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Impact of organic manures and biofertilizers on growth and yield of onion (*Allium cepa* L.)

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Abstract
The field experiment with onion crop was carried out at Campus for Research and Advanced Studies, Dhablan, PG Department of Agriculture, G.S.S.D.G.S. Khalsa College, Patiala during *Rabi* season in 2021-2022. The experiment was laid out in Randomized block design (RBD) comprising of eleven treatments and three replications. In case of different treatments maximum growth parameters such as plant height (53.91 cm), leaf length (49.69 cm), number of leaves plant^{-1} (8.59), yield parameters such as length of bulb (6.32 cm), neck thickness (2.32 cm), weight of bulb (61.22 g) and bulb yield (q ha^{-1}) (383.50) was observed in the treatment T_9: FYM (5 t ha^{-1}) + Vermicompost (1.25 t ha^{-1}) + Poultry manure (1.5 t ha^{-1}) + Jeevamrut (5%) + Panchagavya (5%) + Azotobacter (2.5 Kg ha^{-1}) + PSB (2.5 kg ha^{-1}) and this treatment was significantly superior over the other treatments. The minimum growth and yield were obtained from the treatment T_1 (control).

Keywords: Organic manures, biofertilizers, growth and yield

Introduction
The onion (*Allium cepa* L.) is a significant commercial bulb crop having chromosome number is 2n=16 and belongs to the Alliaceae family. It is a commercial vegetable grown in India, originally from Central Asia. Onion is regarded as the second most significant vegetable crop produced worldwide, after tomatoes. It is a rapidly expanding, short-lived crop with a variety of uses, like raw vegetables, spices, and medicines. It is one of the most widely grown and necessary vegetable and spice crops, grown for domestic use, export, and processing (Brar *et al*. 2015) [2].

The average onion includes 11.0 g of carbohydrate, 1.2 g of protein, 0.6 g of fiber, 86.8 g of moisture, and many vitamins, including thiamine (0.08 mg), riboflavin (0.01 mg), vitamin A (0.01 mg), and vitamin C (11 mg). Additionally, it contains a few minerals per 100 g of bulb, including phosphorus (39 mg), calcium (27 mg), sodium (1.0 mg), and potassium (157 mg) (Sharma *et al*. 2018) [10].

Nowadays liquid organic manures are becoming popular to conflict the adverse effect of chemical fertilizers. They can supply essential nutrients to the crop plant and also provide several growth promoters and bio-control agents to prevent disease and pest infestation. Liquid organic manures can be prepared by using several farm inputs and daily household materials. So, the cost required to prepare these liquid organic manures are very less comparing with the chemical fertilizers and pesticides. In order to maintain sustainability in agriculture liquid organic manures should be adopted in a large extent (Kannaiyan 2000) [6], Kanwar *et al*. (2006) [7].

The use of organic manures and biofertilizers increases onion bulb output and enhances storage quality. The availability of Fe, Cu, Zn, and Mn in soil is increased when organic manures and inorganic fertilizers are combined (Ramesh *et al*. 2017) [9].

Materials and Methods
The experiment was conducted during *Rabi* season 2021-2022 at the Campus for Research and Advanced Studies, Dhablan, G.S.S.D.G.S. Khalsa College, Patiala. The experiment with onion was laid out in Randomized block design (RBD) with eleven treatments and each treatment was replicated three times. The soil of the experimental field was clayey in texture and having pH 7.91, organic carbon 0.71%, available nitrogen 257.62 kg ha^{-1}, phosphorous 22.78 kg ha^{-1} and available potassium 102.25 kg ha$^{-1.}$

The nursery raising was done on 3rd November 2021 and the healthy, disease-free seedlings were transplanted at the spacing of 15 cm × 7.5 cm.

All the organic manures like vermicompost, Poultry manure and farm yard manure were evenly mixed into the soil before transplanting. Liquid manure was applied as three drenching's with jeevamrut and panchagavya 5% at 15-day intervals beginning at the time of transplanting. The 45 days old seedlings were selected and treated with *Azotobacter* and PSB culture for 15 minutes and transplanted in the experimental field. Transplanting was done in the evening of 24th December, 2021 maintaining a spacing of 15 cm × 7.5 cm between the rows and plants, respectively and after transplanting a light irrigation was given to all the treatments for better establishment. Weeding should be done after 15 DAT with the help of khurpi while the minor weeds were removed manually. The data was taken from each plot from randomly selected 5 plants after every 30 days of interval i.e 30, 60, 90, 120 DAT and at harvest.

Details of layout

Experimental design	Randomized Block Design
No. of replication	3
No. of treatment	11
Total number of plots	33
Spacing	15 cm × 7.5 cm
Net plot size	2.4 m × 3.3 m
Variety	PRO-6

Treatment Details

T_1	Control
T_2	FYM (10 t ha^{-1})
T_3	Vermicompost (2.5 t ha^{-1})
T_4	Poultry manure (3 t ha^{-1})
T_5	Jeevamrut (5%)
T_6	Panchagavya (5%)
T_7	FYM (5 t ha^{-1}) + Vermicompost (1.23 t ha^{-1}) + Azotobacter (2.5 Kg ha^{-1}) + PSB (2.5 Kg ha^{-1})
T_8	Vermicompost (1.25 t ha^{-1}) + Poultry manure (1.5 t ha^{-1}) + Azotobacter (2.5 kg ha^{-1}) + PSB (2.5 kg ha^{-1})
T_9	FYM (5 t ha^{-1}) + Vermicompost (1.25 t ha^{-1}) + Poultry manure (1.5 t ha^{-1}) + Jeevamrut (5%) + Panchagavya (5%) + Azotobacter (2.5 Kg ha^{-1}) + PSB (2.5 kg ha^{-1})
T_{10}	Vermicompost (2.5 t ha^{-1}) + Jeevamrut (5%)
T_{11}	Poultry manure (3 t ha^{-1}) + Panchagavya (5%)

Results and Discussion

Impact of organic manures and biofertilizers on growth parameters of onion (*Allium cepa* L.): The effect of manures and biofertilizers on the growth attributing characters of onion are presented in Table 1. Treatment T_9 FYM (5 t ha^{-1}) + Vermicompost (1.25 t ha^{-1}) + Poultry manure (1.5 t ha^{-1}) + Jeevamrut (5%) + Panchagavya (5%) + Azotobacter (2.5 Kg ha^{-1}) + PSB (2.5 kg ha^{-1}) showed maximum plant height (53.91 cm). This treatment was at par with T_8 treatment Vermicompost (1.25 t ha^{-1}) + Poultry manure (1.5 t ha^{-1}) + Azotobacter (2.5 kg ha^{-1}) + PSB (2.5 kg ha^{-1}) (52.23 cm). The minimum plant height (33.26 cm) was found in the treatment T_1 (Control).

Among all the treatments the maximum leaf length (49.69 cm) was given by the treatment T_9: FYM (5 t ha^{-1}) + Vermicompost (1.25 t ha^{-1}) + Poultry manure (1.5 t ha^{-1}) + Jeevamrut (5%) + Panchagavya (5%) + Azotobacter (2.5 kg ha^{-1}) + PSB (2.5 kg ha^{-1}). This treatment was at par with T_8 treatment Vermicompost (1.25 t ha^{-1}) + Poultry manure (1.5 t ha^{-1}) + Azotobacter (2.5 kg ha^{-1}) + PSB (2.5 kg ha^{-1}) (47.89 cm). The minimum leaf length was found in the treatment T_1 (Control) (31.12 cm).

Treatment T_9 with an application of FYM (5 t ha^{-1}) + Vermicompost (1.25 t ha^{-1}) + Poultry manure (1.5 t ha^{-1}) + Jeevamrut (5%) + Panchagavya (5%) + Azotobacter (2.5 kg ha^{-1}) + PSB (2.5 kg ha^{-1}) showed the maximum number of leaves plant^{-1} (8.59). This treatment was at par with the treatment T_8 Vermicompost (1.25 t ha^{-1}) + Poultry manure + Azotobacter (2.5 kg ha^{-1}) + PSB (2.5 kg ha^{-1}) ha^{-1}) (8.34) and treatment T_7 FYM (5 t ha^{-1}) + Vermicompost (1.23 t ha^{-1}) + Azotobacter (2.5 kg ha^{-1}) + PSB (2.5 kg ha^{-1}) (8.11). The minimum number of leaves plant^{-1} was found in the treatment T_1 (Control) (5.24).

The application of organic manures and different nutrients plays an important role in the onion plant in terms of enhancing photosynthetic activity, cell division, cell elongation and vegetative growth of the plant. Additionally, biofertilizers have the capacity to generate compounds that promote growth and alter metabolic processes, which may have boosted cell division and cell elongation, increased uptake of water and nutrients, and ultimately resulted in vegetative development of the plant. The observations recorded with respect to the growth parameters was elaborated by Bagali *et al.* (2012)[1], Gebremichael *et al.* (2017) [4] and Eragegowda *et al.* (2018) [3] in onion.

Table 1: Impact of organic manures and biofertilizers on growth parameters of onion (*Allium cepa* L.)

Treatments	Plant height (cm)	Leaf length (cm)	Number of leaves plant^{-1}
T_1	33.26	31.12	5.24
T_2	40.79	36.21	6.43
T_3	43.24	38.17	6.99
T_4	43.12	37.13	6.84
T_5	38.25	33.87	5.75
T_6	38.89	34.77	5.96
T_7	48.92	44.91	8.11
T_8	52.23	47.89	8.34
T_9	53.91	49.69	8.59
T_{10}	46.23	41.46	7.86
T_{11}	45.27	40.43	7.64
SE (m) ±	0.94	0.94	0.56
CD 5%	1.97	1.97	1.17

Impact of organic manures and biofertilizers on yield parameters of onion (*Allium cepa* L.): The data regarding yield parameters illustrated in Table 2. At harvest the maximum Length of bulb (6.32 cm) was obtained from the treatment T_9 with an application of FYM (5 t ha^{-1}) + Vermicompost (1.25 t ha^{-1}) + Poultry manure (1.5 t ha^{-1}) + Jeevamrut (5%) + Panchagavya (5%) + Azotobacter (2.5 kg

ha^{-1}) + PSB (2.5 kg ha^{-1}) which was at par with the treatment T_8: Vermicompost (1.25 t ha^{-1}) + Poultry manure (1.5 t ha^{-1}) + Azotobacter (2.5 kg ha^{-1}) + PSB (2.5 kg ha^{-1}) (6.21 cm) and treatment T_7:FYM (5 t ha^{-1}) + Vermicompost (1.23 t ha^{-1}) + Azotobacter (2.5 kg ha^{-1}) + PSB (2.5 kg ha^{-1}) (6.18 cm). The minimum length of bulb was found in the treatment T_1 (Control) (4.28 cm).

The maximum neck thickness of onion (2.32 cm) was evaluated from the treatment T_9: FYM (5 t ha^{-1}) + Vermicompost (1.25 t ha^{-1}) + Poultry manure (1.5 t ha^{-1}) + Jeevamrut (5%) + Panchagavya (5%) + Azotobacter (2.5 kg ha^{-1}) + PSB (2.5 kg ha^{-1}). This was at par with the treatment T_8: Vermicompost (1.25 t ha^{-1}) + Poultry manure (1.5 t ha^{-1}) + Azotobacter (2.5 kg ha^{-1}) + PSB (2.5 kg ha^{-1}) (2.27 cm) and treatment T_7: FYM (5 t ha^{-1}) + Vermicompost (1.23 t ha^{-1}) + Azotobacter (2.5 kg ha^{-1}) + PSB (2.5 kg ha^{-1}) (2.17 cm). The minimum neck thickness of onion (1.21 cm) was obtained in the treatment T_1 (Control).

Among all the treatments the maximum weight of bulb (61.22 g) was observed from treatment T_9: FYM (5 t ha^{-1}) + Vermicompost (1.25 t ha^{-1}) + Poultry manure (1.5 t ha^{-1}) + Jeevamrut (5%) + Panchagavya (5%) + Azotobacter (2.5 kg ha^{-1}) + PSB (2.5 kg ha^{-1}) which was at par with the treatment T_8:Vermicompost (1.25 t ha^{-1}) + Poultry manure (1.5 t ha^{-1}) + Azotobacter (2.5 kg ha^{-1}) + PSB (2.5 kg ha^{-1}) (60.58 g) and treatment T_7: FYM (5 t ha^{-1}) + Vermicompost (1.23 t ha^{-1}) + Azotobacter (2.5 kg ha^{-1}) + PSB (2.5 kg ha^{-1}) (59.49 g). The minimum weight of bulb (32.67 g) was recorded from the treatment T_1 (Control).

It was also found that the maximum bulb yield (383.50 q ha^{-1}) was evaluated from the treatment T_9 with an application of FYM (5 t ha^{-1}) + Vermicompost (1.25 t ha^{-1}) + Poultry manure (1.5 t ha^{-1}) + Jeevamrut (5%) + Panchagavya (5%) + Azotobacter (2.5 kg ha^{-1}) + PSB (2.5 kg ha^{-1}) which was at par with the treatment T_8: Vermicompost (1.25 t ha^{-1}) + Poultry manure (1.5 t ha^{-1}) + Azotobacter (2.5 kg ha^{-1}) + PSB (2.5 kg ha^{-1}) (365.70 q ha^{-1}). The minimum total yield (161.91 q ha^{-1}) was observed from the treatment T_1 (Control).

Application of organic manures and biofertilizers provides the favorable conditions for the development of bulb that improves the transportation of water and nutrients. Due to an increased vegetative growth, plants prepare more food for the further growth of yield attributes. The higher vegetative as well as reproductive growth shows the regular nourishment of plants throughout the growing period. The nutrients provide a favorable condition for the proper growth of the plant that leads to the higher yield characteristics. Similar results with respect to the yield parameters were given by Yogita and Ram (2012) [13], Magdi *et al*. (2009) [8], Yadav *et al*. (2015) [12], Singh *et al*. (2019) [11] and Jayathilake *et al*. (2003) [5].

Table 2: Impact of organic manures and biofertilizers on yield parameters of onion (*Allium cepa* L.)

Treatments	Length of bulb (cm)	Neck thickness (cm)	Weight of bulb (g)	Bulb yield (q ha^{-1})
T_1	4.28	1.21	32.67	161.91
T_2	5.34	1.45	48.76	294.40
T_3	5.55	1.69	52.44	304.88
T_4	5.36	1.53	50.38	293.77
T_5	5.11	1.38	36.64	193.60
T_6	5.16	1.41	37.81	224.45
T_7	6.18	2.17	59.49	348.74
T_8	6.21	2.27	60.58	365.70
T_9	6.32	2.32	61.22	383.50
T_{10}	5.65	1.84	56.69	344.23
T_{11}	5.63	1.72	54.74	333.67
SE (m) ±	0.26	0.19	0.89	10.43
CD 5%	0.53	0.40	1.86	21.76

Conclusion

It has been concluded that application of both manures and biofertilizers performed better with respect to higher growth (plant height, leaf length and number of leaves plant^{-1}) and yield attributes (length of bulb, neck thickness, weight of bulb and bulb yield q ha^{-1}). The maximum results obtained from the treatment T_9 with an application of FYM (5 t ha^{-1}) + Vermicompost (1.25 t ha^{-1}) + Poultry manure (1.5 t ha^{-1}) + Jeevamrut (5%) + Panchagavya (5%) + Azotobacter (2.5 kg ha^{-1}) + PSB (2.5 kg ha^{-1}). The combined application of organic manures and biofertilizers provides the balanced dose of nutrients that increases the microbial and enzymatic activities in the soil. It helps in the growth of the plant and gives the higher yield of the crop

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