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Combine effect of chemical fertilizer, Biodynamic and organic manure on growth and yield of late kharif onion (*Allium cepa* L.)

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Abstract
The present investigation entitled "Combine effect of chemical fertilizer, Biodynamic and organic manure on Growth and Yield of late Kharif Onion (*Allium cepa* L.)" was conducted at the instructional farm, Krishi Vigyan Kendra, Karda, Washim during the late kharif season of 2019-20 and 2020-21. The experiment consists of thirteen treatments in combination with chemical fertilizer, Biodynamic preparation, manure and combinations of different organic manure to study the impact on the growth and yield of late kharif onion. The experiment was laid out in a randomized complete block design with three replications. The maximum bulb diameter T_9 (5.58 cm and 5.32 cm) and maximum average weight of bulb (78.51 and 76.20 g), maximum yield per plot (12.61 and 11.80 kg) and yield per ha. (304.54 and 285.10 q) was observed with application of 50% RDN through FYM (q ha^{-1}) + 50% RDN through Vermicompost (q ha^{-1}) + Azatobactor (kg ha^{-1}) + PSB (kg ha^{-1}).

Keywords: Bio-fertilizers, growth, late kharif onion, organic and inorganic fertilizers, yield parameters

Introduction

Onion is one of the most important cash crops grown for vegetables as green and spices as mature bulbs. It adds flavor to various vegetable preparations and hence it is known as the 'Queen of the kitchen'. Onion is also used in preparing soups, sauces, curries, pickles and flavoring in seasoning foods. In India, the productivity of onions is very low due to a lack of manuring and imbalanced fertilization. The use of optimum fertilization is the key factor in increasing productivity which can be realized with the judicious application of plant nutrients to onion crops. Nutrient management practices play an important role for good crop production. The continuous and imbalanced use of inorganic fertilizers is adversely affecting the sustainability of agricultural production besides causing environmental pollution.

Organic agriculture is gaining momentum in India due to individual as well as group efforts to conserve the environment and avoid contamination of farm produce from the use of chemical fertilizers and pesticides. The organic vegetable industry is flourishing due to consumer preference for organically produced vegetables over traditionally grown vegetables due to their health consciousness. The problem of the high cost of chemical fertilizers which supplies only few major nutrients lead to thinking of using different sources of nutrients such as farm yard manure, vermicompost, neem cake, poultry manure and biofertilizers.

Integrated nutrient management is the judicious use of all possible nutrient sources to meet the plant nutrient requirement at an optimum level to sustain the desired crop productivity with minimal impact on the environment. In integrated nutrient management, the immediate nutrient requirement of the crop is met through chemical fertilizers. Thus, the rate and time of chemical fertilizer application should synchronize with the real-time need of the crop. Whereas, the slow and long-term release of nutrients from organic sources helps in meeting the long-term need of the crop. Therefore, integrated nutrient management is the available strategy for advocating judicious and efficient use of chemical fertilizers with the matching addition of organic manures for sustainability for late kharif onion cultivation. This study was, therefore conducted to assess the effect of integrated nutrient management on growth and bulb yield to find economically appropriate integrated nutrient management for late Kharif onion.

Materials and Methods

Cite description

The study was conducted at Krishi Vigyan Kendra, Karda, Washim during late kharif season of 2019-20 and 2020-21. KVK, Karda, block Risod, District Washim which is situated in a subtropical region between 20.03° N, latitude and 76.77° E longitude and at an altitude of 522 m above the mean sea level. The climate of Karda is semi-arid and characterized by three distinct seasons i.e. hot and dry summer from March to May, warm humid and rainy monsoon from June to October and mid cold winter from November to February. The maximum temperature ranged between 26.90 to 43.70 °C and 28.10 °C to 45.20 °C while the minimum temperature ranged between 7.00 °C to 29.3 °C and 8.50 °C to 30.70 °C during crop growing season. The soil of experimental plot was medium black having uniform texture and structure with good drainage.

Treatments and experimental design

In the experimental design, there were thirteen treatments and they were replicated thrice. The experiment was laid out in a randomized block design with three replications. The gross plot size was 2.5 m x 2 m (5 m2). The distance between blocks was 2 meters whereas the distance between plots was 1m and the spacing between rows and plants was 15 cm by 10 cm. The treatment details are T_1 (50% RDN through FYM (43.6 q ha^{-1}) + 50% RDN through Neem cake (13.1 q ha^{-1})), T_2 (50% RDN through FYM (43.6 q ha^{-1}) + 50% RDN through Poultry manure (37.2 q ha^{-1})), T_3 (50% RDN through FYM (43.6 q ha^{-1})+ 50% RDN through Vermicompost (31.0 q ha^{-1})), T_4 (50% RDN through FYM (43.6 q ha^{-1})+ Azatobactor (5 kg ha^{-1}) + PSB (5 kg ha^{-1})), T_5 (50% RDN through Neem cake (13.1 q ha^{-1}) + Azatobactor (5 kg ha^{-1}) + PSB (5 kg ha^{-1})), T_6 (50% RDN through Poultry manure (37.2 q ha^{-1}) + Azatobactor (5 kg ha^{-1}) + PSB (5 kg ha^{-1})), T_7 (50% RDN through FYM (43.6 q ha^{-1}) + 50% RDN through Neem cake (13.1 q ha^{-1}) + Azatobactor (5 kg ha^{-1}) + PSB (5 kg ha^{-1})), T_8 (50% RDN through FYM (43.6 q ha^{-1}) + 50% RDN through Poultry manure (37.2 q ha^{-1}) + Azatobactor (5 kg ha^{-1}) + PSB (5 kg ha^{-1})), T_9 (50% RDN through FYM (43.6 q ha^{-1}) + 50% RDN through Vermicompost (31.0 q ha^{-1}) + Azatobactor (5kg ha^{-1}) + PSB (5 kg ha^{-1})), T_{10} (Biodynamic 501 & 500 + solution S_9 (cow pat pit) + Biodynamic manure (91.0 q ha^{-1})), T_{11} (Biodynamic 501& 500 + solution S_9 (cow pat pit)), T_{12} (Recommended dose of fertilizer (100:50:50 kg ha^{-1})) and T_{13} (Control).

Experiment procedure

The high yielding onion variety Bhima Super developed by ICAR-Directorate of Onion & Garlic Research (DOGR), Rajgurunagar, Pune (Maharashtra) was used. All proper agronomic practices were carried out until the seedlings were transferred to the main field. The field was ploughed followed by harrowing and to bring the soil to a fine tilth. Clods were broken with the rotavator and plot was leveled. seeds were sown on the bed during 2nd week of August and watered regularly on alternate days. Beds were prepared before transplanting the seedlings and 45 days old seedling were transplanted during the last week of September. Experimental plots of 2.5 m x 2 m were prepared. The recommended dose of nitrogen (RDN-100 kg ha^{-1}) was applied through organic manure one month before the transplanting of plant. Chemical fertilizers were applied at the rate of 100 kg ha^{-1} N, 50 kg ha^{-1} P_2O_5 and 50 kg ha^{-1} K_2O in the form of Urea, SSP and MOP respectively. Half dose of nitrogen and full dose of P_2O_5 and K_2O was given at time of transplanting and the remaining half dose of nitrogen was applied 30 days after transplanting. Biodynamic solution S_9 (cow pat pit) was applied at rate of 22.23 kg ha^{-1}. The Biodynamic preparation 500 (cow horn manure) was applied at rate of 75 g in 15 liter of water per acre in the evening and the following morning BD 501 is applied at rate of 2.48 g in 15 liter of water per acre in the very early morning as a fine mist that drifts over the plant. The Biofertilizers, Azatobactor and PSB was mixed with small quantity of fine organic manure and applied in the required quantity per treatment before transplanting of seedling. Light irrigation was given immediately after transplanting and subsequent irrigations were given to the plots at an interval of 10-12 days as per the situation during period of experimentation. Other recommended agronomic practices like weeding, insect pest and disease control, etc., were kept uniformly for all treatments. Harvesting of onion bulbs was done when 70% plants showed neck fall.

Growth and yield parameters

The observations were recorded for growth parameters viz., plant height (cm), leaf length (cm), number of leaves, bolting percentage, crop maturity days, and neck thickness at 30, 60 and 90 days. The yield parameters were bulb diameter (cm), the average weight of bulb (g), bulb yield per plot (kg), bulb yield per ha (q) and double bulb (%). The data were statistically analyzed using analysis of variance (ANOVA) under RBD following the procedure suggested by Panse and Sukhatme (1985) [7]. The economics of various treatments was computed on the basis of the prevailing market price of inputs and produce.

Results and discussion

Growth parameter

The plant height (cm), leaf length (cm), number of leaves, bolting percentage, crop maturity days and neck thickness at 30, 60 and 90 days was significantly affected by the application of organic manure and bio-fertilizers at different stages of plant growth during both years of experiment. The results are presented in Table 1.

Table 1: Effect of integrated nutrient management on growth parameters of late kharif onion

Treatments	Plant height (cm)			Number of leaves per tree			Leaf length of plant (cm)		
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
T_1	25.44	41.44	69.45	6.02	6.99	11.07	24.01	37.96	64.64
T_2	28.89	43.63	70.69	6.06	7.05	11.20	24.91	39.43	67.04
T_3	25.29	38.20	65.46	4.40	5.41	10.66	23.36	37.22	62.92
T_4	22.96	35.74	59.70	4.25	5.29	10.02	20.20	34.83	54.07
T_5	24.11	36.63	61.18	4.34	5.34	10.21	21.60	36.26	58.70
T_6	23.91	40.15	66.67	4.44	5.46	10.91	23.58	37.94	63.14
T_7	28.76	47.09	72.01	6.06	7.07	11.97	25.18	42.38	67.72
T_8	29.05	53.97	72.33	6.12	7.18	12.06	25.89	45.87	68.73

T_9	31.35	60.40	77.20	6.78	7.77	13.07	27.15	53.24	80.76
T_{10}	24.39	37.85	62.24	4.87	5.33	10.39	21.10	36.41	59.28
T_{11}	22.01	31.63	56.25	4.19	5.18	9.95	19.18	36.31	51.22
T_{12}	29.17	58.94	75.34	6.37	7.35	12.40	26.47	52.09	72.61
T_{13}	20.49	28.83	54.33	4.04	4.94	9.62	18.55	36.04	50.84
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig.	Sig.	Sig.
SE(m)+	0.22	0.29	0.29	0.08	0.13	0.17	0.15	0.16	0.17
CD@5%	0.63	0.84	0.86	0.24	0.39	0.51	0.43	0.45	0.50
CV	1.46	1.17	0.77	2.68	3.73	2.73	1.10	0.67	0.47

Plant Height (cm)

The maximum plant height in T_9 (32.14 cm) and it was found to be at par with T_8 (30.14cm), T_2 (30.17cm) T_{12} (29.44cm) and T_7 (28.36cm) at 30 DAT. Significantly maximum plant height at 60 and 90 DAT were noted under T_9 treatment (61.49 and 76.57 cm at 60, 90 DAT respectively) which is followed by T_{12} (58.35 and 75.49 cm at 60, 90 DAT respectively) and T_8 (55.18 and 73.12 cm at 60, 90 DAT respectively). However lowest plant height was recorded in T_{13} (20.72, 28.19 and 55.48cm at 30, 60 and 90 DAT respectively) which is absolute control. During second year of experiment same treatment i.e. T_9 recorded maximum plant height (30.57, 59.30 and 77.84 cm at 30, 60, 90 DAT respectively) and it was found to be at par with T_{12} (28.90, 59.53 and 75.20 at 30, 60 and 90 DAT respectively). The lowest plant height was recorded in T_{13} (20.26, 29.47 and 53.18 cm at 30, 60, 90 DAT, respectively) with absolute control (Fig 2). Pooled mean of two year data showed maximum plant height in T_9 (31.35, 60.40, 77.20 cm) and it was found to be at par with T_{12} (29.17, 58.94, 75.34 cm), T_8 (29.05, 53.97, 72.33 cm) and T_7 (28.76, 47.09. 72.01cm) at 30, 60 and 90 DAT respectively. However lowest plant height was recorded in T_{13} (20.49, 28.83, 54.33 cm at 30, 60 and 90 DAT respectively) which is absolute control. The data regarding plant height of late karif onion after date of transplanting is presented in Fig. 2.

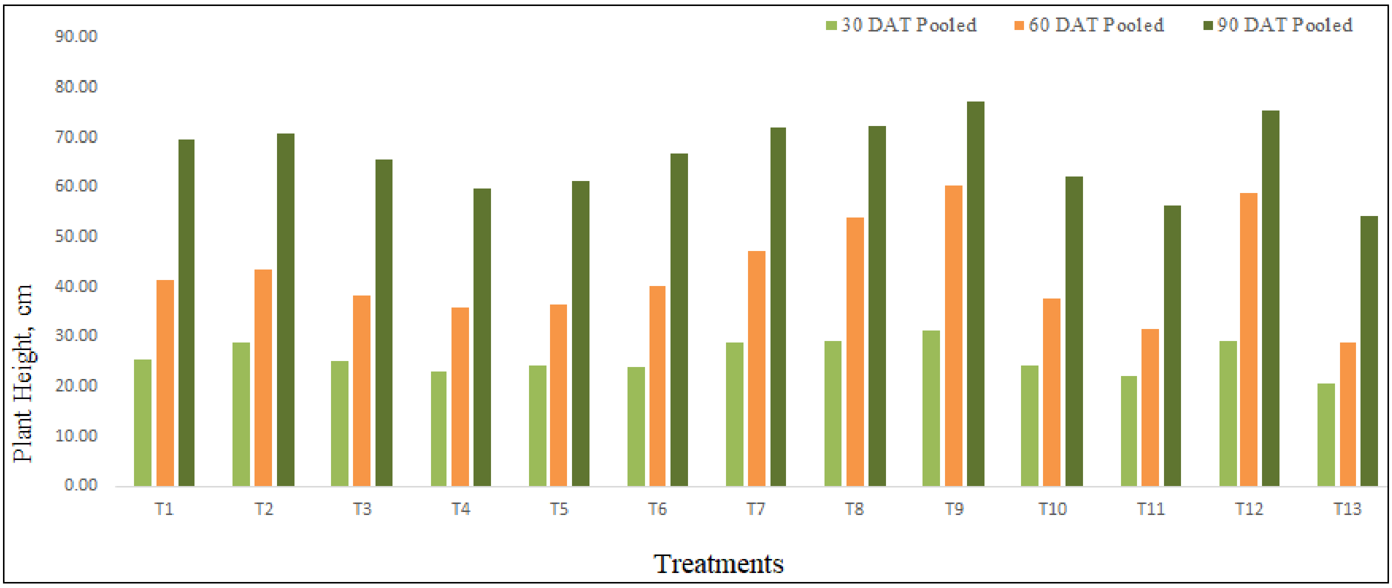

Fig 1: Effect of organic nutrient management on pooled plant height (cm) of onion at different stages of crop growth in late kharif onion

Improvement in plant growth might be due to the organic manures such i.e., FYM, Vermicompost and poultry manures which might have enhanced the soil microbial activity and have interned into higher improved physical condition of soil in respect of granulation, friability and porosity and ultimately provided a balanced nutritional environment to the soil plant nutrition system. (Thanuhathan *et al*., 1997). Pitchai *et al*., (2001) [8] reported that, the enhanced plant growth characters might be due to higher nutrient availability as well as better nutrient uptake by the crops.

Number of leaves per plant

The highest number of leaves^{-1} was recorded in T_9 (6.92 7.92 and 13.14 at 30, 60 and 90 DAT respectively) Which was statistically at par with the treatment T_{12} (6.28, 7.27 and 12.26 at 30, 60 and 90 DAT respectively), T_7 (6.19, 7.19 and 12.08 at 30, 60 and 90 DAT respectively) and T_8 (5.73, 6.79 and 11.77 at 30, 60 and 90 DAT respectively). The lowest number of leaves was recorded in T_{13} (4.23, 4.86 and 9.50 at 30, 60 and 90 DAT respectively). During second year of experiment the highest number of leaves^{-1} was recorded in T_9 (6.64, 7.63, and 13.00 at 30, 60 and 90 DAT respectively) and it was found to be at par with T_8 (6.50, 7.56, and 12.34 at 30, 60 and 90 DAT) and T_{12} (6.46 and 7.43 and 12.54 at 30, 60 and 90 DAT) whereas lowest number of leaves was recorded in T_{13} (3.86 and 5.02 and 9.74 at 30, 60 and 90 DAT respectively) with absolute control. The Pooled mean of two year data shows maximum number of leaves in T_9 (6.78, 7.77 and 13.07 at 30, 60 and 90 DAT respectively) which was found to be at par with T_{12} (6.37 7.35 and 12.40 at 30, 60 and 90 DAT), T_8 (6.12, 7.18 and 12.06 at 30, 60 and 90 DAT) and T_7 (6.06 7.07 and 11.97 at 30, 60 and 90 DAT). Whereas, lowest number of leaves were found in control. (4.04, 4.94 and 9.62 at 30, 60 and 90 DAT respectively). Possible reason for increased number of leaves per plant may be due to the improvement in growth related attributes because of certain growth promoting substances secreted by biofertilizers, better uptake of water, nutrients and their transportation constant nutrient made available throughout crop growth because of organic nutrient sources Similar studies were also conducted by Yogita *et al*. (2012) [17] and Kumar *et al*. (2010) [3]. Varu *et al*. (1997) [15] recorded higher number of leaves per plant with the application of Azotobactor, PSB. The better effect due to application of organic and biofertilizers on vegetative growth was also recorded by several workers i.e., Singh *et al*. (2014) [11] in broccoli, Meena *et al*. (2014a) [5] in tomato.

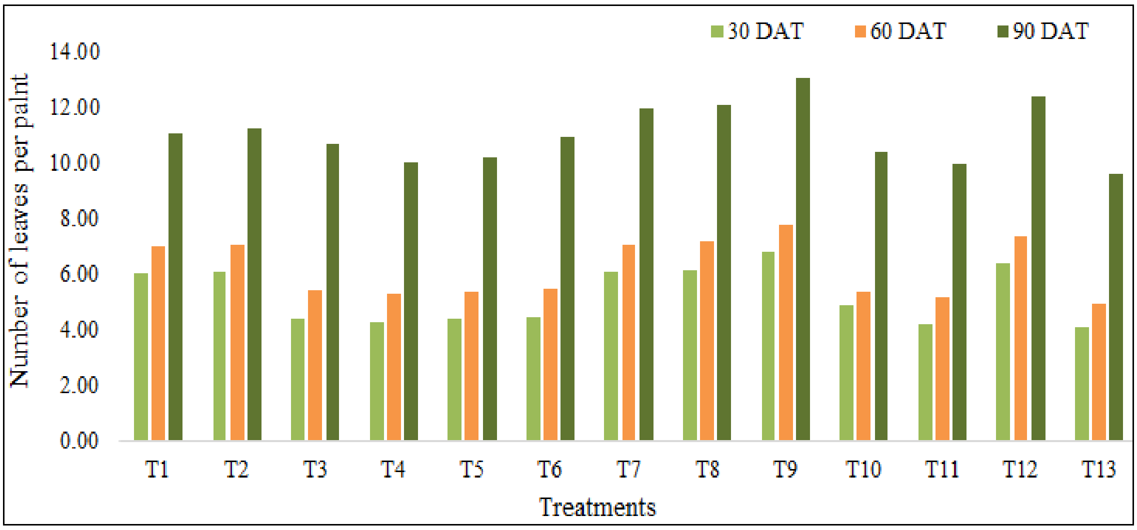

Fig 2: Effect of organic nutrient management on pooled number of leaves per plant of onion at different stages of crop growth in late kharif onion

Leaf length (cm)

The maximum leaf length of plant found in T_9 (26.23, 53.00 and 83.91 cm at 30, 60, 90 DAT respectively) which was at par with T_{12} (26.16, 52.62 and 74.08 cm 30, 60, 90 DAT respectively), T_7 (26.14, 45.43 and 70.98 cm 30, 60, 90 DAT respectively) and T_8 (25.57, 44.33 and 69.45 cm 30, 60, 90 DAT respectively). During the second year, significantly maximum length of plant was found in T_9 (27.15, 53.24 and 80.76 cm at 30, 60 and 90 DAT respectively) which was found at par with T_{12} (26.47, 52.09 and 72.61 cm 30, 60, 90 DAT respectively) and T_8 (25.89, 45.87 and 68.73 cm 30, 60, 90 DAT respectively).The minimum length of plant (17.94, 36.18, 49.45 cm at 30, 60, 90 DAT respectively) observed in T_{13} with Control (Fig 4). Pooled mean of two year data revealed the maximum leaf length of plant in T_9 (27.15, 53.24 and 80.76 cm at 30, 60, 90 DAT respectively) which was significantly superior over all other treatments and it was followed by the treatment T_{12} (26.47, 52.09, 72.61 cm at 30, 60, 90 DAT respectively) the minimum length of plant Found in T_{13} (18.55, 36.04, 50.84 at 30, 60, 90 DAT respectively) with control (Table 1).

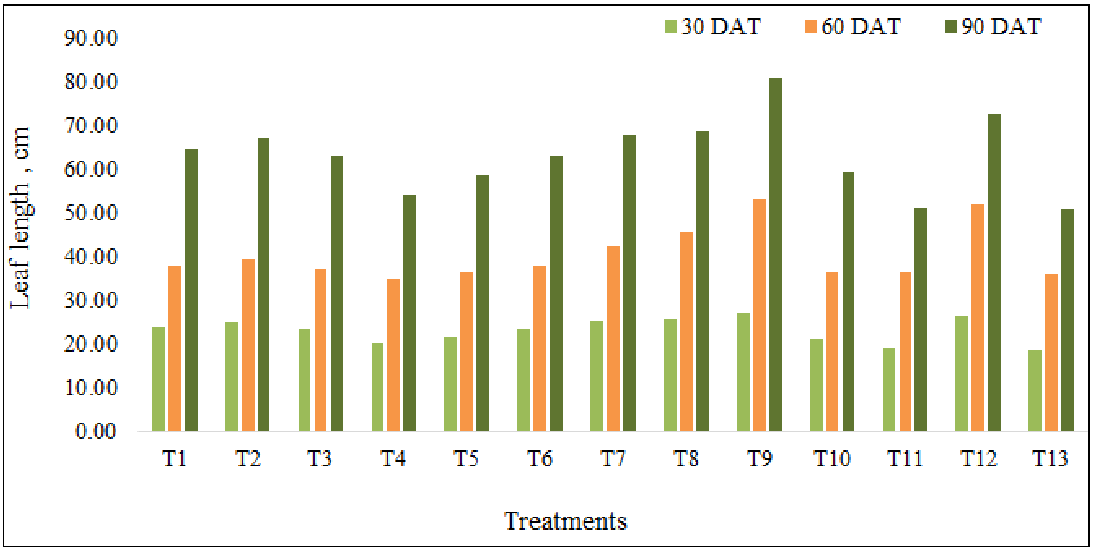

Fig 3: Effect of organic nutrient management on pooled leaves length per plant of onion at different stages of crop growth in late kharif onion

Nitrogen is one of the major key elements for the growth and increase in N supply accelerates the synthesis of chlorophyll and amino acids which enhanced the vegetative growth in terms of leaf length and number of leaves per plant. Similar result was also reported by (Giraddi, 1993) [2].

Yield parameters

The yield parameters of late kharif onion was significantly affected by the application of organic manure and bio-fertilizers at different stages of plant growth during both years of experiment shown in Table 1.

Table 2: Effect of organic nutrient management on yield parameters of late kharif onion

Treatments	Bolting (%)	Maturity days	Neck thickness of bulb (cm)	Diameter of bulb (cm)	Average weight of bulk (g)	Yield (kg plot^{-1})	Yield ha^{-1} (q)
T_1	1.40	118.33	1.07	5.02	67.73	10.48	253.07
T_2	1.20	121.17	1.17	4.94	65.47	9.83	237.45
T_3	1.25	118.00	1.08	4.56	63.78	9.81	236.99
T_4	1.50	120.33	1.15	4.18	56.59	9.28	224.25
T_5	1.35	120.83	1.15	4.22	53.43	8.07	194.89
T_6	1.24	119.50	1.19	4.50	60.56	9.07	219.10
T_7	1.10	119.00	1.08	5.34	74.29	11.01	265.90
T_8	0.82	119.17	1.00	5.29	74.00	10.87	262.63
T_9	0.76	120.17	0.87	5.45	77.35	12.21	294.81
T_{10}	1.27	118.33	1.00	4.78	61.08	9.39	226.91
T_{11}	1.35	120.00	1.08	4.10	52.52	7.78	187.91
T_{12}	1.00	120.83	1.18	4.22	65.48	10.16	245.50
T_{13}	1.59	117.83	1.19	3.85	51.70	7.71	186.15
F test	Sig	Sig	Sig	Sig.	Sig.	Sig	Sig
SE(m)+	0.02	0.31	0.01	0.02	0.66	0.18	4.33
CD @5%	0.05	0.91	0.03	0.06	1.93	0.52	12.65
CV	2.57	0.45	1.56	0.78	1.81	3.21	3.21

Bolting (%) in onion

It was noted that the lowest bolting was recorded by the treatment T_9 (0.69%) followed by T_8 (0.87%), T_{12} (1.05%) and T_7 (1.17%), whereas, the highest bolting was recorded by the treatment T_{13} (1.64%) followed by the treatment T_1 (1.55%). Similarly during second year (2020) of experiment, lowest bolting percent was recorded with T_8 (0.77%) T_9 (0.76%) and T_{12} (1.00%) treatment. However, the maximum bolting was recorded by the treatment T_{13} (1.53%) which was followed by the treatment T_4 (1.49%), T_5 (1.47%). Whereas pooled mean of two year data indicated the significantly minimum bolting in the T_9 treatment (0.76%) and T_8 (0.82%) and maximum bolting was observed in T_{13} (1.59%) followed by T_4 (1.50%). This might be due to adequate nutrition given by treatments of RDF, organic alone and organics with bio-fertilizers. These results are in conformity with Shaikh *et al*. (1981) [10]. The premature flower stalk emergence is known as bolting in onion. Bolting is undesirable since it affects bulb quality and the bulbs are fibrous with very low keeping quality. It is mentioned that inadequate nutrition is one of the factor in the induction of bolting in onion.

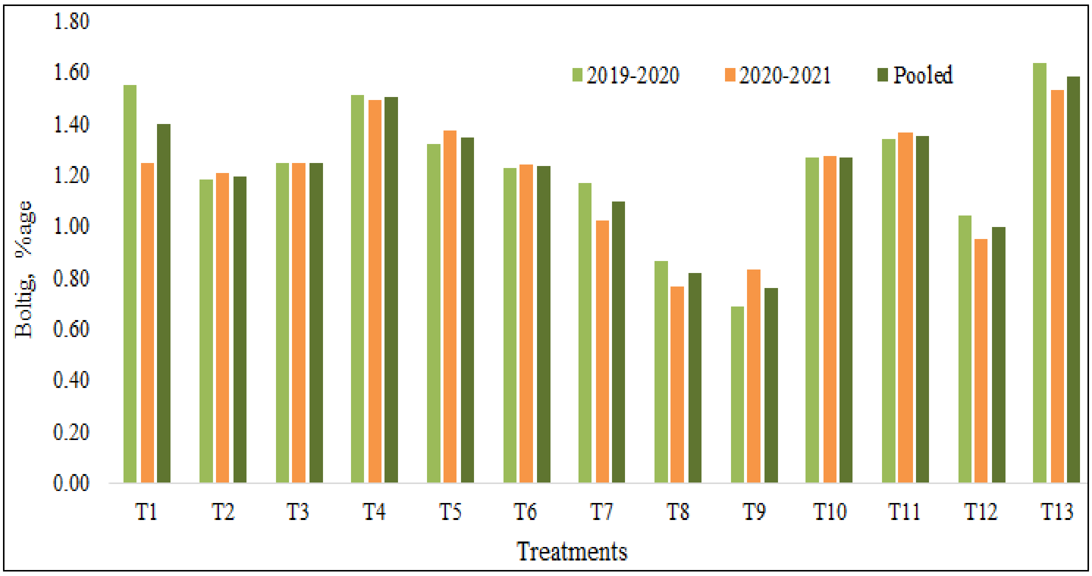

Fig 4: Effect of organic nutrient management on bolting (%) in late kharif onion

Days required for maturity of bulb

The maximum days require for maturity was recorded in treatment T_2 (123.67 days) and it was found to be at par with T_4 (122 days) and T_5 (121.33 days) however minimum days require for maturity (111.67 days) was recorded by the treatment T_1 and T_6 during the first year of experimentation. During second year (2020) of experiment minimum days require for maturity was noted in treatment T_{13} (117.33 days) and it was found to be at par with T_3 (117.67 days). However maximum days require for maturity (121.67 days) observed with the treatment T_9 and T_{11}. The pooled men of two year data indicated the minimum days require for maturity observed with the treatment T_{13} (117.83 days) and it was found to be at par with T_3 treatment (118.00 days). However maximum value were recorded with T_5 treatment (121.17 days). The possible reason for early bulb maturity may be better plant growth, resulting in accelerated photosynthesis and better translocation of photosynthates towards the bulb and ability of the bacterium to produce growth promoting substances due to Azatobactor inoculation which might have induced bulbing at earlier stage and there by enhanced chance of early crop maturity. The findings of the research are in agreement with the research of Yogita *et al.* (2012) [17] and Kumar *et al.* (2010) [3].

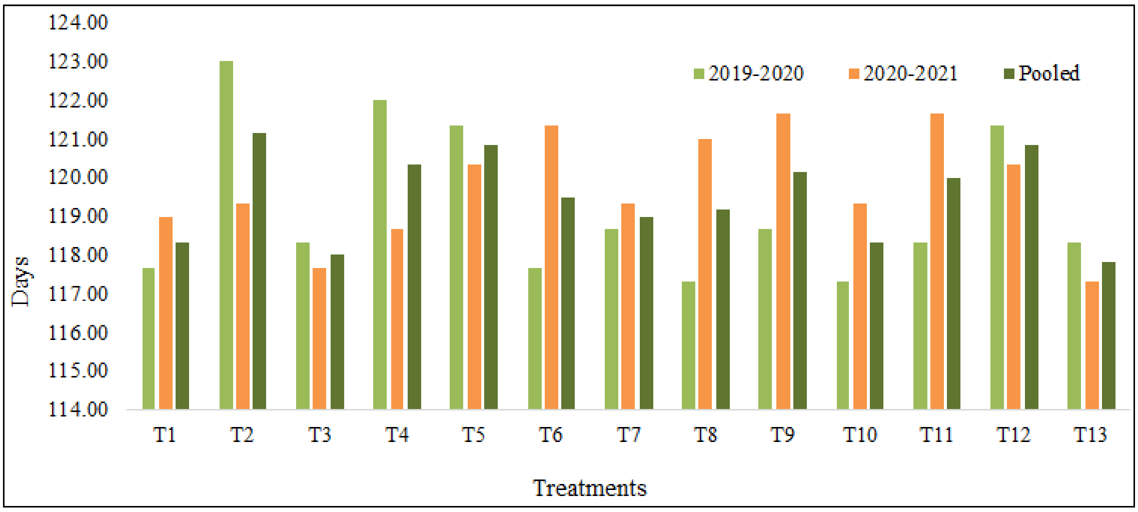

Fig 5: Effect of organic nutrient management on days required for maturity in late kharif onion

Neck thickness (cm)

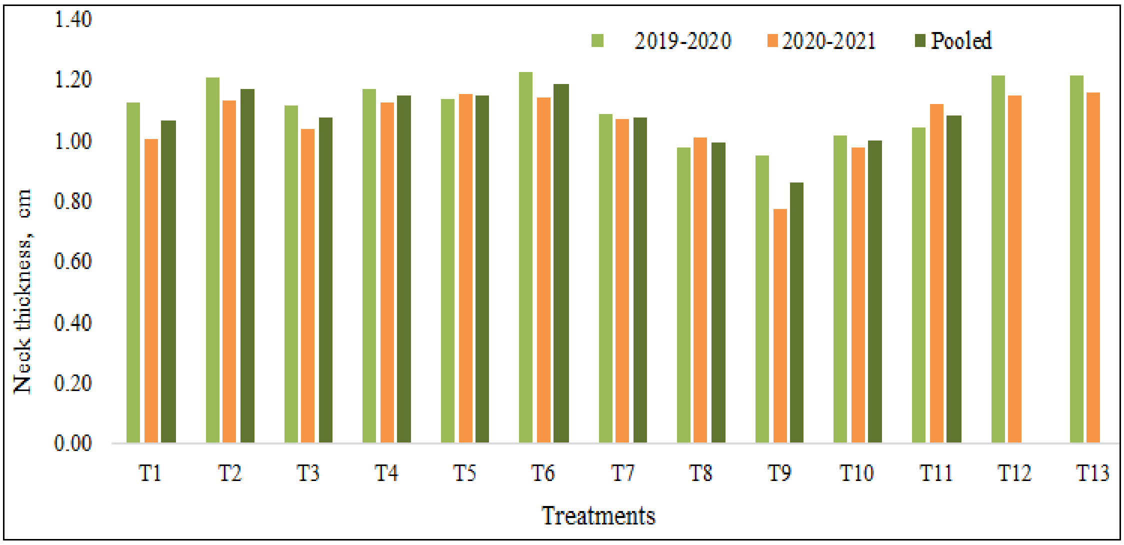

Fig 6: Effect of organic nutrient management on neck thickness (cm) of late kharif onion

The data showed that during the year 2019-2020, the treatment T_9 recorded minimum neck thickness (0.95 cm) and it was found to be at par with T_8 (0.98 cm). However maximum neck thickness was recorded (1.22 cm) in T_{13} and T_{12} treatment (Fig. 7). The minimum neck thickness during second year of experiment was observed in T_9 treatment (0.78cm) which was at par with T_{10} (0.98 cm). However, it was recorded maximum (1.16 cm) in T_{13} and (1.16 cm) in T_{12} treatment the pooled mean of two year data revealed minimum neck thickness (0.87cm) in T_9 treatment followed by (1.00 cm) in T_8. Whereas maximum value (1.19 cm) pertaining to this observation was recorded in T_{13} followed by (1.18 cm) in T_{12}. This might be attributed to continuous availability of nutrients throughout the growing period which increased the number of leaves resulting in better photosynthesis leading to more vigour. The results are in agreement with the work of Yogita *et al.* (2012) [17] and Kumar *et al.* (2010) [3].

Diameter of bulb (cm)

The data pertaining to diameter of bulb is significantly influenced by various treatments and is presented in Table 2 and represented in Fig. 8. Significant variation in respect of bulb diameter was noticed. During the year 2019-2020, the maximum bulb diameter was noted in treatment T_9 (5.58 cm) and it was found to be at par with T_7 (5.47 cm) and T_8 (5.38 cm) whereas the minimum bulb diameter (4.12cm) noted in absolute control treatmentT_7 followed by T_{11} (4.17). During second year (2019-2020) of experiment, the significantly maximum bulb diameter (5.32 cm) was notice in T_9 treatment and it was found to be at par with T_7 (5.21 cm) and T_8 (5.20 cm). Whereas, the lowest (3.57 cm) bulb diameter was recorded in absolute control.

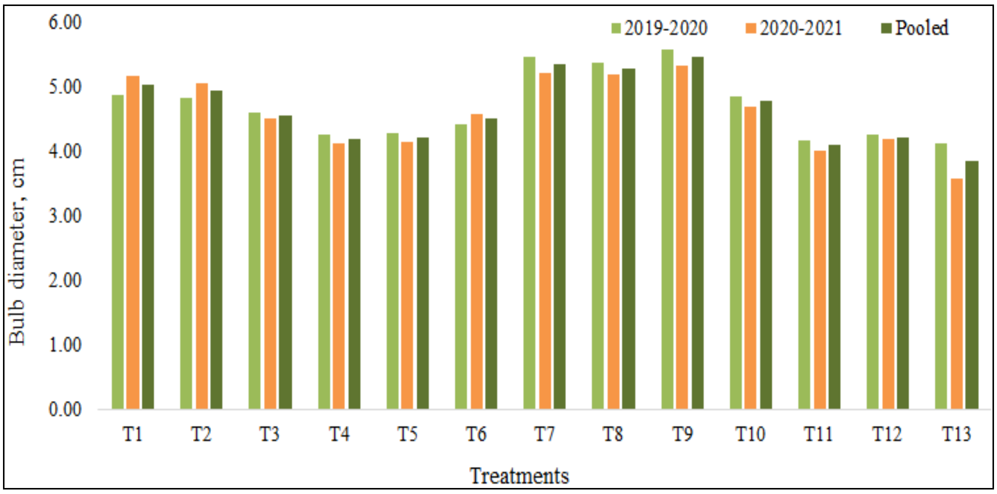

Fig 7: Effect of organic nutrient management on bulb diameter (cm) of late kharif onion

The pooled mean of two year data indicated the significantly maximum bulb diameter (5.45 cm) with treatment T_9 and it was found to be at par with T_7 (5.34) and T_8 (5.29 cm) treatment. However minimum bulb diameter (3.85 cm) recorded in absolute control. Increased vegetative growth of plant having sufficient food materials may helpful in increasing the diameter of bulb and increase in uptake of nutrients resulting in faster synthesis and translocation of phytosynthates from source (leaves) to Sink (bulb) resulted in increase in bulb diameter. Similar result reported by Mamatha *et al.* (2006) [4]. This may be due to combined application of biofertilizerss with organic and inorganic fertilizers which attributed to the fact that biofertilizerss are known to synthesize the growth promoting substances besides increasing the availability of atmospheric nitrogen and soil phosphorus, which might have led to luxuriant bulb size. The related findings were also reported by Yogita *et al.* (2012) [17] and Kumar *et al*. (2010) [3].

Average weight of bulb (g)

Results indicated significant differences (Table 11 and Fig. 9) in average weight of bulb with respect various treatments. During first year (2019) the treatment T_9 was found to be significantly superior in context of bulb weight. It produced bulbs with maximum average weight of 78.51 g. The value of treatment T_9 was at par with treatment T_8 (74.84 g) and T_7 (74.46 g) However, significantly minimum bulb weight was found in T_{11} (52.47 g) followed by T_{13} (52.86 g). During the year 2020-2021, the significantly maximum average weight of bulb noticed in T_9 (76.20 g) and it was at par over T_7 (74.12 g) and T_8 (73.17 g) however lowest value (50.54 g) noted under absolute control.

Pooled mean of two year data indicated the maximum average weight of bulb (77.35g) was note in T_9 it was at par over T_7 (74.29 g) and T_8 (74.00g). However, minimum value (51.70 g) pertaining to this observation was recorded in absolute control.

The increase in the bulb weight could be due to the increased uptake of nutrients and build up of sufficient photosynthates enabling the increase in size of bulbs (length and breadth), ultimately resulting in the increased average bulb weight. These results are in confirmation with the findings of Yogita *et al.* (2012) [17] and Meshram and Shende (1990) [6].

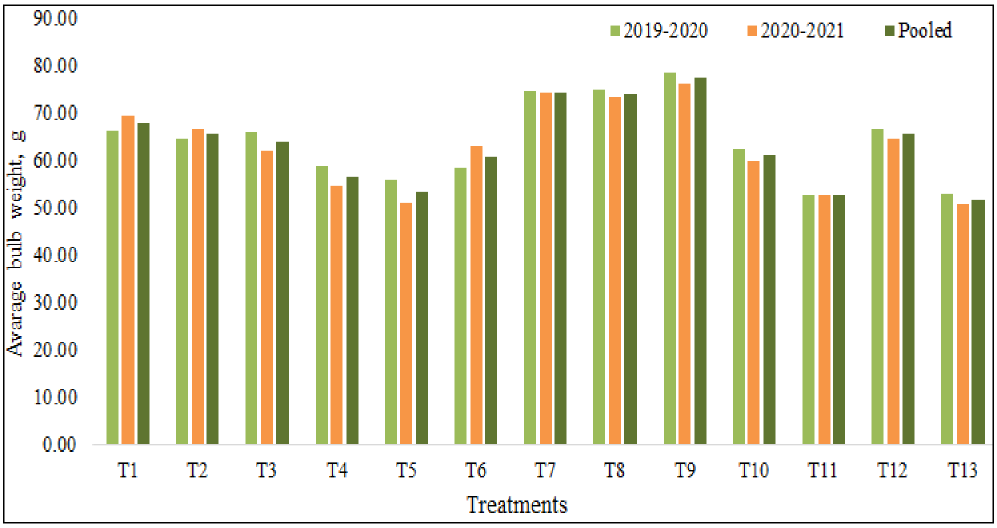

Fig 8: Effect of organic nutrient management on average bulb weight (g) in late kharif onion

Yield per plot (kg plot^{-1})

A simple and easy method of findings out the effect of the application of manure and fertilizer on the crop is by an observation of vegetative growth performance of crop. The level of nutrient supply has a profound effect on the growth of the plants, whether the specific elements directly influenced

rate of growth. There is a direct relationship between specific nutrient supply and the growth or the yield of plants. During the first year of experiment (2019-2020), the highest marketable bulb yield per plot was noticed in treatment T_9 (12.61 kg $plot^{-1}$) and it was found to be at par with treatment T_7 (11.24 kg $plot^{-1}$), T_8 (11.10 kg $plot^{-1}$) and T_1 (10.24 kg $plot^{-1}$). Whereas, significantly lowest bulb yield per plot (7.84 kg $plot^{-1}$) recorded in absolute control treatment i.e. T_{13}. During second year of experimentation (2020-2021), highest marketable bulb yield per plot was noticed in treatment T_9 (11.80 kg $plot^{-1}$) and it was found to be at par with treatment T_7 (10.77 kg $plot^{-1}$), T_1 (10.65 kg $plot^{-1}$) and T_8 (10.71 kg $plot^{-1}$). Whereas, significantly lowest bulb yield per plot (7.57 kg $plot^{-1}$) recorded in absolute control treatment i.e. T_{13}.
Pooled data indicated the significantly highest bulb yield per plot was observed in T_9 treatment (12.21 kg $plot^{-1}$) and it was found to be at par with T_7 (11.01 kg ha^{-1}), T_8 (10.87 kg ha^{-1}) T_1 (10.48 kg ha^{-1}). Significantly lowest value (7.71 kg ha^{-1}) was recorded in absolute control.
The increase in yield may be due to better root proliferation, enhanced nutrients uptake and water, higher leaf number, more photosynthesis and accelerated rate of food assimilation increasing levels of organic nitrogen also increase bulb and haulm yields irrespective of sources. This could be attributed to increased vegetative growth possibly a result of effective utilization of nutrients absorbed and a result of improved nourishment through N-fertilization. Minimum number of bulbs per plot was recorded in control which may be due to lack of proper nutrition this result are in conformity with the finding of Tomar *et al*., (1998) [14], Gajabhiye *et al*., (2003) [1].

Yield ha-1 (q)

Data presented in Fig 10 indicated during the year 2019-2020, significantly highest bulb yield per ha. (304.51q) was observed in the treatment T_9 and it was at par with T_7 (271.58 q) and T_8 (268.12 q), however lowest yield per ha was noted under treatment T_{13} (189.45 q). During second year of experiment, the highest bulbs yield per ha. (285.10 q) was observed in the treatment T_9 and it was found to be at par with the treatment T_7 (260.23 q), T_1 (258.77 q) and T_8 (257.15 q) and the lowest yield per ha (182.84 q) noted in T_{13} treatment. The pooled data indicated the significantly highest bulb yield per ha. (294.81q) was observed in the treatment T_9 which was found to be at par with T_7 (265.90 q), T_8 (262.63 q) and T_1 (253.07q). However, the lowest yield (186.15q) pertaining to this observation was recorded in absolute control (T_{13}). This increase in yield is due to a greater number of bulbs per plot, bulb size and average weight of bulbs. Use of Azotobacter not only makes the atmospheric nitrogen and soil phosphorus available, respectively, to plants but also enhances the plant growth and bulb yield due to release of hormones, vitamins and nutrients The beneficial effect of organic manure in comparison to chemical fertilizer on yield might be due to the additional supply of plant nutrients as well as improvement in overall physic-chemical and biological properties of soil. Similar findings were also reported by Ragland *et al.* (1989) [9], Yadav *et al.* (2012) [16] and Yogita *et al.* (2012) [17].

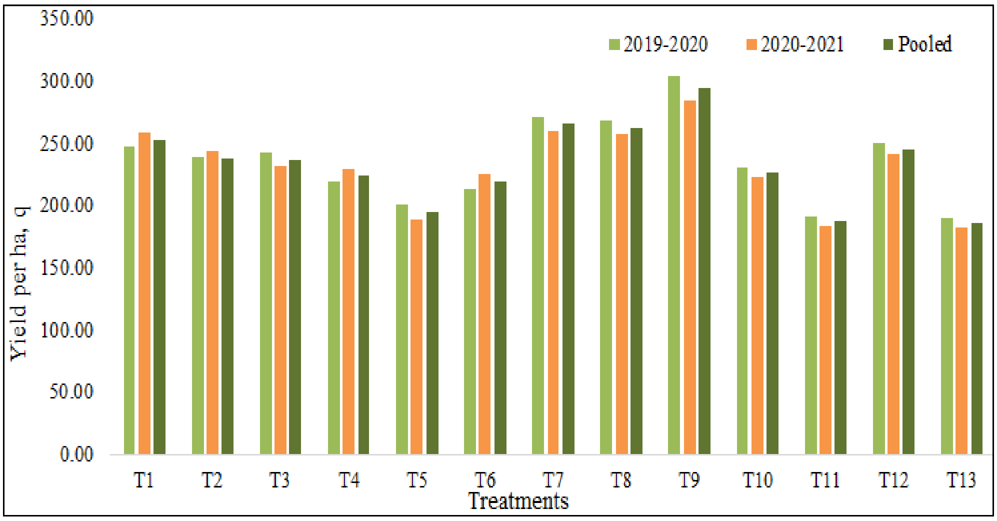

Fig 9: Effect of organic nutrient management on yield per ha (q) in late kharif onion

Conclusion

Lowest bolting was noted in T_9, T_8, T_7 and T_{12} during both the year of study. However, maximum bolting was observed with control treatment i.e.T_{13} during 2019 and 2020. The minimum neck thickness was observed in T_9 (0.95 cm) followed by T_8. (0.98 cm). The maximum bulb diameter T_9 (5.58 cm and 5.32 cm) and maximum average weight of bulb (78.51 and 76.20 g), maximum yield per plot (12.61 and 11.80 kg) and yield per ha. (304.54 and 285.10 q) was observed with application of 50% RDN through FYM (q ha^{-1}) + 50% RDN through Vermicompost (q ha^{-1}) + Azatobactor (kg ha^{-1}) + PSB (kg ha^{-1}).

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