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Response of onion (*Allium cepa* L.) cv. pusa red to various organic manures under subtropical condition of Garhwal Himalaya

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Abstract
A field trial was conducted at Horticultural Research Centre, Chauras Campus, Department of Horticulture, H.N.B Garhwal University, Srinagar Garhwal, Uttarakhand, during winter season 2014-15 to evaluate the influenced of different organic manures and bio-fertilizer on various quantitative and qualitative traits of onion cv. Pusa Red. The whole research experiment was carried out in randomized block design with three replications. In this research trail, obtained results showed that the combined uses of organic manures is more effective compression to single organic manure. The results is vary scattered, the different combinations showed their superiority in different characters like, T_9 (CM+FYM) for bulb diameter (cm), fresh weight of bulb (g) and yield/plot (kg), T_{16} (CM+VAM+MOC) for plant height at 30 days after transplanting and leaf diameter T_{19} (NC+FYM+CM) for neck diameter, number of scales/ bulbs and T_{17} (VAM+MOC+NC) found best for plant height at harvesting and number of roots/ plant organic manures and bio-fertilizer, while for the quality parameters *viz.*, total soluble solids (^{0}Brix), ascorbic acid (mg/100g) and total soluble sugar T_{20} (CM+VAM+MOC+NC) gives the best results over all other treatments. The results showed that the combined use of organic and bio-fertilizer significantly effective on quality production of onion in Garhwal hills of Uttarakhand.

Keywords: onion, quantitative, qualitative, organic manures, bio-fertilizer and ascorbic acid

Introduction
Onion (*Allium cepa* L.) belongs to the family Amaryllidaceae and it is one of the most important monocotyledonous, cross-pollinated and cool season vegetable crops. According to Vavilov (1951) [1], the primary centre of origin lies in Central Asia and the Near East and the Mediterranean are the secondary centre of origin. Onion is an important vegetable crop worldwide and it has been used in various forms of the food. The genus *Allium* is very large with more than 500 species, which are mostly bulbous perennial plants. Two types of onions are commercially grown in India *i.e*., Common onion (*A. cepa* var. *Cepa*) and Multiplier onion (*A. cepa* var. *Aggregatum*). Onion is queen of the kitchen, it is the most important bulbous crop of India and cultivated under a wide range of climatic conditions. In India, onion is cultivated very extensively in Maharashtra and Gujarat as a cash crop due to its high potential for export. Onion bulbs are rich in minerals like phosphorus, calcium and carbohydrates. It is also widely used in salad, pickles, chutney, stew, flavorings, sauce and for preparation of certain other products and extracts like onion powder and onion salt. It is very useful for human beings because it has several nutritional and medicinal properties as mentioned by *Charaka* in "*Charaka Samhita*", a famous early medical treatise of India. Mostly in India red colour onion is preferred, while in Japan, Europe and America yellow colour varieties are preferred. Small sized onions are more nutritive comparison to large size. The pungency in onion is due to a volatile oil known as *allyl-propyl disulphide*. The outer skin colour is due to presence of *quercetin* (Thamburaj and Singh, 2003) [7]. Organic manure to meet the nutrient requirement of crops would be an inevitable practice in the years to come for sustainable agriculture since organic manure generally improves the soil's physical, chemical and biological properties along with conserving the moisture-holding capacity of the soil, and thus resulting in unenhanced crop productivity. The high cost and scarcity of inorganic fertilizer makes it not reliable. The amount of nutrients and the type of elements available from the specific organic fertilizer used is again dependent on the age, origin as well as climatic conditions such as temperature and rainfall (Grubinger, 1999; Lampkin, 2000 and FSSA, 2003) [6, 4, 3]. The bio-fertilizers are organic in origin and thus are absolutely safe, therefore, it is essential to adopt a strategy of integrated nutrient management using combination of chemical fertilizers, organic manures and bio-fertilizers so as to minimize the cost of production and to maintain biological productivity of soils, particularly because the farmers

are reluctant to adopt recommended fertilizer doses due to the high cost and risk of crop failure on account of aberrant weather conditions.

Materials and Methods

The experiment was carried out at Horticultural Research Centre, Chauras Campus, Department of Horticulture, H.N.B Garhwal University, Srinagar (Garhwal), Uttarakhand during winter season, 2014-2015. Srinagar (Garhwal) is located in the heart of Alaknanda valley (78° 47' 30" E longitude and 30° 13' 0" N latitude and at an elevation of 540 m above MSL), a semi-arid, subtropical climate with dry summer and rigorous winters with occasional dense fog in the morning hours from mid-December to mid-February. The experiment materials consist of four organic manures, one bio-fertilizer and their combinations *viz.*, farm yard manure 25t/ ha (FYM), mustard oil cake 3t/ha (MC), chicken manure 8t/ha (CM), neem cake 1t/ha (NC), *vesicular arbuscular mycorrhiza* (VAM), CM+VAM, CM+MOC, CM+NC, CM+FYM, VAM+MOC, VAM+NC, VAM+FYM, MOC+NC, MOC+FYM, NC+FYM, CM+VAM+MOC, VAM+MOC+NC, MOC+NC+FYM, NC+FYM+CM, CM+VAM+MOC+NC, CM+VAM+MOC+NC+FYM and control. The research work was conducted in Randomized Block Design with three replications. The entire experimental field was divided into three blocks and each block consisted of 22 plots of equal size including control. Onion seeds cv. Pusa Red was collected from IARI, New Delhi. The five week old seedlings of onion cv. Pusa Red were transplanted in flat beds during the January, 2015. Each experimental plot was measured 3.6 x 2.6 m^2 areas with 15 x 10 cm spacing. The onion seedlings were treated by VAM and the rest organic manures were applied 15 days before last ploughing. All the necessary intercultural operations and plant protection measures recommended for the quality crop growth. Five randomly selected plants from each plot per replication were tagged for the following observations *viz.*, plant height after 30 days of transplanting (cm), number of leaves after 30 days of transplanting, plant height at harvesting (cm), number of leaves at harvesting, leaf diameter (cm^2), leaf length (cm), neck length (cm), neck diameter (cm), number of roots per plant, fresh weight of bulb (gm), bulb diameter (cm), yield per plot (kg), number of scales per bulb, total soluble solids (^{o}Brix), ascorbic acid (mg $100g^{-1}$) and total soluble sugar (%) for statistical analysis. The obtained data were analyzed using analysis of variance (ANOVA) under RBD following the procedure as stated by Panse and Sukhatme (1985) [2].

Result and Discussion

Growth parameters

The result presented in table 1 showed that there was a significant effect of various organic manure on growth parameters of onion plants.The maximum (22.10 cm) plant height 30 days after transplant was recorded in treatment T_{16} (CM+VAM+ MOC), whereas minimum (10.61cm) in T_{22} (control). The maximum number of (3.83) leaves 30 days after transplanting per plant was recorded in treatment T_6 (CM+VAM), on other hand the treatment T_{22} (control) showed minimum (2.67) number of leaves per plant after 30 days after transplanting. The maximum plant height (78.26 cm) at harvest was reported in treatment T_{17} (VAM+MOC+NC) and minimum (53.50 cm) in treatment T_{22} (control). These findings confirm the results obtained by Brinjh *et al*., (2014) [16] onion. The maximum (9.43) number of leaves per plant at the harvest was found in treatment T_7 (CM+MOC), while minimum (7.13) in the treatment T_9 (CM+FYM). These results are in accordance with the investigation of Jayathilake *et al*., (2002) [5] and Barman *et al.,* (2013) [13] in onion. The combined doses of organic manures significantly influenced the leaf length of onion. The maximum length of leaf (65.24 cm) was found under the treatment T_{10} (VAM+MOC), whereas the minimum (46.24cm) length of leaf was reported in the treatment T_{22} (control). These results are in accordance with the investigation of Kisetu and Joseph (2013) [14] and Rather *et al.,* (2003) [8] in onion. The maximum (2.57 cm) leaf diameter was found in T_{16} (CM+ VAM+MOC), while the treatment T_{22} (control) showed the minimum (1.57 cm). These results are in accordance with those of Brinjh *et al.,* (2014) [16] and Zedan *et al.,* (2011) [11] in onion. The maximum (4.47cm) neck length was recorded in treatment T_{22} (control) and the minimum (1.80cm) in treatment T_{10} (VAM+MOC). Jayathilake *et al*., (2003) [5] reported the similar results with respect to neck length in onion. The maximum (1.80 cm) neck diameter was recorded in treatment T_{19} (NC+FYM+CM). On the other hand, the minimum (1.43 cm) neck diameter was observed in treatment T_{22} (control). These results are in accordance with the investigation of Magdi and Mohamed (2009) [10] in onion.

Yield and quality parameters

The performance of onion cv. Pusa Red with respect to yield and quality was significantly influenced by the various organic manure.The treatment T_{17} (VAM+MOC+NC) showed the maximum (104.53) number of roots per plant, while the minimum (82.4) in the treatment T_{20} (CM+VAM+ MOC+NC). Similar result is reported by Kumar *et al.,* (2013) [15] in radish. Increase in fresh weight of bulb was slow in early stage of growth and a faster at later stage. As the plant leaves and roots system improved, the bulb development progressed significantly. The maximum (160.15gm) fresh weight of bulb was found in treatment T_9 (CM+FYM), while the minimum (40.25 gm) in treatment T_{22} (control). These results are in accordance with those of Brinjh *et al.,* (2014) [16], Mandloi *et al*., (2008) [9] and Bangali *et al*., (2012) [12] in onion. Bulb diameter in onion was significantly affected by combination of organic manure. These finding may be due to improved physiological activities like, photosynthesis during which food is manufacture by the leaves and tarns to bulb. The maximum (5.25cm) bulb diameter was recorded under treatment T_9 (CM+FYM). On other hand minimum diameter (4.01 cm) was observed in the treatment T_{22} (control). The findings are in accordance with the investigation Mandloi *et al*., (2008) [9] in onion. An increase in yield of onion is directly correlated with the bulb diameter and bulb weight. This increase may be due to rapidly increased photosynthetic activities and assimilation of photosynthesis to growing bulbs. These finding are in agreement with the investigation of Damse *et al*., (2014) [17] in garlic and Meena *et al*., (2015) [19] in onion. The maximum yield per plot (35.18kg) was recorded under T_9 (CM+FYM) where as the lowest yield (15.86 kg) was found under treatment T_{22} (control). The maximum scales per bulb (11.07/bulb) were recorded in treatment T_{19} (NC+FYM+CM) while the minimum number of scales (7.53/bulb) was recorded under in treatment T_{22} (control). These results are in accordance with the investigation of Naik *et al.,* (2014) [18] and Rather *et al.,* (2003) [8] in onion. In general, all the chemical constituents studied were increased by organic manures as compared to control. Combined organic manures were more effective than that of individuals. Quality is one of the most important traits of any crop that

improves their market values. In onion the maximum TSS (15.39°Brix) was found in treatment T_{20} (CM+VAM+MOC+NC) where as the minimum TSS (10.37 °Brix) was found under the treatment T_{22} (control). Ascorbic acid content in onion is accelerated by the activity of oxidize enzyme in presence of organic manures. The maximum ascorbic acid content (13.41 mg/100g) was found with treatment T_{20} (CM+VAM+MOC+NC) while as the minimum ascorbic acid content (11.84mg/100g) was recorded with treatment T_{22} (control). Most of the sucrose formed in matured leaves might have been transported to growing and storage tissue. The maximum total soluble sugar (12.58%) was found under treatment T_{20} (CM+VAM+MOC+NC). The minimum total soluble sugar (10.21%) was found under treatment T_{22} (control).

Table 1: Effect of organic manures on various growth parameters of onion cv. Pusa Red

Treatments	Plant height (cm) 30 ATP	Number of leaves 30 ATP	Plant height (cm) harvesting	Number of leaves harvesting	Leaf diameter (cm)	Leaf length (cm)	Neck length (cm)	Neck diameter (cm)
CM (T_1)	16.41	3.30	55.28	8.57	1.83	52.25	2.30	1.33
VAM (T_2)	15.70	2.73	57.64	8.23	1.97	50.16	3.70	1.27
MC (T_3)	17.47	3.27	58.24	8.27	1.87	51.35	2.93	1.50
NC (T_4)	15.61	3.10	60.23	8.03	1.83	55.66	3.57	1.47
FYM (T_5)	16.33	3.30	61.57	7.43	2.02	54.51	4.30	1.50
CM+VAM (T_6)	20.18	3.83	60.13	7.77	2.02	58.30	4.43	1.33
CM+MOC (T_7)	17.32	3.07	54.69	9.43	2.30	59.13	4.13	1.40
CM+NC (T_8)	18.50	3.40	69.35	7.47	2.07	61.35	3.63	1.73
CM+FYM (T_9)	16.28	3.27	64.20	7.13	2.07	55.56	3.63	1.43
VAM+MOC (T_{10})	18.37	3.33	72.36	7.50	2.07	65.24	1.80	1.20
VAM+NC (T_{11})	14.67	3.00	56.17	7.30	2.04	58.17	2.50	1.43
VAM+FYM (T_{12})	12.42	3.20	59.31	8.00	2.22	57.20	3.03	1.33
MOC+NC (T_{13})	17.03	3.27	70.14	8.80	2.20	58.18	2.57	1.30
MOC+FYM (T_{14})	19.23	3.23	75.67	7.80	2.13	63.36	2.20	1.30
NC+FYM (T_{15})	17.47	3.27	63.40	7.70	2.20	61.46	2.80	1.43
CM+VAM+MOC (T_{16})	22.10	3.27	75.34	8.20	2.57	61.07	3.03	1.53
VAM+MOC+NC (T_{17})	20.57	3.20	78.26	9.10	2.17	64.56	2.73	1.37
MOC+NC+FYM (T_{18})	17.67	3.23	56.46	7.37	2.10	60.25	3.27	1.50
NC+FYM+CM (T_{19})	17.50	3.30	62.57	7.63	2.40	59.57	3.67	1.83
CM+VAM+MOC+NC (T_{20})	20.12	3.33	71.24	7.97	2.30	58.62	3.13	1.50
CM+VAM+MOC+NC+FYM (T_{21})	18.43	3.33	67.62	7.77	2.17	52.32	3.00	1.43
Control (T_{22})	10.61	2.67	53.50	7.37	1.57	46.24	4.47	1.43
S.Em.±	00.09	0.06	00.05	0.05	0.04	00.06	0.06	0.04
C. D. at 5%	00.27	0.19	00.14	0.15	0.12	00.17	0.18	0.13

Table 2: Effect of organic manures on various yield and quality parameters of onion cv. Pusa Red

Treatment	Number of roots /plant	Fresh weight of bulb (g)	Bulb diameter (cm)	Yield per plot (kg)	Number of scales/bulb	TSS (°Brix)	Ascorbic acid (mg $100g^{-1}$)	Total soluble sugar (%)
CM (T_1)	83.50	130.14	4.30	28.15	10.13	12.57	12.33	11.28
VAM (T_2)	96.29	120.46	4.32	26.62	10.27	13.21	12.59	11.59
MC (T_3)	89.20	129.71	4.74	30.69	09.01	13.65	12.18	12.06
NC (T_4)	96.27	130.67	4.58	29.63	09.83	12.02	11.99	11.60
FYM (T_5)	83.35	119.61	4.79	25.18	10.47	12.96	12.06	12.08
CM+VAM (T_6)	101.24	136.98	4.72	31.12	10.13	14.00	12.60	11.97
CM+MOC (T_7)	97.49	115.30	4.12	22.52	09.63	15.18	13.03	12.12
CM+NC (T_8)	099.22	101.98	4.02	20.62	10.00	12.96	12.97	11.54
CM+FYM (T_9)	92.01	160.15	5.25	35.18	09.50	12.53	12.98	12.30
VAM+MOC (T_{10})	95.27	150.25	4.12	32.73	09.43	14.23	11.95	10.64
VAM+NC (T_{11})	101.67	151.84	4.05	30.82	09.57	14.55	12.07	10.87
VAM+FYM (T_{12})	94.87	158.65	5.18	34.16	08.20	13.80	13.02	11.08
MOC+NC (T_{13})	83.30	153.48	5.10	32.12	09.53	12.64	12.60	11.05
MOC+FYM (T_{14})	83.33	155.88	5.17	33.65	09.10	13.29	13.15	11.12
NC+FYM (T_{15})	90.47	115.44	4.98	29.62	10.10	12.49	12.12	11.50
CM+VAM+MOC (T_{16})	95.60	122.50	5.02	31.62	10.27	13.98	12.07	12.04
VAM+MOC+NC (T_{17})	104.53	112.29	4.82	22.52	09.60	13.79	11.98	11.02
MOC+NC+FYM (T_{18})	99.37	110.24	5.10	28.62	09.73	14.19	12.36	10.58
NC+FYM+CM (T_{19})	83.43	110.27	5.11	29.58	11.07	12.38	12.21	11.40
CM+VAM+MOC+NC (T_{20})	82.40	100.99	4.96	22.69	10.17	15.39	13.41	12.58
CM+VAM+MOC+NC+FYM (T_{21})	89.20	099.42	4.82	19.62	09.73	13.16	12.14	11.16
Control (T_{22})	85.23	040.25	4.01	15.86	07.53	10.37	11.85	10.21
S.Em.±	000.35	000.07	0.04	00.03	00.05	00.05	00.02	00.02
C. D. at 5%	001.00	000.21	0.12	00.09	00.16	00.15	00.07	00.07

Conclusion

On the basis of results obtained from the present investigation, it may be concluded that the treatment T_9 (CM+FYM) is showed superiority for bulb diameter (cm), fresh weight of bulb (g) and yield/plot (kg) over the other treatments. On the other hand, for quality characters *viz.*, total soluble solids (^{0}Brix), ascorbic acid (mg/100g) and total soluble sugar the treatment T_{20} (CM+VAM+MOC+NC) reported best results over all other treatments. Hence, these two treatments should be use to enhance the production of onion under Garhwal region.

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