International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2023; 11(1): 25-30

Received: 03-10-2022
Accepted: 09-11-2022

Y Raja Joslin
Research Scholar, Department of vegetable science, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

P Irene Vethamoni
Dean, Horticultural College and Research Institute, Coimbatore, Tamil Nadu, India

K Rajappan
Professor, Horticultural College and Research Institute for Women, Trichy, Tamil Nadu, India

L Chithra
Professor, Horticultural College and Research Institute for Women, Trichy, Tamil Nadu, India

S Jeeva
Professor, Horticultural College and Research Institute for Women, Trichy, Tamil Nadu, India

Corresponding Author:
Y Raja Joslin
Research Scholar, Department of vegetable science, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Evaluation of organic production technologies for improvement of yield and quality of multiplier onion (*Allium cepa* L. *var. aggregatum*)

Y Raja Joslin, P Irene Vethamoni, K Rajappan, L Chithra and S Jeeva

Abstract
Onion is one of the important bulbous vegetable crop used as fresh vegetable and in Ayurveda system of medicine the residual effect due to chemical fertilizer is highly harmful to human being. Hence, development of organic cultivation practices is essential. The present experiment on "Evaluation of organic production practices for improvement of yield and quality of multiplier onion (*Allium cepa L. var. aggregatum*) cv. CO (On 5)" was carried out to find out the suitable organic nutrients combinations for higher yield during two cropping seasons in 2017-18 and 2018-19. The experiment was laid out in a Factorial Randomized Block Design. Totally 15 treatments were replicated in thrice. The Growth stimulators were sprayed twenty day after transplanting (DAP) and on 40th DAP. Among the different levels of treatments, significant increase in yield parameters was found in treatment T_9, Soil application of vermicompost 5 t ha^{-1} along with biofertilizer (*Azospirillum*, *phosphobacteria*, Potash mobilizing bacteria and Sulphur oxidizing bacteria each @ 2 kg ha^{-1} + VAM @ 12 kg ha^{-1}) and spraying of bio stimulant seaweed extract (0.1%) gave the maximum Bulb weight/ clump (14.22 g), plant height (25.73cm), Number of leaves/plant (11.46 Nos.), equatorial diameter of the bulblet (1.80 cm), polar diameter of the bulblet (2.48cm), bulb yield (8.98 t ha^{-1}). The results revealed that the overall performance of Treatment T_9 was superior to all the other treatments and this organic cultivation package is recommended in Ariyalur district, Tamil Nadu. After harvesting, the leaves were removed leaving 2.0cm neck space from the bulb and post-harvest quality characters were studied. It was found that Treatment T_9 recorded highest in quality characters *viz*., moisture content, TSS, pyruvic acid, ascorbic acid and soluble protein.

Keywords: Multiplier onion, organic nutrient, vermicompost, biofertilizer, bio stimulant, bulb yield

Introduction

Onion a biennial herb belonging to the family *Alliaceae*. Multiplier onion (*Allium cepa var. aggregatum*) is commercially grown in large scale in Tamil Nadu as short duration annual crop for its bulb. Multiplier onion is used both as raw and mature bulb stage as vegetable and spice. Multiplier onion is commercially propagated through seed bulbs. Multiplier onion (*Allium cepa* L. var. *aggregatum* Don.) is one of the most important commercial vegetable crops in Ariyalur and Perambalur Districts of Tamil Nadu. On global scale aggregatum onion is a minor bulb crop however in South East Asia especially in India it is a highly remunerative crop. The word "onion" is derived from Latin word which means "large pearl". The onion bulbs are rich in minerals, carbohydrates, proteins and vitamin C. Onions are rich in powerful sulphur containing compounds that are responsible for pungent odours and many of health promoting effects (Trivedi and Dhumal, 2013) [30]. It is a crop of tropical and subtropical region which are tolerant to hot and humid tropical climate, better tolerance to pest and diseases and have longer storage life than the common onion.

Multiplier onion is commonly propagated by bulbs rather than seed. The high cost of the seed material i.e., bulb cost is a major problem which drastically increases the cost of cultivation of multiplier onion.

The research studies on organic production technology in multiplier onion are very scanty. Indiscriminate use of chemical fertilizers and pesticides becomes health hazardous to human being as well as environment. Use of organic manures in commercial crop production is one of the best alternate methods and awareness on organic produce is being increased. Improvements of environmental conditions as well as public health are also important reasons for advocating increased use of organic material.

Maintenance of soil fertility is essential for optimum and sustained production. Inorganic fertilizers can be used to replenish soil nutrients and increase crop yields, but are too costly for the peasant farmers. The use of mineral fertilizers has been associated with increased soil acidity, nutrient imbalance and soil degradation (Kang and Juo, 1980) [12]. This has necessitated research on the use of organic manures. The use of organic materials has been proposed as one of the main pillars of sustainable agriculture as they provide large amounts of macro and micro nutrients for crop growth and eco-friendly besides being renewable alternatives to mineral fertilizers. Farmyard manure has been used as a soil conditioner since ancient times and its benefit have not been fully harnessed due to large quantities required in order to satisfy the nutritional needs of crops (Makinde *et al*., 2007) [13]. The need for renewable forms of energy and reduced cost of fertilizing crops, have revived the use of organic manures worldwide (Ayoola and Adeniran, 2006) [5]. Improvement in environmental conditions and public health are important reasons for advocating increased use of organic materials (Ojeniyi, 2000; Maritus and Vleic, 2001) [18]. At this junction standardization of organic protocols for crop production is important particularly in crop like onion. With this view the present investigation was carried out to find out the suitable organic inputs for growth and seed yield of multiplier onion.

In multiplier onion, var. CO (On) 5 has got better market preference because of its size and appealing colour. This variety of aggregatum onion is seedling transplanted which gives benefit to farmers in saving initial cost compared to other varieties where bulbs are used as planting material.

Onion is highly perishable, with poor keeping quality. In India, presently about 35 to 40 percent of the onion is estimated to be lost by post-harvest losses during various operations including handling and storage. The losses are mainly due to reduction in moisture and dry matter, sprouting and rotting. Though there are many research on post-harvest studies in onion with Organic manures, bio agents and spraying of growth stimulators of Seaweed extract (0.1%), Panchagavya (0.3%) and Humic acid treatment, the aims of this research was identification of suitable Organic manures and bio agents growth stimulators alternate to inorganic fertilizer to reduce the loss of quality and prolong the shelf life of onion. This study therefore, sought to determine the effect of Organic manures, bio agents and growth stimulators treatments on the quality and post harvest shelf life of onion bulbs.

Materials and Methods

A field experiment was carried out to study the effect of organic manures, biofertilizer and biostimulant on the growth and yield of multiplier onion (*Allium cepa* L. *var. aggregatum* Don.) in the farm field of ICAR Krishi Vigyan Kendra at cholamadevi village located in Ariyalur district of Tamil Nadu during the year 2017-18 and 2018-19.

Except FYM and vermicompost no other inorganic materials were incorporated in the identified field for the past 12 years. The site is located at 11º.140858' North latitude; 79º.405854' East longitude. The area usually receives annual rainfall of 954 mm, average maximum temperature of 39 ºC, average minimum temperature of 18 ºC and 66% Relative humidity. Texture of soil is sandy clay loam having 7.8 pH and 0.14 µmho/cm EC. Seedlings of CO (On) 5 varieties are used for cultivation. The experiment was laid out in a Factorial Randomized Block Design. Factor 1 was five levels of organic manures including basal soil application of FYM -25 t ha^{-1}, Vermicompost -5 t ha^{-1}, FYM -25 t ha^{-1} along with bio fertilizers (*Azospirillum*, *phosphobacteria*, Potash mobilizing bacteria and Sulphur oxidizing bacteria each @ 2 kg ha^{-1} + VAM @ 12 kg ha^{-1}), Vermicompost -5 t ha^{-1} along with bio fertilizers (*Azospirillum*, *phosphobacteria*, Potash mobilizing bacteria and Sulphur oxidizing bacteria each @ 2 kg ha^{-1} + VAM @ 12 kg ha^{-1}) and Control. Factor II was three levels of bio stimulants comprising humic acid @ 0.2%, sea weed extract @ 0.1% and Panchagavya @ 3%. All 15 treatments were replicated thrice. The organic manures- Vermicompost and FYM were applied in required quantities, Biofertilizer *viz*., *Azospirillum*, *phosphobacteria*, Potash mobilizing bacteria and Sulphur oxidizing bacteria each @ 2 kg ha^{-1} and VAM @ 12 kg ha^{-1} were basally applied in the main field.

The experimental field was ploughed three times by tractor and levelled to get fine tilth. Ridges and furrows were prepared at a distance of 20 cm. The preparation of plots and allocation of treatments were carried out according to the treatment schedule which were randomized. The main field was divided into 45 plots; each measuring 4m × 3m. Bulbs were planted along both the sides of the ridges at a spacing of 10 cm. Organic manures like FYM and Vermicompost were incorporated after the last ploughing in soil with spade. Before planting, biofertilizer like *Azospirillum*, *phosphobacteria*, Potash mobilizing bacteria and Sulphur oxidizing bacteria each @ 2 kg ha^{-1} and VAM inoculum @ 12 kg ha^{-1} were incorporated at the time of planting. Humic acid, Sea weed extract and Panchagavya all prepared as 0.2%, 0.1%, & 3% solution was sprayed twice on 20th and 40th days after transplanting in respective treatments. Five randomly selected plants in individual plot were tagged for recording observations and were statistically analyzed with SPSS software.

Multiplier onion seed varieties were sown in nursery during the second fortnight of September, 2017 and 45 DAS healthy seedlings of CO (On) 5 variety were transplanted at a spacing of 20cm x10 cm during the first week of November, 2017 and the second crop was raised in the second fortnight of March, 2018 and transplanted during the first week of May, 2018. Recommended cultural practices like seed treatment with *Pseudomonas fluorescence* @ 10g kg^{-1} of seed, Soil application of *Trichoderma Viridi* @ 2.5 kg ha^{-1}, seedling root dipping and basal manure application along with farm yard manure 25 t ha^{-1}and vermicompost 5 t ha^{-1}, Organic pest and disease management like spraying of *Pseudomonas fluorescens* (5 g lit^{-1}) + *Beauveria bassiana* (10 g lit^{-1}) on 30 DAP and Spraying of Azadiractin 1% (2 ml lit^{-1}) on 40 DAP, irrigation etc., were followed to raise the crop successfully. The observations recorded were plant height, number of leaves/plant, Equatorial and polar diameter of the bulblet, weight of bulb, No. of bulblets/clump and bulb yield.

Treatment Details

T$_1$: Soil application of FYM @ 25 t ha^{-1} + foliar spraying of humic acid (0.3%) on 20 & 40 DAP

T$_2$: Soil application of Vermicompost @ 5 t ha^{-1} + foliar spraying of humic acid (0.3%)

T$_3$: Soil application of FYM @ 25 t ha^{-1} + *Azospirillum*, *phosphobacteria*, PMB and SOB each @ 2 kg ha^{-1} + VAM @ 12 kg ha^{-1} + foliar spraying of humic acid (0.3%)

T$_4$: Soil application of Vermicompost @ 5 t ha^{-1} + *Azospirillum*, *phosphobacteria*, PMB and SOB each @ 2 kg ha^{-1} + VAM @ 12 kg ha^{-1} + foliar spraying of humic acid (0.3%)

T_5: No manure (control) + foliar spraying of humic acid (0.3%)

T_6: Soil application of FYM @ 25 t ha^{-1} + foliar spraying of Seaweed extract (0.1%)

T_7: Soil application of Vermicompost @ 5 t ha^{-1} + foliar spraying of Seaweed extract (0.1%)

T_8: Soil application of FYM @ 25 t ha^{-1} + *Azospirillum*, *phosphobacteria*, PMB and SOB each @ 2 kg ha^{-1} + VAM @ 12 kg ha^{-1} + foliar spraying of Seaweed extract (0.1%)

T_9: Soil application of Vermicompost @ 5 t ha^{-1} + *Azospirillum*, *phosphobacteria*, PMB and SOB each @ 2 kg ha^{-1} + VAM @ 12 kg ha^{-1} + foliar spraying of Seaweed extract (0.1%)

T_{10}: No manure (control) + foliar spraying of Seaweed extract (0.1%)

T_{11}: Soil application of FYM @ 25 t ha^{-1} + foliar spraying of Panchagavya (3.0%)

T_{12}: Soil application of Vermicompost @ 5 t ha^{-1} + foliar spraying of Panchagavya (3.0%)

T_{13}: Soil application of FYM @ 25 t ha^{-1} + *Azospirillum*, *phosphobacteria*, PMB and SOB each @ 2 kg ha^{-1} + VAM @ 12 kg ha^{-1} + foliar spraying of Panchagavya (3.0%)

T_{14}: Soil application of Vermicompost @ 5 t ha^{-1} + *Azospirillum*, *phosphobacteria*, PMB and SOB each @ 2 kg ha^{-1} + VAM @ 12 kg ha^{-1} + foliar spraying of Panchagavya (3.0%)

T_{15}: No manure (control) + foliar spraying of Panchagavya (3.0%)

Common practices for all treatments

1. Seed treatment with *Pseudomonas fluorescens* @10 g kg^{-1} of seed
2. Soil application of *Trichoderma viridi* @ 2.5 kg ha^{-1}
3. Spraying of *Pseudomonas fluorescens* (5 g $litre^{-1}$) + *Beauveria bassiana* (10 g $litre^{-1}$) on 30 DAP
4. Spraying of Azadiractin 1% (2 ml lit^{-1}) on 40 DAP

Result and Discussions

Organic farming or organic foods are becoming symbol of healthy living and common people are getting more and more aware about what they are consuming. Onions is among miraculous vegetable consumed as green and bulb as well as for many medicinal purposes. Results of growth, yield and quality characters are presented in the Table 1and 2. The data recorded on number of bulbs per plant, bulb diameter, bulb weight/clump, number of bulblets per clump and bulb yield per hectare as influenced by different organic manures, bio fertilizer, bio stimulants and their interaction effects are presented in the table-1.

Table 1: Effect of organic manures, bio fertilizers and bio stimulants on the growth and yield characteristics of multiplier onion.

Treatments	Plant height (cm)	Number of leaves/plant (Nos.)	Shoot to bulb ratio (%)	Equatorial diameter of the Bulblet (cm)	Bulb weight/ clump (g)	No. of Bulblets /Clump (Nos.)	Bulb yield (t ha^{-1})
T_1	23.25	10.14	0.51	1.69	12.69	3.32	7.88
T_2	23.95	10.44	0.53	1.71	12.93	3.39	8.29
T_3	24.78	10.19	0.56	1.75	13.10	3.40	8.57
T_4	25.29	11.36	0.57	1.80	13.19	3.41	8.81
T_5	18.38	7.47	0.45	1.58	11.48	2.21	5.64
T_6	23.71	10.64	0.56	1.70	13.02	3.31	8.10
T_7	24.52	10.34	0.57	1.73	13.14	3.43	8.47
T_8	25.27	11.32	0.60	1.79	13.86	3.45	8.78
T_9	25.82	11.50	0.61	1.83	14.22	3.49	8.98
T_{10}	18.88	7.46	0.45	1.58	11.70	2.35	5.86
T_{11}	23.49	9.32	0.47	1.69	12.33	3.21	7.97
T_{12}	24.28	10.33	0.52	1.72	13.05	3.37	8.37
T_{13}	25.01	10.62	0.54	1.76	13.01	3.39	8.60
T_{14}	25.69	11.35	0.59	1.81	13.47	3.45	8.91
T_{15}	18.64	7.53	0.44	1.58	12.26	2.75	5.82
Mean	23.40	10.00	0.53	1.71	12.90	3.19	7.94
S.Ed.	2.58	1.42	0.05	0.08	0.72	0.41	1.16
CD (0.05)	6.67	2.02	0.003	0.007	0.53	0.17	1.36

The result revealed that organic manures had significant influence on all the growth characters *viz*., plant height, number of leaves, Equatorial diameter of the bulblet, bulb weight, No. of bulblets and bulb yield. Among the different organic manures used soil application of vermicompost @ 5 t ha^{-1} excelled than other organic manures of the present study. Increased growth characters due to application of vermicompost might be due to the presence of micronutrients particularly magnesium an essential mineral for photosynthesis might have increased the photosynthetic rate resulted in increased growth. These results are in agreement with the findings of Nehra *et al*. (2001) [16] and Sanwal *et al*. (2007) [25]. Regarding plant height it was observed that significantly higher plant height of 25.82 cm was observed with soil application of vermicompost @ 5 t ha^{-1} (T_9). Application of organic manures significantly increased the number of bulbs per clump. Maximum number of bulbs per clump (3.49) was recorded in treatment T_9, application of vermicompost along with bio fertilizer and spraying of bio stimulant seaweed extract (0.1%) followed by treatment T_{14} (3.45). Organic manures improved the soil condition and leads to the better growth and yield. Similar results were reported by Sundharaiya *et al*. (2016) [28]. Significantly higher bulb weight per clump was recorded in treatment T_9, application of vermicompost along with bio fertilizer and spraying of bio stimulant seaweed extract (0.1%) (3.49) followed by treatment T_{14} (14.22g) whereas minimum bulb weight was recorded in control (11.48g). Increased application of organic manures increases onion bulb size. Application of higher amount of FYM makes unavailable sources of nutrients into available form and increased the nutrient uptake by plant which leads to increase in crop growth and yield. Similar result was also reported by Sundharaiya *et al*. (2016) [28]. From the result it was also

observed that the treatment T_9 and T_{14} were on par with each other. The other growth character *viz*., diameter of bulblet and number of leaves also showed a similar trend. Foliar application of bio stimulant also showed significant influence on all the growth characters. The increased growth attributes due to foliar application of seaweed extract might be due to increased root proliferation and establishment; thereby plants are able to uptake the nutrients even from the distance and deep place thus, increased nutrient uptake might have resulted in increased growth attributes. Crouch *et al*. (1990) [6] reported that seaweed extracts improve nutrient uptake by roots, resulting in root systems with improved water and nutrient efficiency thereby causing enhanced general plant growth and vigour. Similar reports also made by Singh and Chandel (2005) [22] in wheat and Sylvia *et al*. (2005) [29] in okra. Soil application of FYM in combination with fortnight foliar application of seaweed extract @ 0.1% produced very good plants with higher growth characters. The stimulating effect of seaweed extract on growth characters might be attributed to its essential action on enhancing cell division because it contains higher amounts of nutrients *viz*., (N,P,K, Mg, Ca, S, Cu, Fe, Mn, B and Mo), natural hormones like cytokinins, IAA and GA3, amino acids, vitamins and antioxidants (James,1994[11] and Soliman *et al*. 2000[27]) and these components play an important roles in improving cell division and the biosynthesis of organic foods. These results are in agreement with results of El-Sawy, (2005) [9] and Oraby, (2013) [19]. Soil application of FYM improves soil health and releases macro and micro nutrients and it maintain soil fertility and water holding capacity might have been the reason for increased yield traits in onion (Sandeep Kumar *et al*. 2016) [23]. Yield increases in seaweed treated plants are thought to be associated with the hormonal substances present in the extracts especially cytokinins. (Dogra and Mandradia, 2012) [7]. In addition to growth hormones, the increase in yield characters could be due to the fact that seaweed extracts contain macro, micronutrients and organic matters like, amino acids that improve vegetative growth and yield (Abd El-Migeed *et al*. 2004; Abd El-Moniem and Abd-Allah 2008) [1, 2] Interaction effect of organic manures and biostimulant showed non-significant effect on all the yield traits except number of bulblets. The increased yield observed by the soil application of organic manures and foliar application of bio stimulant might be due to increased plant height, leaf length, leaf breadth and number of leaves. Nutrients contained in organic manures are released more slowly and are stored for a longer time in the soil, thereby ensuring a long residual effect (Sharma and Mitra, 1991) [26] thus, supporting better root development, leading to higher crop yields (Abou El-Magd, 2005) [3]. The beneficial effect of seaweed extract on bulb yield could be due to the stimulatory influence of seaweed extract on triggering profuse plant growth. These results are in accordance with the findings of Arthur *et al*. (2003) [4]. Positive effect of farm yard manure and seaweed extract on bulb yield might be attributed to their essential role in balancing the ratio between carbohydrates and nitrogen in favour of flowering. The increased bulb yields due to vermicompost, biofertilizer and seaweed extract might have due to the beneficial effect of vermicompost, biofertilizer and seaweed extract on growth and bulb traits owing to the availability of macro and micro nutrients and growth hormones. Corroborative results are also made by Neumann and Zur-Nieden, (2001) [17]. From the results it was inferred that soil application of vermicompost 5 t ha^{-1}, biofertilizer and foliar application of seaweed extract @ 0.1percent had beneficial effect on plant vigour, bulb yield traits and bulb quality traits on multiplier onion cv. Co (On 5).

In aggregatum onion, the formation of bulblets starts from 40 DAP and the bulblet number varies based on the nutrient management in the land. In onion, the important yield contributing characters are mean weight of bulblets and bulb diameter. Increase in bulb yield was mainly attributed to positive association between yield and yield contributing parameters like bulb weight and size in terms of equatorial and polar diameters of the bulb. The findings of UD. Deen & MD. Mosleh (2008) [32] supported that increased yield may be because of difference in yield components as bulb volume, average weight of the bulbs and crop stand. Clump weight is the most important component that contributes directly to the yield of aggregatum onion (Shoba Thingalmaniyan *et al*. 2017) [20]. Onion is a crop of green harvest as well as bulb yield. Length of leaves have it importance not only as photo-synthetically active site but also as economic point. Application of FYM significantly enhanced the plant height (76.10 cm) over control (70.60 cm) in wheat (Singh and Agarwal 2001) [21]. The average number of leaves was noted maximum in the T_9 (11.50), followed by T_4 (11.34). The average bulb equatorial diameter was observed maximum in T_9 (1.83 cm) cm followed by T_{14} (1.81 cm). Similar result was recorded for garlic bulb diameter (3.95cm) over control (3.53cm) (Zakari *et al*., 2014) [35] and for onion (Soni *et al*. 2016) [24]. Above description suggests that application of Vermicompost along with combinations of bio fertilizers and bio stimulants increases the growth and yield parameter.

Application of vermicompost and biofertilizer improved the bulb dimension significantly. Increase in porosity and water holding capacity of the soil due to organic manures might have contributed in keeping the land favourable for accumulation of photosynthesis in underground organs, which ultimately would have resulted in increased bulb length and diameter. Further, there may be improved solubilization of plant nutrients due to combined application of vermicompost, farmyard manure and bio-fertilizers leading to increased uptake of NPK. Comparatively increased yield was also obtained due to application of farm yard manure. This may be attributed to the high amount of macro nutrients and other essential nutrients required for plant growth (Dekisissa *et al*. 2008) [8]. The use of such manure positively influences vegetative growth of plants due to better mineralization as stated by Elbehri *et al*. (1993) [10] in grain amaranth and by Ojeniyi and Sanni, (2000) in okra. Higher yield was also realized due to application of Vermicompost. This may be attributed to the high level of nutrients along with growth stimulating substances excreted by earthworms into their casts. The findings of Mohamed Rafi *et al*. (2002) [14] revealed that application of FYM 12.5 t ha^{-1} + Vermicompost 2.5 t ha^{-1} + Panchagavya 3% foliar spray improved the yield of tomato. Further, bulking after 40 days would have been supported by continuous supply of nutrients by the way of sprays (bio stimulants) that are linked to the increased bulb diameter as reported in large onion by Velu, (2002) [33] and in shallot onion by Yoldas *et al*. (2011) [34]. Such results of increased bulb weight, bulb yield per plant and bulb yield per hectare due to vermicompost and farmyard manure application could be attributed to easy solubilisation effect of released plant nutrients leading to improved nutrient status and water holding capacity of the soil. VAM are wide spread group of soil fungi that enhance yield of crops (Thanuja, 2002) [31]. Nagaraju *et al*. (2000) [15] reported that, the bulb diameter of onion significantly increased with the application

of VAM in combination with 50% SSP as compared to 100% SSP and no inoculation. In this experiment yield increase in seaweed treated plants are thought to be associated with the hormonal substances present in the extracts especially Cytokinin. Similar findings were reported by Dogra and Mandradia, (2012) [7] in onion plants.

Table 2: Effect of organic manures, bio fertilizers and bio stimulants on yield attributes Quality parameters of multiplier onion.

Treatments	TSS (Brix)	Ascorbic acid (mg/100g)	Pyruvic acid (µmol g^{-1})	soluble protein (mg g^{-1})
T_1	16.35	8.22	2.34	17.66
T_2	17.37	8.63	2.35	17.65
T_3	18.53	9.52	2.36	18.78
T_4	18.87	9.72	2.37	18.80
T_5	15.75	7.28	2.24	16.73
T_6	17.10	8.65	2.38	17.72
T_7	18.28	8.77	2.39	17.77
T_8	19.60	9.83	2.42	18.77
T_9	20.08	9.86	2.44	18.91
T_{10}	16.17	7.74	2.28	16.83
T_{11}	16.75	8.46	2.38	17.64
T_{12}	17.83	8.66	2.39	17.71
T_{13}	19.32	9.74	2.41	18.57
T_{14}	19.87	9.75	2.43	18.83
T_{15}	16.15	7.92	2.28	16.81
Mean	17.87	8.85	2.36	17.94
S.Ed	1.47	0.84	0.05	0.78
CD (0.05)	2.16	0.71	0.003	0.61

Among the different levels of Treatments, T_9 treatment application of vermicompost along with biofertilizer and spraying of bio stimulant seaweed extract (0.1%) recorded the highest values for all the quality traits like TSS (Brix), Ascorbic acid (mg/100g), Pyruvic acid (µmol g-1) and Soluble protein (mg g-1) observed. The next best treatment was T_{14} treatment application of vermicompost along with bio fertilizer and spraying of bio stimulant Panchagavya (3%). Foliar application of bio stimulants (seaweed) also had significant influence on quality of onion. Combined application of organic manures, bio fertilizer and bio stimulants also showed significant differences for all the quality parameters. The minimum was observed in control (T_5). Repeated usage of such inputs over a few years would establish the merits of using organic nutrients in terms of sustainability.

Conclusion

Present study concludes that vermicompost along with bio fertilizer and bio stimulant seaweed extract (0.1%) significantly influenced on various observed growth, yield and quality parameters in comparison to Farmyard Manure, FYM + bio fertilizer, vermicompost and control. Among all treatments T_9 (8.98 t ha^{-1}) showed optimum results. Even treatment T_{14} and T_8 showed better result over control. The results revealed that the overall performance of Treatment T_9 was superior to all the other Treatments and this organic cultivation package is recommended in Ariyalur district.

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