

ISSN 1819-1894

Asian Journal of
Agricultural
Research



Research Article

Impact Assessment of Different Organic Manures on Growth, Morphology and Yield of Onion (*Allium cepa* L.) Cultivar

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Abstract

Background and Objective: Fertilizers are essential for agricultural productivity and provide necessary plant nutrients. A field experiment was conducted at Horticultural Research Centre, Chauras Campus, Department of Horticulture, H.N.B Garhwal University, Srinagar Garhwal, Uttarakhand. **Materials and Methods:** During winter season 2014-15 to evaluate the influence of different organic manures and bio-fertilizer on various quantitative and qualitative traits of onion cv. Pusa Red. **Results:** Results of the study showed that the combined uses of organic manures are more effective as compared to single applied organic manure. In our study combined applied fertilizer enhanced growth and morphology and biochemical characteristic of plant. Yield characteristic including bulb diameter (cm), fresh weight of bulb (g) and total yield (kg/plot) was also higher in combined uses of fertilizer treated plants. **Conclusion:** Study concluded that the efficacy of bio fertilizers can be enhanced by increasing the combined dose of bio-fertilizers and provide suitable carriers to replace chemical fertilizers load for cultivation with eco-friendly and organic nutrient technologies.

Key words: Onion, organic manures, growth, morphology, bio-chemical characteristic, yield

Citation: Khulakpam Naseeruddin Shah, Indra Jeet Chaudhary, Deepak Kumar Rana and Vivek Singh, 2019. Impact assessment of different organic manures on growth, morphology and yield of onion (*Allium cepa* L.) cultivar. Asian J. Agric. Res., 13: 20-27.

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Fertilizers including chemical and bio fertilizers are essential for plant growth and productivity. Fertilizers provide necessary plant nutrients, however, use of synthetic chemical fertilizers are no more considered as ecologically suitable. The alternative nutrient sources e.g., organic fertilizers have been applied to reduce the load of chemical fertilizers^{1,2}. In recent years, bio fertilizers used as an important component of nutrient supply system and to improve crop yield².

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 Vavilov³, the primary center 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*⁴.

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 rainfall⁵⁻⁷. 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.

Henceforth, the present study is aimed to investigate the suitable bio fertilizer for a sustainable agricultural crop. It hypothesized that the selection of the organic manure is a most important parameters for sustainable agriculture.

MATERIALS AND METHODS

Experimental design: 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, sub-tropical 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 25 t ha⁻¹ (FYM), mustard oil cake 3 t ha⁻¹ (MC), chicken manure 8 t ha⁻¹ (CM), neem cake 1 t ha⁻¹ (NC) and *vesicular arbuscular mycorrhiza* (VAM) given in Table 1. The research study 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 (3.6 × 2.6 m² areas with 15 × 10 cm spacing) including control. Onion seeds cv. Pusa Red was collected from IARI, New Delhi. The 5 week old seedlings of onion cv. Pusa Red were transplanted in flat beds during the January, 2015. The onion seedlings were treated by VAM and the rest organic manures were applied 15 days before last plugging. 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 morphology and biomass and yield characteristics.

Plant growth and morphology: Root shoots length and plant height was determined by a meter scale and it's expressed in cm/plant. Collected plant samples were washed

Table 1: Treatments

| Treatments | Abbreviations | Combination of manure |
|------------|-------------------|-----------------------------------------------------------------------------------------------------------|
| T1 | Control | ---- |
| T2 | CM | Chicken manure |
| T3 | VAM | <i>Vesicular arbuscular mycorrhiza</i> |
| T4 | MC | Mustard oil cake |
| T5 | NC | Neem cake |
| T6 | FYM | Farm yard manure |
| T7 | CM+VAM | Chicken manure + <i>Vesicular arbuscular mycorrhiza</i> |
| T8 | CM+MOC | Chicken manure + mustard oil cake |
| T9 | CM+NC | Chicken manure + Neem cake |
| T10 | CM+FYM | Chicken manure + Farm yard manure |
| T11 | VAM+MOC | <i>Vesicular arbuscular mycorrhiza</i> + Mustard oil cake |
| T12 | VAM+NC | <i>Vesicular arbuscular mycorrhiza</i> + Neem cake |
| T13 | VAM+FYM | <i>Vesicular arbuscular mycorrhiza</i> + Farm yard manure |
| T14 | MOC+NC | Mustard oil cake + Neem cake |
| T15 | MOC+FYM | Mustard oil cake + Farm yard manure |
| T16 | NC+FYM | Neem cake + Farm yard manure |
| T17 | CM+VAM+MOC | Chicken manure + Farm yard manure + Mustard oil cake |
| T18 | VAM+MOC+NC | <i>Vesicular arbuscular mycorrhiza</i> + Mustard oil cake + Neem cake |
| T19 | MOC+NC+FYM | Mustard oil cake + Neem cake + Farm yard manure |
| T20 | NC+FYM+CM | Neem cake + Farm yard manure + Chicken manure |
| T21 | CM+VAM+MOC+NC | Chicken manure + <i>Vesicular arbuscular mycorrhiza</i> + Mustard oil cake + Neem cake |
| T22 | CM+VAM+MOC+NC+FYM | Chicken manure + <i>Vesicular arbuscular mycorrhiza</i> + Mustard oil cake + Neem cake + Farm yard manure |

thoroughly and the excessive water was dried by tissue paper. These plants were separated into parts and kept in the hot air oven at 80°C till a constant weight achieved. Number of leaves, leaf diameter (cm²), leaf length (cm), neck length (cm), neck diameter (cm), number of roots per plant was also analyzed at 30 DAS, 60 DAS and 90 DAS.

Biochemical and yield characteristics: Yield characteristics were measured such as fresh weight of bulb (g plant⁻¹), bulb diameter (cm), yield per plot (kg) and number of scales per bulb after DAH. Analysis of total soluble solids (°Brix), ascorbic acid (mg 100 g⁻¹) and total soluble sugar (%) was also opted at DAH of plant.

Statistical analysis: Data were analyzed using principal component analysis (PCA) bi-plot: Standardized PC1 and PC2 scores are plotted in software Origin Pro (2019).

RESULTS

Growth and morphological characteristics: Result of study showed various organic manures increased the plant growth, morphology and biomass of onion plant (Fig. 1). The maximum number of leaves was recorded (3.83 plant⁻¹) in treatment T₇ (CM+VAM) at 30 DAS on other hand the treatment T₂₂ (control) showed minimum (2.67) number of leaves/plant at same DAS. The maximum (9.43) number of leaves/plant at the harvesting time was found in treatment

T₈ (CM+MOC), while minimum (7.13) in the treatment T₁₀ (CM+FYM). The treatment T₁₈ (VAM+MOC+NC) showed the maximum (104.53) number of roots/plant, while the minimum (82.4) in the treatment T₂₁ (CM+VAM+ MOC+NC) (Fig. 1).

The combined doses of organic manures significantly influenced the leaf length and root length of onion. The maximum length of leaf (65.24 cm) was found under the treatment T₁₁ (VAM+MOC), whereas the minimum (46.24 cm) length of leaf was reported in the treatment T₁ (control) (Fig. 1).

Combine dose of organic manures was also enhanced the total plant height of onion plant. The maximum plant height was observed (22.10 cm) at 30 DAS in treatment T₁₇ (CM+VAM+MOC), whereas minimum (10.61 cm) in T₁ (control). The maximum plant height of harvested plant was found in treatment T₁₈ (VAM+MOC+NC) (78.26 cm) and minimum in treatment T₁ (control) (53.50 cm). Over all increment of plant height was observed maximum in treatment T₁₈ (30.79%) as compared to control plant (Fig. 1).

Chemical characteristics: 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 higher value of TSS (15.39°Brix) was observed in treatment T₂₁ (CM+VAM+MOC+NC) whereas the lowest in

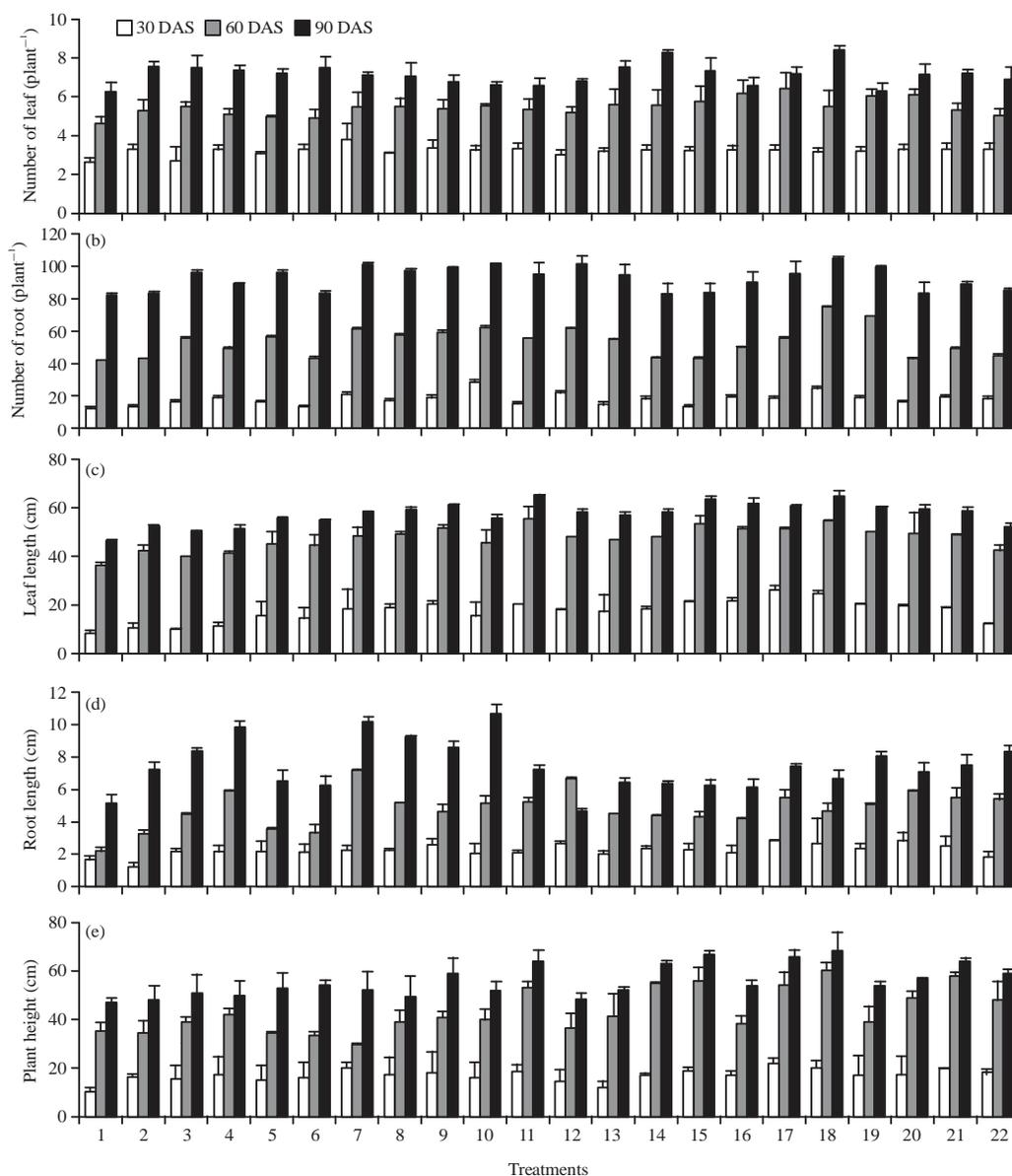


Fig. 1(a-e): Effect of different organic manures composition on (a) Number of leaf, (b) Number of root, (c) Leaf length (cm), (d) Root length (cm) and (e) Plant height (cm) of onion cv. Pusa Red
Standard deviation represented in each bars

(10.37°Brix) treatment T₁ (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/100 g) was found with treatment T₂₀ (CM+VAM+MOC+NC) while as the minimum ascorbic acid content (11.84 mg/100 g) was recorded with treatment T₁ (control) (Fig. 2). 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 T₂₁ (CM+VAM+MOC+NC). The

minimum total soluble sugar (10.21%) was found under treatment T₁ (control) (Fig. 2).

Yield characteristics: Yield characteristics were significantly increased by various applications of organic manures. On the basis of bulb and yield characteristic result is showed in Fig. 3.

Bulb diameter and number of scale: Bulb diameter in onion was significantly affected by combination of organic manures. These finding may be due to improved physiological activities

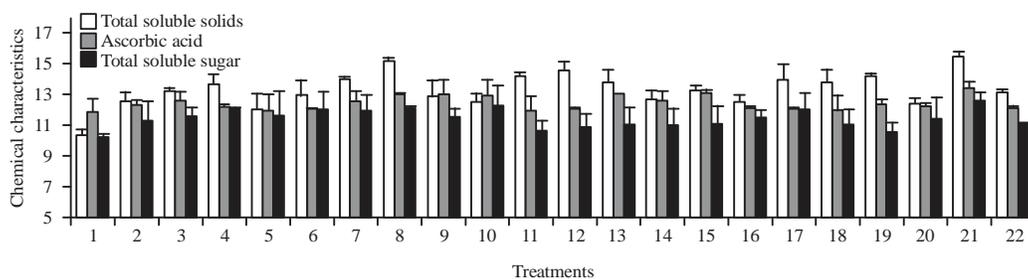


Fig. 2: Effect of different organic manures composition on total soluble solids (°Brix), ascorbic acid (mg/100 g) and total soluble sugar (%) of onion cv. Pusa Red
Standard deviation represented in each bars

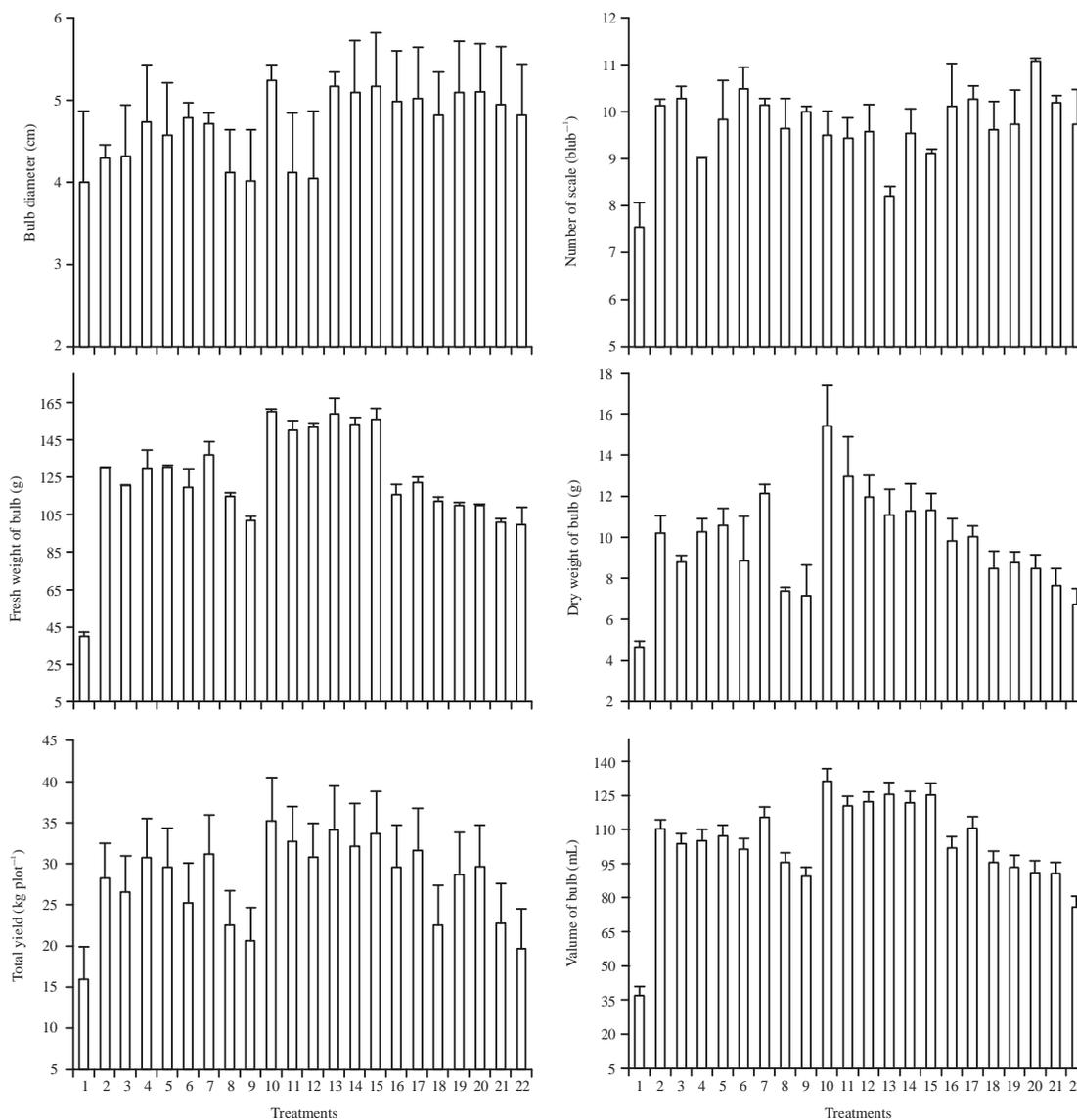


Fig. 3(a-f): Effect of different organic manures composition on (a) Neck length (cm), (b) Neck diameter (cm), (c) Bulb diameter (cm), (d) Number of scale (bulb⁻¹), (e) Fresh weight of bulb (g) and (f) Yield (kg/plot) and volume of bulb (mL) of onion cv. Pusa Red
standard deviation represented in each bars

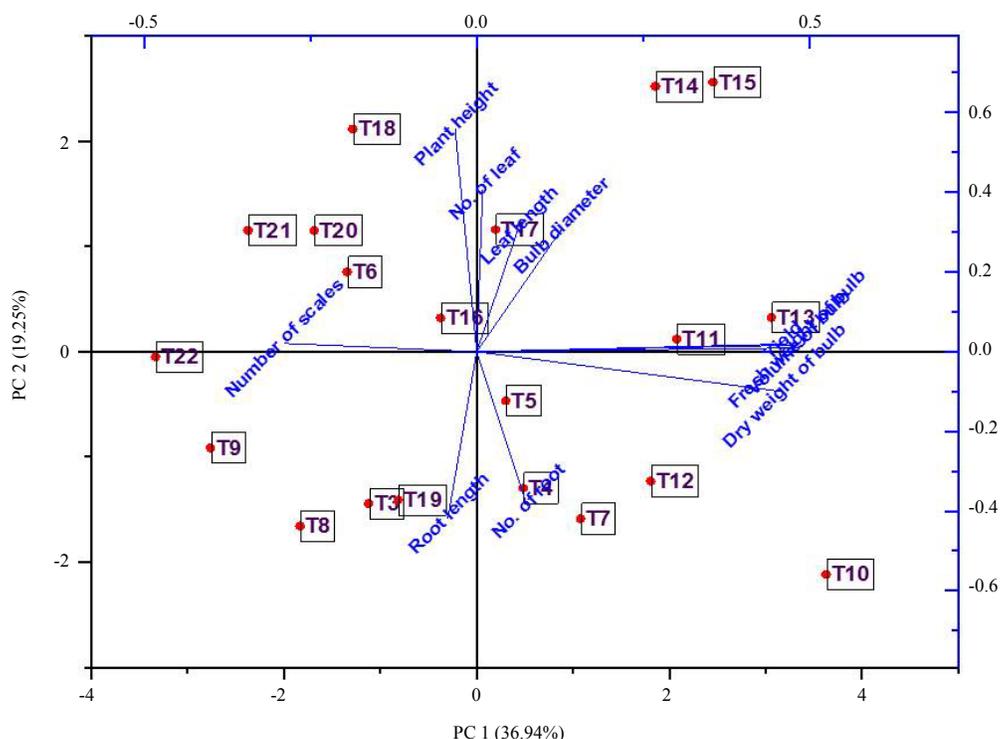


Fig. 4: Principle component analysis (PCA) correlates bi-plot responses to various treatments. Symbol represent the standardized scores on PC1 (x-axis) and PC2 (y-axis) for the organic manures treatment of onion cv. Pusa Red. Vector coordinates represent the correlations between standardized variables and principle components (PCs)

like, photosynthesis during which food is manufacture by the leaves and tarns to bulb. The maximum (5.25 cm) bulb diameter was recorded under treatment T₁₀ (CM+FYM). On other hand minimum diameter (4.01 cm) was observed in the treatment T₁ (control). While maximum scales per bulb (11.07/bulb) were recorded in treatment T₂₀ (NC+FYM+CM) and minimum number of scales (7.53/bulb) was recorded under in treatment T₁ (control).

Fresh and dry weight of bulb: 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 (160.15 g) fresh weight of bulb was found in treatment T₁₀ (CM+FYM), while the minimum (40.25 g) in treatment T₁ (control).

Total yield and volume of bulb: An increase in yield of onion is directly correlated with the bulb diameter and bulb weight. This increase may be due to rapidly increased photo-synthetic activities and assimilation of photosynthesis to growing bulbs. The maximum yield per plot (35.18 kg) was recorded under T₁₀ (CM+FYM) whereas the lowest yield (15.86 kg) was found

under treatment T₁ (control). Application of organic manure increased the yield of onion i.e., T₁₀ (54.91%) > T₁₃ (53.57%) > T₁₅ (52.86%) > T₁₁ (51.54%) > T₁₄ (50.62%) > T₁₇ (49.84%) > T₇ (49.03%) > T₁₂ (48.53%) > T₄ (48.32%) > T₅ (46.47%) > T₁₆ (46.45%) > T₂₀ (46.38%) > T₁₉ (44.58%) > T₂ (43.65%) > T₃ (40.42%) > T₆ (37.01%) > T₂₁ (30.10%) > T₁₈ (29.57%) > T₈ (29.57%) > T₉ (23.08%) > T₂₂ (19.16%) as compared to control.

PCA analysis: Data was analyses by Past3 software for PCA analysis of correlation between treatments on onion plant. Two component of PCA showed total variability 36.94% for PC1 and 19.25% for PC2 (Fig. 4). Resultant combined organic manure applied treatment showed the variation with positive correlation.

DISCUSSION

Crop loss due to nutrient unavailability is well documented in the literature with species and cultivar level variability to fertilizers. Variability among the plant cultivar can provide an opportunity for selecting most effective bio fertilizers. Result of the experiment showed that the organic manures increased growth and productivity of onion

cultivar (*Allium cepa* L.). Various study reported that the effectiveness of bio-fertilizer on agricultural crops. In our study using different type of combine organic manure and applied on onion plant for observation of their effectiveness. Result of study showed various combined organic manures increased the plant growth and biomass of onion plant (Fig. 1). Chaudhary and Singh⁸ was also reported that organic matrix based bio fertilizer enhanced the growth and yield of wheat cultivar.

Number of leaf and root is one of the most important growth parameter. In our study number of leaf and root was also higher in combine applied organic manure. The maximum number of leaves was recorded at 30 DAS of plant in treatment T₇ (CM+VAM), on other hand the treatment T₂₂ (control) showed minimum number of leaves/plant at same days. At the end of harvesting time maximum number of leaves/plant was found in treatment T₈ (CM+MOC) >T₁₀ (CM+FYM). Same result was also reported by Jayathilake *et al.*⁵ and Barman *et al.*⁹ in onion plants. The treatment T₁₈ (VAM+MOC+NC) showed the maximum number of roots/plant, while the minimum in the treatment T₂₁ (CM+VAM+MOC+NC). In case of root, similar result is reported by Kumar *et al.*¹⁰ in radish plant.

The combined doses of organic manures significantly influenced the leaf length and root length of onion plant. The maximum length of leaf and root was found under the treatment T₁₁ (VAM+MOC), whereas the minimum in the treatment T₁ (control). Kisetu and Joseph¹¹ and Rather *et al.*¹² were also reported organic manure enhanced leaf length of onion plant. Application of combine organic manure increased total plant height of onion plant. The combined applied organic manure, maximum increment of plant height was reported in treatment T₁₈ (VAM+MOC+NC) as compared to treatment T₁ (control). Same study reported by Brinjh *et al.*¹³ on onion plant.

Biochemical characteristic is a most important parameter of plant physiology. Applied organic manures significantly increased the chemical properties of plants. In this study combined organic manures were more effective than individuals. In other word, if the agricultural crop is healthy and qualitative then increased the market value. In this experimental study, TSS (15.39°Brix) of the plant was increased in treatment T₂₁ (CM+VAM+ MOC+NC) as compared to no fertilizer treatment T₁ (control). Ascorbic acid content and total soluble sugar were higher in combine applied organic manures in onion plant. Ascorbic acid accelerated by the activity of oxidize enzyme in presence of organic manures. Maximum sucrose was formed in matured

leaves might have been transported to growing and storage tissue. In our study maximum total soluble sugar was found in treatment T₂₁ (12.58%) and minimum in control (10.21%).

Yield characteristic including bulb diameter, number of scale and fresh and dry weight of bulb and total yield of plant indicate the health of plant. 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 tans to bulb. The higher value of bulb diameter was recorded in treatment T₁₀ (CM+FYM) as compared to control plants. The findings are in accordance with the investigation¹⁴ in onion. An others yield parameter, the number of scale per bulb was higher in treatment T₂₀ (NC+FYM+CM) as compared to treatment T₁ (control). Same results are investigated by Naik *et al.*¹⁵ and Rather *et al.*¹² in onion plant.

In our study fresh and dry weight of bulb increased in combined applied organic manure. 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 (160.15 g) fresh weight of bulb was found in treatment T₁₀ (CM+FYM), while the minimum (40.25 g) in treatment T₁ (control). These results are in accordance with those of Brinjh *et al.*¹³, Mandloi *et al.*¹⁴ and Bagali *et al.*¹⁶ in onion.

The performance of onion cv. Pusa Red with respect to yield and quality was significantly influenced by the various organic manures. An increase in yield of onion is directly correlated with the bulb diameter and bulb weight. This increase may be due to rapidly increased photo synthetic activities and assimilation of photosynthesis to growing bulbs. Same study was report given by Damset *et al.*² in garlic and Meena *et al.*¹⁷ in onion.

CONCLUSION

On the basis of results obtained from the present investigation, it may be concluded that the treatment T₁₀ (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 (°Brix), ascorbic acid (mg/100 g) and total soluble sugar the treatment T₂₁ (CM+VAM+MOC+NC) reported best results over all other treatments. Hence, these 2 treatments should be used to enhance the production of onion under Garhwal region.

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