommended for *rabi* season. Suitable for export purposes.

Puna Fursungi: Developed at NHRDF in Pune. Bulbs are red, sphericalin shape with 5.80 to 6.25 cm in diameter. Crop matures in 110-120 days after transplanting. The keeping quality of bulb is good. Bulb contains 12-14°brix Total Soluble Solids and 13-15% dry matter. The variety yields of 380-400 q/ha. It is tolerant to *Stemphylium* Blight.

N-53(Nasik red) -Developed at NIPHAD in Pune. Cultivation of Nasik red is popular thoughout the country during *kharif* season. Bulbs are flattish round in shape, red in colour, medium to large in size and mildly pungent. Bulb contains 11-12°Brix Total Soluble Solids. A high yielding cultivar with an average yield ranging from 25 t/ha. Crop matures in 90-100 days after transplanting.

Agrifound Light Red: Developed by NHRDF through mass selection from a local *rabi* cultivar. Bulbs are light red, globular in shape, tight skinned, 4-6 cm in diameter with a 13^0Brix Total Soluble Solids. It has good keeping quality and less bolting habit. Matures in 140 days after transplanting. Average yield 30-32.5 t/ha. Recommended for cultivation during *rabi* season in throughout the country. It can be grown in late *kharif* season also in Nasik district of Maharashtra.

Raised seed beds were used for the nursery. Before sowing, farm yard manure was thoroughly mixed with the soil, levelled and then watered, seeds of eight cultivars were sown separately in lines at 10 cm spacing at shallow depth of 0.5 cm apart and then lightly covered with finely sieved leaf mould. Seeds were sown on 05 December 2019, in nursery beds. Healthy seedling of 10-15 cm height with 3 to 4 leaves were ready for transplanting in 45 to 60 days after sowing. Healthy seedling were transplanting on 15 February 2020 on flat beds in rows as per the recommended spacing of 15 × 7.5 cm. Light irrigation was given after transplanting for better formation of the seedlings in the field. The intercropping treatment were T_1: Pusa Madhavi, T_2: Puna Fursungi, T_3: N-53 and T_4: Agrifound Light Red. Each treatment were used as a randomized block design (RBD).

Plant survival is calculated by counting the number of plant of each plot that have stay alive, divide it by the number of total transplanted plant and multiply by 100 to express as a percentage of survival (Kumari *et al*. 2018). Plant height was measured from the base of the plant to the tip of the longest leaf of five randomly selected plants at 90 days after transplanting. Height of plant measured in centimetre using the metric scale. Leaf length was measured at physiological maturity from sheath to the tip of longest leaf at 90 days after transplanting five randomly selected plants using metric scale. Number of leaves per plant at 90 days after transplantation was recorded on the five randomly selected plant and their average was worked out. Neck length of five randomly selected plants was measured in centimetre with the help of meter scale after the crop harvest. Neck diameter of five randomly selected plants was measured in centimetre with the help of vernier calipers after crop harvest. Bulb height of five randomly selected plants was measured in centimetre with the help of vernier calipers after crop harvest. Bulb diameter of five randomly selected plants was measured in centimetre with the help of vernier calipers after crop harvest. The date at which 50 per cent of the plants in a given plot recorded neck fall was noted and the days required for harvesting was calculated from date of transplanting to 50 per cent neck fall recorded. Moisture content of the bulbs was determined using the weight loss (g) on drying and initial sample weight (g) using the following formula-

$$\text{Moisture (\%)} = \frac{\text{Weight loss (g) on drying}}{\text{Initial sample weight}} \times 100$$

Select five randomly bulbs per treatment per replication and crushed then juice passed out through muslin cloth, a drop of juice was placed on the plate of hand refractometer (0-32°Brix ERMA JAPAN HAND REFRACTOMETER) and reading was noted. The mean values thus obtained were connected at 20°C and expressed as per cent Total Soluble Solids (°Brix) (Ranganna, 2010).

RESULTS AND DISCUSSION

In the present investigation, a significant difference has been observed among all the treatments given in Table 1 and Table 2.

It is evident from the data that plant height was significant for all the varieties of onion intercropped in Kinnow orchard. The observed data showed that plant height was maximum (49.98 cm) for the T_4 (Agrifound Light Red) followed by T_3 (N-53) (46.09 cm) and T_1 (Pusa Madhavi) (43.04 cm) while plant height was minimum (37.33 cm) for T_2 (Puna Fursungi). Differences in plant height in this species at different stages of plant growth may be due to their genetic behavior and climate also soil suitability for specific cultivars.. These findings are in accordance with the findings of Mohanty and Prusti (2001) on onion plant height. Similarly, Jagdande *et al.* (2004) reported that the plant height of Agrifound Light Red was 69.33 cm at 90 DAT. Kerure *et al.* (2016) was also observed plant height (54.10 cm) of Agrifound Light Red variety. The leaf length was significant for all the varieties intercropped in the Kinnow orchard. The recorded data showed that leaf length was maximum for T_4 (Agrifound Light Red-41.75 cm) followed by T_3 (N-53-38.12 cm) and T_1 (Pusa Madhavi-35.39cm) while, it was least recorded for T_2 (Puna Fursungi-31.08 cm). The increase in leaf length might be due to the genetical variation or potentiality of different onion cultivars. Greater availability of nutrients in adequate quantity especially during leaf formation and developmental stages might have directed the plants to translocate most of its reserved food materials towards building the leaf length as compared to those which could not produce longer leaves (Flore and Layne 1999). Kerure *et al.* (2016) was observed maximum leaf length in onion cv. Agrifound Light Red in Karnataka. It is revealed that is a significant difference in leaves per plant for the different treatments. The maximum leaves per plant 13.25 obtained in N-53 (T_3) while minimum leaves per plant 9.40 was recorded in Agrifound Light Red (T_4). The differences in number of leaves may be due to genetic makeup of variety and suitability under different climatic and soil conditions. The present results are in accordance with the findings of Mohanty (2001); Tripathy *et al.* (2013); Kushal *et al.* (2015); Sarkar *et al.* (2015) on onion. Mohanty *et al.* (2000) also concluded that the maximum number of leaves per plant was produced in onion cv. N-53 as compared to other varieties of onion. Mohanty *et al.* (2002) evaluated twelve varieties of onion during *kharif* season over five years, the pooled analysis revealed that the cultivar N-53 produced the maximum number of leaves per plant. There findings are in support of the present results on leaves per plant. The neck length among all four intercropped varieties of onion, T_3(N-53) showed highest neck length *i.e.* 4.25 cm followed by T_4 (Agrifound Light Red) (4.05 cm), T_1 (Pusa Madhavi) (3.75 cm) and T_2 (Puna Fursungi) (2.58 cm). It can be stated that T_3 (N-53) and T_4 (Agrifound Light Red) performed well in terms of neck length when intercropped in Kinnow orchard as compared to Pusa Madhavi and Puna Fursungi. The variation in neck length may be due to genetical makeup of varieties climate and soil of the region. The present finding are in accordance with the Sharma (2009); Dwivedi *et al.* (2012); Tripathy *et al.* (2013); Sarkar *et al.* (2015) on neck length of onion. The increase in neck length of onion is due to the varietal differences among the cultivars under trail and differences in their genetic makeup (Young *et al.*, 2004). The observations recorded for neck diameter are showed the significant difference among treatments. From the data given in table it is revealed that highest neck diameter 1.53 cm was found in T_3 (N-53) and 1.06cm in T_4 (Agrifound Light Red). Lowest neck diameter 0.74 cm was found in T_1 (Pusa Madhavi) among all the treatments. The variation in neck diameter may be due to genetically makeup of varieties, climate and soil of the region. The present finding are in accordance with the Sharma (2009); Dwivedi *et al.* (2012); Tripathy *et al.* (2013); Sarkar *et al.* (2015) on onion. These findings are accordingly with Mohanty *et al.* (2000) who reported that the thickest neck was marked in onion cv. N-53 (Mohanty *et al.*, 2002). Data revealed that the maximum bulb height 4.19 cm was found in T_4 (Agrifound Light Red) followed by 3.72 cm in T_3 (N-53) and minimum 3.66 cm for T_2 (Puna Fursungi). Low temperature is favourable for bulb development. The wider spacing provides more area, light and less nutrient competition among plants, which increase bulb polar (Bulb height) diameter and bulb equatorial (Bulb diameter) diameter (Devi *et al.*, 2008; Jilani *et al.*, 2010). Dikshit *et al.* (2020) also reported that maximum bulb height (Polar diameter) of cultivar Agrifound light red. The varieties in bulb height among treatments might be due to varietal characteristics. Bulb diameter showed that the bulb diameter was highest 5.03 cm for the T_4 (Agrifound Light Red) followed by 4.42 cm in T_3 (N-53) and 4.44 cm in T_1 (Pusa Madhavi) among all four intercropped varieties of onion in Kinnow orchard while minimum bulb diameter 4.08 cm, was found in T_2 (Puna Fursungi). The varietal characters influence the bulb diameter resulting difference among bulb diameter of treatment. Low temperature is favourable for bulb development. The wider spacing provides more area, light and less nutrient competition among plants, which increase polar (Bulb height) diameter and equatorial (Bulb diameter) diameter of bulb (Devi *et al.*, 2008; Jilani *et al.*, 2010). Similar results found by Srivastav *et al.* (2017) who reported maximum bulb diameter in onion cv. Agrifound light red. It is clear from the data that days of maturity was significant for all theintercropped varieties and obtained maximum 139.25 DAT for the T_4 (Agrifound Light Red) followed by 134.50 DAT in T_2 (Puna Fursungi) whereas minimum 126.50 DAT for T_3(N-53). This type of difference among different varieties may be due to genetic makeup of different varieties and different response to soil and climatic conditions. Similar results also reported by Sharma (2009); Singh and Bhonde (2011); Tripathy *et al.* (2014); Hirave *et al.* (2015); Kushal *et al.* (2015); Tarai *et al.* (2015) in onion which favours the present results. Jaiswal *et al.* (1984) conducted experiment on seven varieties of onion. They reported that the variety N-53, took minimum period for maturity as compared to other varieties of onion under the agroclimatic conditions of Faizabad, U.P. Moisture content was high in T_3 (N-53) *i.e.* (89.88%) and (87.22%) in T_2 (Puna Fursungi), whereas T_4 (Agrifound Light Red) showed least (84.52 %) moisture content in

the bulb followed by T_1 (Pusa Madhavi-86.96 %) among all four varieties of onion intercropped in Kinnow orchard. Based on moisture content in the bulb, it can be stated that the storagequality of T_4 (Agrifound Light Red) will be better when compared with the other varieties of onion so, intercropping of T_4 (Agrifound Light Red) would be suitable in Kinnow orchard and T_3(N-53) would be least suitable variety among rest of the varieties because of more moisture content resulting lower storability. This type of difference among different varieties may be due to genetic makeup of different varieties and adaptability under different climatic conditions similar results also reported by Sharma (2009); Singh and Bhonde (2011); Tripathy *et al.* (2014); Hirave *et al.* (2015); Kushal *et al.* (2015); Tarai *et al.* (2015) in onion. That all the four intercropped varities differed significantly with regard of total soluble solids content of the bulb. The highest total soluble solidswas observed in T_2 (Puna Fursungi) (11.82°B), T_4 (Agrifound Light Red) (11.63°B) and T_1 (Pusa Madhavi) (10.65°B) while T_3 (N-53) (10.10°B) showed least total soluble solids value. The increased total soluble solidswas due to enhanced physiological activity and availability of nutrients and development of strong source and sink relationship. These results are in conformity with findings of Patil *et al.* (1991); Khar *et al.* (2007); Yadav *et al.* (2010); Dewangan *et al.* (2012) in onion. The T.S.S content of onion bulb was varying from 14.21 to 12.57 percent. Scrutiny of results indicated that the treatment effects were significant (Ahlawat and Singh 2013).

Table 1: Plant height, Leaf length, Leaves per plant, Neck length and Neck diameter of onion varieties as intercropping in pre-bearing Kinnow orchard.

Treatments	Plant height (cm)	Leaf length (cm)	Leaves per plant (No.)	Neck length (cm)	Neck diameter (cm)
T_1 (Pusa Madhavi)	43.04	35.39	12.40	3.75	0.74
T_2 (Puna Fursungi)	37.33	31.08	9.85	2.58	0.95
T_3 (N-53)	46.09	38.12	13.25	4.25	1.09
T_4 (Agrifound Light Red)	49.98	41.75	9.40	4.05	1.06
SEm±	0.81	0.70	0.34	0.18	0.03
CD	2.60	2.23	1.10	0.56	0.09

Table 2: Bulb height, Bulb diameter, Days of maturity, Moisture content in bulb and total soluble solids of onion varieties as intercropping in pre-bearing Kinnow orchard.

Treatments	Bulb height (cm)	Bulb diameter (cm)	Days of maturity (DAT)	Moisture content in bulb (%)	Total Soluble Solids (°brix)
T_1 (Pusa Madhavi)	3.83	4.44	133.50	86.96	10.65
T_2 (Puna Fursungi)	3.66	4.08	134.50	87.22	11.82
T_3 (N-53)	3.72	4.42	126.50	89.88	10.10
T_4(Agrifound Light Red)	4.19	5.03	139.25	84.52	11.63
SEm±	0.12	0.12	0.93	0.45	0.34
CD	0.38	0.38	2.97	1.44	1.09

CONCLUSION

It can be concluded that N-53 variety of onion performed better among all four verities which were intercropped in pre bearing Kinnow orchard durin g the study and it can be recommend to the farmers to i ntercrop such vegetable crops being short duration, shal low-rooted will not only help the farmers to utilize the vacant space efficiently but also enable them to earn additional income from the same piece of land.

FUTURE SCOPE

Onion varieties can be cultivated as intercrop in pre-bearing Kinnow orchard for additional income under eastern UP climatic conditions. Onion variety N-53 has been found best for intercropping in pre-bearing Kinnow orchard.

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Conflict of Interest. None.

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