Original Research Article

Effect of inorganic fertilizers (NPK) with organic sources (Biomix & HA) on bulb quality and storage quality of onion (*Allium cepa* L.)

Abstract

Present investigation was laid out in Factorial Randomized Block Design (FRBD) with three different levels of RDF; F_1: RDF 80% (80:40:40 NPK kg/ha), F_2: RDF 100% (100:50:50 NPK kg/ha) and F_3: RDF120% (120:60:60 NPK kg/ha) with six levels of organic sources *viz.,* S_0 : Control, S_1 : Biomix 10 kg/ha, S_2 : Biomix 12.5 kg/ha, S_3 : Biomix 15 kg/ha, S_4 : Humic acid 05 kg/ha and S_5 : Humic acid 10 kg/ha comprising eighteen treatments and replicated thrice.

The onion bulb produced under 120 % RDF have recorded the higher values of the quality parameters, *viz.,* Chlorophyll content (63.44 SPAD Value), ascorbic acid content (11.71 mg/100g), total soluble solids (12.23 %), reducing sugar (2.33 %), non reducing sugar (5.27 %) and total sugar (7.60 %). Among, the organic sources humic acid 10 kg/ha recorded higher chlorophyll content (59.66 SPAD Value), total soluble solids (11.91 %), reducing sugar (2.29 %), non reducing sugar (5.03 %) and total sugar (7.32 %), except ascorbic acid (10.89 mg/100g) content which was recorded maximum under biomix 15 kg/ha.

In five months of storage studies, the minimum physiological loss in weight (18.47 %) at ambient condition was observed under 80:40:40 NPK kg/ha and maximum total soluble solids (%) were recorded with 120:60:60 NPK kg/ha. In organic sources the less PLW (18.55 %) at ambient storage was recorded under biomix 15 kg/ha during five months of storage study. In fifth month of storage period more total soluble solids was found under humic acid 10 kg/ha treatment.

Key words : Fertilizers, NPK, RDF, Organic sources, Biomix, Humic acid, Bulb quality, Storage quality, Onion

Introduction

Onion (*Allium cepa* L.) is a perennial (often biennial) monocotyledonous bulbous belonging to the Alliaceae family and one of the most important crops of vegetables and spices grown under a wide range of climatic conditions worldwide (Brewster, 1994; McCallum, 2001).

Recent molecular techniques that illustrated the relationships and phylogeny of the various species have largely established them (Friesen *et al*., 2006; Fritsch and Friesen, 2002). The species of the *Allium* genus are among the ancient cultivated crops and have been commonly cultivated and used in Egyptian artefacts dating from 2700 B.C. (Fritsch and Friesen, 2002). The current species, however, *Allium cepa* is known only from cultivation, but appears to have been primarily domesticated in the Central Asian Mountains by wild ancestors, especially in the Iran and Pakistan regions.

In a variety of flavoured salads and soups, onion is used in both the green and mature stages for salad and spice. It is very popular in food and commonly used in almost all regions of the world for cooking, and has been used throughout history in various cultures and rituals; it is therefore called the "Kitchen Queen". (Brewster, 1994).

In India, it is grown on an area of 1.64 million hectares with a production of 26.93 million MT and productivity of 16.43 MT per hectare. (*Anon*., 2021). In Maharashtra is also leading in total export of onion sharing almost 64% of the total produce exported from India. There is a lot of demand of Indian onion in the world, the country has exported 1,434,925 metric tons of fresh onion to the world for the worth of Rs. 2,49,668 lakh during the year 2021. The average yield per hectare of onion in India is 16.43 metric tonnes and that of Maharashtra 17.9 metric tons. Maharashtra state has the dominant position in respect of onion accounting for 25.90 per cent of the total area and 29.08 per cent of the total production of onion in India (*Anon.*, 2021).

Over several years, numerous possible health and nutritional benefits resulting from onion consumption have been studied. Onions provide flavour and contain health-related properties of useful phytochemicals, including different sulphur-containing compounds such as Alkenyl cysteine sulphoxides, anti-oxidant compounds that are likely to be used to protect against fungi and insects, create the distinctive odour, flavour, and lachrymatory (tear stimulating) properties of onions along with their breakdown products (Brewster, 1994).

Baswant -780: Bulbs are flattish round in shape, red in colour, medium to large in size and mildly pungent. Total soluble solids is 11 – 12 %. Keeping quality is poor. Ready for harvest in 90 to 100 days after transplanting and average yield is 25 t/ha. Suitable for *kharif* season in Maharashtra. (*Anon.*, 2021).

Long term fertilizers trials have clearly shown the positive role of organic sources with chemical fertilizers in maintaining the productivity of soil by maintaining the soil fertility and important physical properties (Bharadwaj *et al*., 1994). Fertilizer prices are increasing day by day so becoming unaffordable by small and marginal farmers, depleting soil fertility due to widening gap between nutrient removal and supplies, growing concern about environmental hazards and increasing threat to sustainable agriculture. Besides above facts, the long term use of biomix and humic acid is economical, eco-friendly, more efficient, productive and accessible to marginal and small farmers with chemical fertilizers.

Biomix is known fact that the bioagents are playing important role in plant disease management, pest management and boosting plant growth. Department of Pathology, VNMKV, Parbhani, introduced biocontrol in the region and developed experimental product in the year 2005 and he named as Biomix. A new Biomix was formulated by Dr. K.T. Apet adding some biofungicides, biopesticides and growth promoting bioagents. It contents *Trichoderma viride, Trichoderma harzianum, Asperillus niger, Pseudomonas fluorescens, Pseudomonas striata, Beauveria bassiana, Neumoria relyi, Metarhizium anisopliae, Gluconacetobactor, Paecilomyces lilacinus, Bacillus subtillis, verticillium lecanii, PPFM, Azospirillum brasilince.*

Humic acid is the dark "Humus" found in soil and made up of organic matter derived from microbial degradation. Humus, enriches the soil thereby allowing fertilizer chemicals to reach their maximum potential in promulgating plant growth. Humic acid typically, contains heterocyclic compounds with carboxylic, phenolic, alcoholic and carbonyl functional groups. It is extracted from lignite or low rank coals. It is complex with high molecular weight humic constituents containing plant growth stimulating substances (Sangeetha, 2003). Application of humic acid, enhances water retention and maintains air water relationship in the soil. It acts as absorbent for nutrients thereby prevents leaching losses and increases the porosity and cation exchange capacity of the soil. It helps in the formation of stable complexes with metal ions and thereby increases the availability of nutrients to the plants. Sufficient information exists on the impact of humic acid on field crops like rice, groundnut, soybean etc. (Sangeetha, 2003).

Applied nutrients are subjected to losses like leaching and volatilization resulting in economic loss to farmer. Balanced fertilization has to be made for different crops for attaining maximum yield and profit. There is meager information on the balanced use of chemical fertilizers with organic sources (Biomix and Humic Acid) for onion crop.

Postharvest losses in onion are a matter of serious concern throughout the world. While India is the world's second largest producer and exporter of onions, huge (25-30 %) post-harvest losses include weight loss, sprouting and microbial decay limiting domestic supply and export (Murkute and Gopal , 2013) . During late kharif seseaon the scarcity of high-yielding varieties to sustain quality also causes currency fluctuations in markets. Since onion biodiversity is found to be low, the excavation of accessible germplasm with appropriate markers is essential for an effective programme of crop improvement. The biochemical characteristics may be related to the ability to store onions, since they affect the sprouting and weight loss that influences the onion appropriate maintenance quality (Elhassaneen and Sanad, 2009).

Lack of ample knowledge on use of biomix and humic acid for onion vegetable crops paved the way for formulating the present research

Material and Methods

The present experiment entitled "Effect of different levels of fertilizers with organic sources on growth, yield and quality of onion (*Allium cepa* L.)" was conducted at Department of Horticulture, VNMKV, Parbhani in late *Kharif* season during 2020-21 and 2021-22.

There were two factors studied in this experiment one major factor A) Different levels of RDF (F_1: RDF 80% (80:40:40 NPK kg/ha), F_2: RDF 100% (100:50:50 NPK kg/ha) and F_3: RDF120% (120:60:60 NPK kg/ha)) and sub factor B) Organic sources (S_0: Control, S_1: Biomix 10 kg/ha, S_2: Biomix 12.5 kg/ha, S_3: Biomix 15 kg/ha, S_4: Humic acid 05 kg/ha and S_5: Humic acid 10 kg/ha). The experiment was laid out in Factorial Randomized Block Design (FRBD) with eighteen treatments and replicated thrice. The onions were transplanted with 15 cm row to row and 10 cm plant to plant spacing.

Chart 1: Treatment combinations

Sr. No.	Treatment	Treatment combination details
1.	F_1S_0	RDF 80%/ha (80:40:40 NPK kg/ha) + Control
2.	F_1S_1	RDF 80%/ha + Biomix 10 kg/ha
3.	F_1S_2	RDF 80%/ha + Biomix 12.5 kg/ha
4.	F_1S_3	RDF 80%/ha + Biomix 15 kg/ha
5.	F_1S_4	RDF 80%/ha + Humic acid 05 kg/ha
6.	F_1S_5	RDF 80%/ha + Humic acid 10 kg/ha
7.	F_2S_0	RDF 100%/ha (100:50:50 NPK kg/ha) + Control
8.	F_2S_1	RDF 100%/ha + Biomix 10 kg/ha
9.	F_2S_2	RDF 100%/ha + Biomix 12.5 kg/ha
10.	F_2S_3	RDF 100%/ha + Biomix 15 kg/ha
11.	F_2S_4	RDF 100%/ha + Humic acid 05 kg/ha
12.	F_2S_5	RDF 100%/ha + Humic acid 10 kg/ha
13.	F_3S_0	RDF 120%/ha (120:60:60 NPK kg/ha) + Control
14.	F_3S_1	RDF 120%/ha + Biomix 10 kg/ha /ha
15.	F_3S_2	RDF 120%/ha + Biomix 12.5 kg/ha
16.	F_3S_3	RDF 120%/ha + Biomix 15 kg/ha
17.	F_3S_4	RDF 120%/ha + Humic acid 05 kg/ha
18.	F_3S_5	RDF 120%/ha + Humic acid 10 kg/ha

Treatment application

Different levels of RDF

Soil application of different levels of recommended dose of fertilizers as per the treatment for onion is i. RDF 80% (80:40:40 NPK kg/ha), ii. RDF 100% (100:50:50 NPK kg/ha) and iii. RDF 120% (120:60:60 NPK kg/ha). Nitrogen was applied as per treatment through urea, half as basal dose and remaining half in two equal splits at 10 and 30 days after transplanting. Phosphorus and potassium was applied through single super phosphate and muriate of potash respectively just before transplanting.

Organic sources

Biomix

Soil application (drenching) of different levels of biomix for onion *viz.*, i. Biomix 10 kg/ha, ii. Biomix 12.5 kg/ha and Biomix 15 kg/ha.

Procedure for preparation of biomix solution for drenching: Take 5 liter of water and add biomix quantity as per the treatment and prepared solution per plot.

Humic acid

Soil application (drenching) of different levels of humic acid for onion is i. Humic acid 5 kg/ha and ii. Humic acid 10 kg/ha.

Procedure for preparation of humic acid solution for drenching: Take humic acid quantity as per the treatment. Added in 5 liter of water per plot and mixed well.

Different bulb quality parameters *viz.*, Chlorophyll content, ascorbic acid content, total soluble solids, reducing sugar, non reducing sugar, total sugar; and storage quality attributes *viz.*, physiological loss in weight (%) and total soluble solids (T.S.S) during five months of storage period were recorded and subjected for statistical analysis as per Panse and Sukhatme (1985).

Treatment evaluation/Details of observations recorded

Quality parameters

Total chlorophyll content (SPAD Value)

The total chlorophyll content was estimated by using '*Chlorophyll Spade Meter*' *(Minolta SPAD 502, Konica Inc. Tokyo, Japan)* from the leaves of five selected observational plants and average mean was worked out.

Ascorbic acid content (mg/100g)

Determination of ascorbic acid was done by 2,6 dichlorophenol indophenols dye method as described by Ranganna (1986). A known quantity of onion juice or powder with 3% metaphosphoric acid (HPO3) to make the final volume 26 of 100 ml and then filtered. A known quantity of aliquot was titrated against 0.025%. 2,6 dichlorophenol indophenols dye to a pink colour end point. The ascorbic acid content of the sample was calculated taking into consideration the dye factor and expressed as mg ascorbic acid per 100 g juice extract.

$$\textbf{Dye factor} = \frac{0.5}{\text{Titrate reading}}$$

$$\textbf{Ascorbic acid (mg/100g)} = \frac{\text{Titrate} \times \text{Dye factor} \times \text{Vol. made up reading}}{\text{Aliquot extract} \times \text{Weight of sample taken for estimation}} \times 100$$

Total soluble solids (%)

Total soluble solids (TSS) percentage was determined with the help of hand refractometer at the time of harvesting of bulb. The average content was worked out from all the five selected observational plants (bulbs) and it was expressed in percentage.

Reducing sugars (%)

Reducing sugars of bulb/juice were determined by method described by Ranganna (1986). A known quantity of sample was taken in a volumetric flask, some distilled water added and dissolved. Thereafter, 2 ml of 45 % basis lead acetate solution was added for clarification. After 10 minute, the solution was delayed by adding potassium oxalate crystals remained undisclosed and the volume made up to level with distilled water and filtrate was titrated against boiling standard Fehling's mixtures (5 ml of Fehling's solutions A and B each) till the blue colour appeared. Then, 1-2 drops of methylene blue indicator was added and the titration was continued till the content attained a brick red colour and titrate value was noted. The percentage of reducing sugar was calculated according to following formula

$$\text{Reducing sugars (\%)} = \frac{\text{Glucose equivalent x total volume made up}}{\text{Titrate value x weight of sample}} \text{ X } 100$$

Non reducing sugar (%)

Non Reducing sugars content was determined by using Benedict’s method. It was expressed in percent. In this method the juice powder of onion was taken for analysis. In this method the juice extracted from bulb is inverted by boiling 27 with mineral acid to obtain invert sugar solution. It is titrated against Benedict's reagent.

Total sugar (%)

Total sugars were determined by adding the value of reducing and non reducing sugars. It was expressed in per cent.

Storage study

Storage Condition: Freshly harvested, healthy onion bulbs of average size were selected for storage experiment as per treatment. The bulbs were grouped in sets of 5 for each replication (n=3) in each treatment set, and stored under ambient conditions. PWL % and TSS % recorded at monthly interval for five months with initial post-harvest analysis at the harvesting was considered the reference.

Physiological loss in weight (%)

Physiological loss in weight (%) was determined (Bhattarai and Gautam, 2006) by using following formula:

Physiological loss in weight (%) = [(Initial weight – Final weight) / Initial weight] x 100

Total soluble solids (%)

Total soluble solids of the juice were recorded with the help of hand refractometer by taking a drop of juice of composite on prime of the refractometer and observing it against the light. The hand refractometer was calibrated with distilled water before use.

Statistical analysis of data

The statistical analysis of collected data was done by the standard procedure. The analysis of variance was carried out according to factorial randomized block design (FRBD). The significance of treatment differences was tested by 'F' test on the basis of null hypothesis. The appropriate standard error (S.E m.±) was computed in each case. Co-efficient of variance per cent was also worked out for all the characters. The results have been calculated at probability level 5 per cent according to Panse and Sukhatme (1985).

Results and Discussion

Effect on bulb quality parameters at harvest

The data on bulb quality parameters of onion vegetable as influenced by different levels of RDF with organic sources is presented in Table 1.

Effect of different levels of RDF

Different quality parameters were also significantly influenced due to different levels of RDF. The onion produced under RDF 120 percent was recorded the highest values of the quality parameters, *viz.* Chlorophyll content (63.44 SPAD Value), ascorbic acid content (11.71 mg/100g), total soluble solids (12.23 %), reducing sugar (2.33 %), non reducing sugar (5.27 %) and total sugar (7.60 %), followed by RDF 100 per cent. Lower values of these all quality parameters were recorded under RDF 80 per cent.

Nitrogen application increased, chlorophyll a and b contents were enhanced that in turn recorded higher SPAD reading in onion (Vairavan *et al*. 2021), hence, chlorophyll content significantly increased with the increased levels of NPK application. Especially nitrogen helped in vigorous vegetative growth and imparted deep green colour to the foliage which favoured photosynthetic activity of the plants. These results were in line with Yadav, (2006) and Hou *et al.*, (2021).

The different quality parameters like vitamin C content varied with different doses of application of P and K (Rani *et al.* 2020). Increasing the fertigation level from 80% to 120% NPK influenced the ascorbic content of onion due to be potassium, it is a quality nutrient that is highly responsible for carbohydrate metabolism and thus increases the ascorbic acid content. The similar result reported by Vairavan *et al.*, (2021) in onion.

Higher total soluble solids was recorded due to higher application of nutrient that resulted in enhanced vegetative growth that in turn improved the photosynthetic activity and greater accumulation of carbohydrates in onion bulbs. This might be due to the fact that nitrogen has helped in vigorous vegetative growth and imparted deep green colour to the foliage which favored photosynthetic activity of the plants so there was greater accumulation of food material *i.e.* carbohydrates in the bulb which ultimately resulted in more synthesis of total soluble solids (TSS) content. The similar results have been reported by Aswani *et al.*, (2005). The results are also in accordance with the findings of Ahmad *et al.*, (2009); Godara and Mehta (2013) and Vairavan *et al.* (2021) in onion.

There were significant effects of different RDF levels on reducing and non reducing sugar of onion. These may be due to the effect of each incremental dose of RDF caused significant increase in reducing and non reducing sugar of onion. Highest reducing and non reducing sugar per cent were observed with RDF level F_3. It showed that application of NPK fertilizers exerted the positive effect on reducing sugar which may be due to the optimum availability of NPK. The nitrogen plays an important role in chlorophyll structure which is responsible for photosynthesis and manufacture of food material in the plants. Phosphorus stimulates early root development and improves the quality of produce. Potash helps to translocation of carbohydrates. These results are in conformity with Aswani *et al.*, (2005) in onion.

There were significant effects of different RDF levels on total sugar of onion. These may be due to the effect of each incremental dose of RDF caused significant increase in total sugar of onion. Highest total sugars per cent were observed with F_3. These may be due to the higher reducing sugar and non-reducing sugar in higher amount of NPK levels.

Effect of different levels of organic sources

Among the organic sources humic acid 10 kg/ha recorded higher chlorophyll content (59.66 SPAD Value), total soluble solids (11.91 %), reducing sugar (2.29 %), non reducing sugar (5.03 %) and total sugar (7.32 %), except ascorbic acid (10.89 mg/100g) content which was recorded maximum under biomix 15 kg/ha. However, it was statistically at par with treatment (S_2, S_3 and S_4 for chlorophyll content), (S_2, S_4 and S_5 for ascorbic acid content), (S_2, S_3 and S_4 for total soluble solids), (S_3 for reducing sugar), (S_3 and S_4 for non-reducing sugar) and (S_2, S_3 and S_4 for total sugar). Minimum values of these all quality parameters were recorded under control treatment.

The presence of humic substances in the nutrient solution produces an increase in the chlorophyll apparatus in tomato (Zdenek Sladky, 1959). Chlorophyll pigments are essential constituent of leaf and act as a seat of photosynthesis. The total chlorophyll content of onion was highest recorded with humic acid 10 kg/ha at 60 days after transplanting. Soil application of humic acid was found to be more effective in increasing the total chlorophyll content. The increase might have been due to that stimulation activity of humic acid on the synthesis of chlorophyll precursor. This is in line with the earlier findings of Sangeetha (2003) in onion.

Biomix is known fact that the bioagents are playing important role in plant disease management, pest management and boosting quality of different vegetables (Apet, 2018). The application of biomix at 15 kg/ha recorded higher ascorbic acid content in onion bulb. The reason might be due to the application of biomix increases the available nutrient status in soil, which decides the activity of ascorbicase enzyme, which is responsible for the production of ascorbic acid. The enzyme invertase activity was enhanced by biomix, which resulted in hydrolysis of sucrose to glucose and this might have increased the ascorbic acid content. These perceptions are in congruity/ conformity with Altintas and Bal (2005) in lettuce.

In the present study the maximum total soluble solids was reported in the treatment receiving 10 kg humic acid/ha. This might be due to that the application of humic acid increased the nutrient uptake by plant, which resulted in higher photosynthetic rate, better source sink relationship, translocation and accumulation of photo assimilates. Similar results were reported by Sangeetha (2003) in onion.

Maximum reducing and non reducing sugar of onion bulb recorded with humic acid 10 kg/ha. This might be due to humic substances alter the carbohydrate metabolism of plants and promote the accumulation of reducing sugars. This is in line with finding of Sangeetha (2003) in onion.

Soil application of humic acid @ 10 kg/ha recorded higher total sugar content in onion. Humic substances possess auxin activity (O'Donnel, 1973), which might have created a larger sink to mobilize the sugars synthesized in leaves to growing bulbs. Humic substances alter the carbohydrate metabolism of plants and promote the accumulation of reducing sugars and non-reducing sugar in onion (Flaig and Saalbach, 1955). These results are in accordance with the findings of Sangeetha (2003) in onion.

Effect of different levels of RDF with organic sources

The interaction effect of different levels of NPK with organic sources on chlorophyll content (SPAD Value), ascorbic acid content (mg/100g), total soluble solids (%), reducing sugar (%), non reducing sugar (%) and total sugar (%) was found to be non-significant.

Table 1: Effect of different levels of RDF with organic sources on mean chlorophyll content (SPAD Value at 60 days after transplanting), ascorbic acid (mg/100g), total Soluble Solids (%) and reducing Sugar (%), non reducing sugar (%) and total sugar (%) of onion

Treatment	Chlorophyll content	Ascorbic acid content	Total soluble solids	Reducing sugar	Non Reducing sugar	Total sugar
Main treatment: Different levels of RDF/ha (F)						
F_1: RDF 80% (80:40:40 NPK kg/ha)	50.85	9.19	10.58	1.95	4.23	6.17
F_2: RDF 100% (100:50:50 NPK kg/ha)	55.84	10.42	11.43	2.11	4.64	6.74
F_3: RDF120% (120:60:60 NPK kg/ha)	63.44	11.71	12.23	2.33	5.27	7.60
SE (m) $\pm$	0.86	0.12	0.12	0.03	0.06	0.08
CD @ 5%	2.55	0.35	0.35	0.09	0.18	0.24
Sub treatment: Organic sources/ha (S)						
S_0 : Control	53.85	10.01	10.97	2.01	4.39	6.40
S_1 : Biomix 10 kg/ha	55.41	10.26	11.18	2.06	4.54	6.60
S_2 : Biomix 12.5 kg/ha	56.55	10.59	11.36	2.10	4.68	6.78
S_3 : Biomix 15 kg/ha	57.97	10.89	11.56	2.18	4.75	6.93
S_4 : Humic acid 05 kg/ha	56.83	10.26	11.50	2.13	4.88	7.01
S_5 : Humic acid 10 kg/ha	59.66	10.63	11.91	2.29	5.03	7.32
SE (m) $\pm$	1.22	0.17	0.17	0.04	0.10	0.13
CD @ 5%	3.62	0.50	0.50	0.12	0.31	0.39
Interaction effect: Different levels f RDF/ha (F) x Organic sources/ha (S)						

F_1S_0: RDF 80%/ha + Control	48.14	8.71	10.07	1.82	4.02	5.84
F_1S_1: RDF 80%/ha + Biomix 10 kg/ha	49.63	8.90	10.27	1.86	4.12	5.98
F_1S_2: RDF 80%/ha + Biomix 12.5 kg/ha	50.68	9.30	10.52	1.91	4.18	6.09
F_1S_3: RDF 80%/ha + Biomix 15 kg/ha	52.19	9.68	10.76	2.03	4.22	6.24
F_1S_4: RDF 80%/ha + Humic acid 05 kg/ha	51.22	9.09	10.65	1.95	4.25	6.20
F_1S_5: RDF 80%/ha + Humic acid 10 kg/ha	53.26	9.44	11.2	2.11	4.59	6.70
F_2S_0: RDF 100%/ha + Control	53.58	10.10	10.95	2.01	4.16	6.17
F_2S_1: RDF 100%/ha + Biomix 10 kg/ha	54.74	10.34	11.24	2.08	4.35	6.43
F_2S_2: RDF 100%/ha + Biomix 12.5 kg/ha	55.78	10.58	11.38	2.10	4.62	6.72
F_2S_3: RDF 100%/ha + Biomix 15 kg/ha	56.61	10.71	11.68	2.14	4.67	6.81
F_2S_4: RDF 100%/ha + Humic acid 05 kg/ha	55.89	10.26	11.59	2.12	5.00	7.12
F_2S_5: RDF 100%/ha + Humic acid 10 kg/ha	58.41	10.54	11.76	2.19	5.02	7.21
F_3S_0: RDF 120%/ha + Control	59.82	11.22	11.88	2.19	5.00	7.19
F_3S_1: RDF 120%/ha + Biomix 10 kg/ha	61.85	11.54	12.02	2.23	5.15	7.38
F_3S_2: RDF 120%/ha + Biomix 12.5 kg/ha	63.19	11.90	12.19	2.29	5.25	7.54
F_3S_3: RDF 120%/ha + Biomix 15 kg/ha	65.11	12.28	12.25	2.37	5.37	7.74
F_3S_4: RDF 120%/ha + Humic acid 05 kg/ha	63.38	11.42	12.26	2.32	5.39	7.71
F_3S_5: RDF 120%/ha + Humic acid 10 kg/ha	67.31	11.92	12.77	2.57	5.48	8.04
SE (m) ±	1.96	0.30	0.29	0.08	0.2	0.22
CD @ 5%	NS	NS	NS	NS	NS	NS

Effect on storage quality attributes

The data on storage quality attributes of onion vegetable as influenced by different levels of RDF with organic sources is presented in Table 2 and 3.

Effect of different levels of RDF

In five months of storage studies regarding physiological loss in weight (%) and total soluble solids (T.S.S) of onion bulb was found significant under different levels of NPK kg/ha, except in fourth month of storage studies the total soluble solids were found to be non significant. The minimum physiological loss in weight (18.47 %) at ambient condition was observed under 80:40:40 NPK kg/ha during five months of storage period. The maximum total soluble solids (%) were recorded with 120:60:60 NPK kg/ha during 1st, 2nd, 3rd and 5th months of storage period.

Lowest physiological loss in weight was occurred in application of lower levels of NPK. These might due to be lowest neck thickness, neck length at harvest; and lower moisture loss of onion bulb during five months of storage period.

During five month of storage period the maximum total soluble solids were recorded in F_3. These might be due to the supply of the NPK at optimum levels. NPK improves the quality of onion bulbs, especially, phosphorus and potash improves keeping quality and dry matter accumulation of onion.

Effect of different levels of organic sources

During five months of storage studies physiological loss in weight (%) of bulbs significantly influenced by organic sources but total soluble solids was not affected significantly, except for 5^{th} month of storage period was found to be significant. The less PLW (18.55 %) at ambient storage was recorded under biomix 15 kg/ha during five months of storage study, followed by S_2 treatment. More PLW was recorded with control treatment. In fifth month of storage period more TSS was found in humic acid 10 kg/ha, followed by biomix 15 kg/ha and minimum was observed in control treatment.

Significantly minimum physiological loss in weight of onion was recorded with the biomix 15 kg/ha during storage period. This might be to less neck thickness and higher nutrient uptake like potassium. Potassium improves many parameters like shining, colour, keeping quality and dry matter accumulation of many crops including onion. Similar results were reported by Rani *et al*., (2020) in onion.

During storage of onion bulbs the values of total soluble solids were progressively increased from the first storage period, until its reach the highest values at the third month of storage period and later it linearly decreased at the end of fifth month of storage period. This can be attributed to low moisture content in the bulb as the storage period increases, this led to increase the concentration of total soluble solids and dry matter in the bulb and accordingly bulb firmness is increased. Similar results were reported by Abou-El-Hassan *et al*. (2018) in onion.

Maximum total soluble solids were recorded with S_5 during storage period this also might be due to higher nutrient uptake like potassium. Potassium also improves many param eters like shining, colour, keeping quality and dry matter accumulation of many crops including onion. Similar results were reported by Rani *et al*., (2020) in onion

Effect of different levels of RDF with organic sources

In five months of storage studies regarding physiological loss in weight (%) and total soluble solids (T.S.S) of onion bulb were found non-significant under the interaction effect of different levels of RDF with organic sources.

Table 2: Effect of different levels of RDF with organic sources on mean physiological loss in weight (%) of onion during 5 month of storage period

Treatment	Physiological loss in weight (%)				
	Month I	Month II	Month III	Month IV	Month V
Main treatment: Different levels of RDF/ha (F)					
F_1	4.43 (12.15)	8.24 (16.68)	12.43 (20.64)	14.10 (22.06)	18.47 (25.45)
F_2	6.84 (15.16)	15.34 (23.08)	20.45 (26.89)	21.24 (27.44)	23.41 (28.94)
F_3	5.51 (13.58	12.71 (20.89)	17.12 (24.44	18.52 (25.49)	21.20 (27.42)
SE (m) $\pm$	0.15	0.27	0.36	0.35	0.54
CD @ 5%	0.43	0.79	1.03	1.01	1.56
Sub treatment: Organic sources/ha (S)					
S_0	6.50 (14.77)	14.46 (22.35)	19.00 (25.84)	20.17 (26.69)	22.67 (28.43)
S_1	5.50 (13.56)	11.47 (19.80)	15.90 (23.50)	17.58 (24.79)	20.80 (27.13)
S_2	5.01 (12.93)	11.02 (19.39)	15.51 (23.19)	16.96 (24.32)	19.79 (26.41)
S_3	4.59 (12.37)	9.68 (18.13)	14.33 (22.24)	16.10 (23.66)	18.55 (25.51)
S_4	6.17 (14.38)	13.20 (21.30)	17.94 (25.06)	18.63 (25.57)	22.42 (28.26)
S_5	5.77 (13.90)	12.76 (20.93)	17.32 (24.59)	18.29 (25.32)	21.95 (27.94)
SE (m) $\pm$	0.21	0.39	0.51	0.5	0.77
CD @ 5%	0.61	1.12	1.58	1.44	2.31
Interaction effect: Different levels f RDF/ha (F) x Organic sources/ha (S)					
F_1S_0	5.16 (13.13)	10.68 (19.07)	14.56 (22.43)	16.83 (24.22)	20.20 (26.71)
F_1S_1	4.14 (11.74)	7.52 (15.92)	12.22 (20.46)	13.71 (21.73)	18.35 (25.36)
F_1S_2	3.83 (11.29)	7.25 (15.62)	11.51 (19.83)	13.00 (21.13)	17.52 (24.74)
F_1S_3	3.44 (10.69)	6.84 (15.16)	10.90 (19.28)	11.83 (20.12)	16.35 (23.85)
F_1S_4	5.21 (13.19)	8.21 (16.65)	12.98 (21.12)	14.91 (22.71)	19.49 (26.20)
F_1S_5	4.80 (12.66)	8.93 (17.39)	12.45 (20.66)	14.32 (22.24)	18.91 (25.78)
F_2S_0	7.93 (16.36)	17.37 (24.63)	22.90 (28.59)	22.80 (28.52)	25.40 (30.26)
F_2S_1	6.64 (14.93)	14.48 (22.37)	19.01 (25.85)	21.23 (27.44)	22.93 (28.61)
F_2S_2	6.15 (14.36)	13.82 (21.82)	18.79 (25.69)	20.10 (26.64)	21.64 (27.72)
F_2S_3	5.72 (13.84)	12.70 (20.88)	16.88 (24.26)	19.13 (25.94)	20.02 (26.58)
F_2S_4	7.49 (15.88)	16.88 (24.26)	22.60 (28.39)	22.10 (28.04)	25.30 (30.20)
F_2S_5	7.09 (15.44)	16.78 (24.18)	22.50 (28.32)	22.10 (28.04)	25.20 (30.13)
F_3S_0	6.42 (14.68)	15.34 (23.06)	19.53 (26.23)	20.88 (27.19)	22.41 (28.25)
F_3S_1	5.73 (13.85)	12.39 (20.61)	16.48 (23.95)	17.79 (24.95)	21.12 (27.36)
F_3S_2	5.06 (13.00)	11.98 (20.25)	16.23 (23.76)	17.77 (24.93)	20.20 (26.71)
F_3S_3	4.62 (12.41)	9.50 (17.95)	15.22 (22.96)	17.35 (24.62)	19.29 (26.05)
F_3S_4	5.82 (13.96)	14.50 (22.38)	18.23 (25.28)	18.88 (25.75)	22.47 (28.30)
F_3S_5	5.41 (13.45)	12.56 (20.76)	17.01 (24.36)	18.44 (25.43)	21.74 (27.79)

SE (m) ±	0.36	0.67	0.88	0.86	1.33
CD @ 5%	NS	NS	NS	NS	NS

Table 3: Effect of different levels of RDF with organic sources on mean total soluble solids (%) of onion during 5 month of storage period

Treatment	Total soluble solids (%)				
	Month I	**Month II**	**Month III**	**Month IV**	**Month V**
Main treatment: Different levels of RDF/ha (F)					
F_1	11.96	12.41	12.60	12.54	10.32
F_2	13.07	13.37	14.02	13.1	11.13
F_3	13.55	14.09	14.42	13.55	11.64
SE (m) ±	0.34	0.35	0.36	0.34	0.29
CD @ 5%	0.97	1.00	1.02	NS	0.82
Sub treatment: Organic sources/ha (S)					
S_0	11.91	12.22	12.57	12.22	9.77
S_1	13.01	13.36	13.61	13.04	10.91
S_2	13.15	13.52	13.95	13.22	11.18
S_3	13.16	13.59	14.03	13.31	11.55
S_4	12.55	13.34	13.75	13.10	11.09
S_5	13.36	13.7	14.17	13.44	11.68
SE (m) ±	0.48	0.49	0.51	0.48	0.41
CD @ 5%	NS	NS	NS	NS	1.17
Interaction effect: Different levels f RDF/ha (F) x Organic sources/ha (S)					
F_1S_0	10.34	10.65	10.71	10.80	9.03
F_1S_1	12.43	12.50	12.28	12.81	10.04
F_1S_2	12.52	12.79	12.93	12.86	10.10
F_1S_3	12.73	12.93	13.23	12.98	11.20
F_1S_4	11.23	12.71	13.11	12.80	10.56
F_1S_5	12.52	12.88	13.31	12.97	10.97
F_2S_0	12.19	12.21	12.91	12.50	10.01
F_2S_1	13.07	13.51	14.02	12.74	10.85
F_2S_2	13.32	13.59	14.26	13.20	11.50
F_2S_3	13.63	13.80	14.32	13.41	11.60
F_2S_4	13.10	13.43	14.13	13.20	11.14
F_2S_5	13.09	13.68	14.48	13.53	11.69
F_3S_0	13.21	13.80	14.09	13.35	10.28
F_3S_1	13.53	14.09	14.52	13.57	11.84
F_3S_2	13.61	14.19	14.68	13.59	11.95
F_3S_3	13.73	14.29	14.53	13.74	12.11
F_3S_4	13.31	13.88	14.01	13.30	11.56
F_3S_5	13.88	14.29	14.71	13.77	12.11
SE (m) ±	0.83	0.85	1.16	0.84	0.70
CD @ 5%	NS	NS	NS	NS	NS

Conclusion

The overall assessment of the results of present investigation on the "Effect of different levels of fertilizers with organic sources on growth, yield and quality of onion (*Allium cepa* L.)" concluded that, with increasing rate of fertilizers all the bulb biochemical quality and storage quality attributing characters were increased. It was noticed that significantly highest biochemical quality and storage quality attributing characters was observed with the application of 120% RDF kg/ha as compared to other treatments. Among, the organic sources humic acid 10 kg/ha recorded highest bulb biochemical quality parameters, except ascorbic acid content which was recorded maximum under biomix 15 kg/ha. Less physiological loss in weight at ambient storage was recorded under biomix 15 kg/ha during five months of storage study in different levels of organic sources, except, for total soluble solids which was maximum under humic acid 10 kg/ha.

References

Abou-El-Hassan, S., Elmehrat, H. G., Ragab, A. A., Abo-Dahab, M.A. & Megiud, A. (2018). Growth, yield, bulb quality and storability of some onion cultivars response to compost, vermicompost and plant growth promoting rhizobacteria. *Middle East Journal of Agriculture Research*. 07(02), 292-306.

Ahmad H. Al-Fraihat. (2009) Effect of different nitrogen and sulphur fertilizer levels on growth, yield and quality of onion (*Allium cepa* L.). *Jordan Journal of Agriculture Sci*ence. 5(2), 155-166.

Altintas, S. & Bal, U. (2005). *Trichoderma harzianum* application increases cucumber (*Cucumis sativus*) yield in unheated glasshouse. *Journal of Applied Horticulture*. 7(1), 1-5.

Anonymous (2021). *Indian Horticulture Database*. Ministry of Agriculture, Government of India. www.nhb.gov.in.

Anonymous (2021). *Krishi Dainandini*. MPKV, Rahuri.

Anonymous (2021). *Krishi Dainandini*. VNMKV, Parbhani.

Anonymous (2021). https://agritimes.co.in/amp/horticulture/indias-horticulture-crops-production-estimated-331-05-mt-during-2020-21.

Apet, K.T. (2018). *Biomix consortium product of bioagents*. Department of Plant Pathology, College of Agriculture, VNMKV, Parbhani.

Aswani, G., Paliwal, R. & Sarolia, D.K. (2005). Effect of nitrogen and bio-fertilizer on yield and quality of rabi onion (*Allium cepa* l) cv. Puna red. *Agriculture Science Digest*. 25(2), 124 – 126.

Bharadwaj, V., Omanwar, P.K., Sharma, R.A. & Vishwanath. (1994). Long term effect of continuous rotational cropping and fertilization on crop yields and nutrient uptake. *Journal of Indian Society of Soil Science.* 42, 247-253.

Bhattarai, D.R. & Gautam, D.M. (2006). Effect of Harvesting Method and Calcium on Post-Harvest Physiology of Tomato. Nepal Agriculture Research Journal. 7(11), 37-41.

Brewster, J.L. (1994). Onions and other vegetable *Alliums (1st ed.). Wallingford, UK: Centre for Agriculture and Bioscience International.* 3(01), 16-21.

Elhassaneen, Y.A. & Sanad, M.I. (2009). Phenolics, selenium, vitamin C, amino acids and pungency levels and antioxidant activities in two Egyptian varieties. American Journal of Food Technology. 4(11), 241-254.

Flaig, W. and Saalbach, E. (1955). Zur Kenntnis von Huminsauren XII. Z. Pflanzenernaehr. Bodnekde. 71, 215-224.

Friesen, N., Fritsch, R., & Nlattner, F.R. (2006). Phylogeny and new intrageneric classification of *Allium* (Alliaceae) based on nuclear ribosomal DNA ITS sequences. Paper presented at: Proceedings of the Third International Conference on the Comparative Biology of the Monocotyledons, pp.28-32 (Rancho Santa Ana Botanic Garden, Claremont, California).

Fritsch, R.M. & Friesen, N. (2002). Evolution, Domestication & Taxonomy. In *Allium Crop Science*: Recent Advances, H.D. Rabinowitch, and L. Currah, eds. (Oxon: CABI Publishing). 2(05), 5-30.

Godara A.S. & Mehta, R. S. (2013). Response of onion (*Allium cepa* L.) to crop geometry and nitrogen levels. *Progressive Horticulture*. 45(1), 214-217.

Hou, W., Shen, J., Xu, W., Khan, M. R., Wang, Y., Zhou, X. & Zhang, Z. (2021). Recommended nitrogen rates and the verification of effect based on leaf SPAD readings of rice. PeerJ, 9, e12107. https://dx.doi.org/10.7717% 2Fpeerj.12107.

McCallum, J., Leite, D., Pither,-Joyce, M., & Havey, M.J. (2001). Expressed sequence markers for genetic analysis of bulb onion (*Allium cepa* L.). *Theoretical and Applied Genetics.* 1(03), 979-985.

Murkute, A.A. & Gopal, J. (2013). Taming the glut. Agric Today. 1(06), 28–30.

O'Donnel, R.W. (1973). The auxin like effects of humic preparation from leonardite. *Soil Sci*. 115, 106-112.

Panse, V. G. and Sukhatme, P. V. (1985). Statistical methods for Agricultural Workers, ICAR, New Delhi., 15(2): 164-168.

Ranganna, S. (1986). Handbook of analysis and Quality Control for Fruits and Vegetable Products, New Delhi: Tata Mc Grow Hill Publishing Co. Ltd.

Rani, K., Umesh, U. N. & Kumar, B. (2020). Effect of potash on yield and quality of onion (*Allium cepa* L.). *International Journal of Agriculture Science and Research (IJASR).* 10(3), 49–56.

Sangeetha, M. (2003). Effect of lignite humic acid on soil fertility, growth, yield and quality of onion. *M.Sc. thesis, Tamil Nadu Agricultural University, Coimbatore*.

Vairavan, C., Thiyageshwari, S., Malarvizhi, P. & Saraswathi , T. (2021). Response of growth, yield and quality of small onion (*Allium cepa* L. var. aggregatum don.) to Tamil Nadu Agricultural University-Water Soluble Fertilizers (TNAU-WSF). *Journal of Applied and Natural Science*. 13(4), 1350 - 1356.

Yadav, D. K. (2006). Integrated nutrient management in rabi onion (*Allium cepa* L.) under semi-arid condition. Ph. D. Thesis, Rajasthan Agricultural University.

Zdenek Sladky. (1959). The effect of extracted humus substances on growth of tomato plants. *Biologia plantarum*. 1(2), 142-150.