Varietal response to organic and inorganic fertilizers on growth, bulb yield and quality of onion (*Allium cepa* L.)

ABSTRACT

A field experiment was conducted in the Rabi season of 2021-22 at the research farm of the Regional Research Center, Raiya (Jhajjar) of Maharana Pratap Horticultural University, Karnal, Haryana. The study aimed to examine the impact of organic manures and inorganic fertilizers on the growth, bulb yield and quality of two local varieties of onion. The experiment consists of two factors viz. different combinations of organic and inorganic nutrient sources (T_1: RDF (125:50:25 kg/ha), T2: RDN supplied through FYM, T3: RDN supplied through Vermi-compost, T4: RDN supplied through Poultry manure, T5: 50% Recommended dose of NPK + 50% RDN supplied through FYM, T6: 50% Recommended dose of NPK + 50% RDN supplied through Vermi-compost, T7: 50% Recommended dose of NPK + 50% RDN supplied through poultry manure, T8: control) that were laid out in a randomized block design (factorial) with four replications and two varieties namely Hisar Onion-2 and Hisar Onion-4. The outcomes of the study revealed that the leaf length (52.72 cm), number of leaves (10.28), equatorial diameter (6.09 cm), polar diameter (5.16 cm), bulb yield and yield related parameters such as average fresh weight of bulbs (82.39 g), yield per plot (26.74 kg), yield per hectare (29.71 t) and A grade bulbs (73.55%) were recorded maximum, while bolting percentage (2.28%) and twin bulbs percentage (3.16%) was recorded minimum under the treatment T_6 Hisar Onion-4 exhibited superiority in almost all growth and bulb yield parameters except number of leaves, which was noted higher in Hisar Onion-2.

Keywords: Onion, organic, inorganic, manures, fertilizers, yield and variety)

1. INTRODUCTION

Onion (*Allium cepa* L.) holds significant importance as a key commercial bulb vegetable and spice crop, extensively cultivated in India as well as globally. It is one of the most important monocotyledonous, cross-pollinated and cool season vegetable crops. It belongs to the family Alliaceae and genus *Allium,* which is an extensive genus comprising over 500 species, primarily consisting of bulbous perennial plants. It is highly productive crop and usually finds a place as “King of kitchen”. The primary edible component of the onion is its bulb, a modified organ comprising thickened, fleshy scale leaves and a stem plate. This bulb serves as a rich source of carbohydrates, proteins, vitamin C, and minerals such as phosphorus, calcium, and sulphur. The distinct flavor and pungency of the onion are attributed to the presence of a volatile organic compound, 'allyl propyl disulphide,' which is rich in sulphur. It is used in almost every household as cooked vegetable, salad and in preparation of sauce, soups, pickles *etc*.

Onion at edible stage is rich in medicinal properties like antibacterial values, promotes bile production and reduces blood sugar. Phenolic compound like Catechol's present in onion possess antifungal properties. It can also be used to cure heart diseases, slow down strokes and stimulate the immune system. The essential oil extracted from onion seed is an antithelmitic, expectorant, balsamic, rubefacient, pain killing and has anticoagulant qualities. It contains various anticancer agents that have been reported to have cancer-preventive properties in animals. India occupies second place in the production of onion after China and third in export after Netherlands and China. The major onion growing countries are China, USA, India, Iran, Turkey, Egypt, Russia and Pakistan. India ranks first in area (1.29 million ha) and second in production (24.45 million tonnes) of onion bulbs in the world [1]. India accounts 19.90% of the total world production in onion and ranks second after China (26.99%). In India, onion is grown in most of states like, Maharashtra, Karnataka, Gujarat, Bihar, Madhya Pradesh, Rajasthan, Andhra Pradesh and Haryana (Anonymous, 2019-2020b). Haryana ranks eighth position in production (2.27%) of onion bulb in India [2].

According to Brewester [3], this bulb crop is more susceptible to nutrient deficiencies because of their unbranched and shallow root system, therefore shows significant response to additional dose of organic and inorganic fertilizers. To achieve a higher bulb yield, excessive amounts of inorganic fertilizers are often applied. Heavy, imbalanced and continuous application of inorganic fertilizers without organic supplements causes several lethal effects on the soil. It not only harms environment and human health but also causes deficiency of micronutrients and leads to unsustainable crop production. Therefore, nutrients required by onion crop are supplied through the application of inorganic fertilizers and organic manures. Historically, the application of organic manures has been documented to enhance the physical, chemical, and biological properties of soil.

However, due to slow release of nutrients, these organic manures alone may not fully meet the nutritional needs of high-yielding cultivars. Thus, there is a need to supplement their use with inorganic fertilizers. The judicious application of inorganic fertilizers in onion cultivation contributes to improved growth, bulb development and overall bulb yield. The combined use of fertilizers along with organic manures results in a higher yield compared to the use of inorganic fertilizers alone [4].

The use of organic manure to fulfill crop nutrient requirements is anticipated to become an essential practice in the future for sustainable agriculture. Organic manure plays a crucial role in enhancing the physical, chemical, and biological properties of soil, while also conserving its moisture-holding capacity and thus, resulting in enhanced crop productivity. Organic manures positively impact root growth by enhancing root rhizosphere conditions including soil structure and moisture levels. Additionally, they stimulate plant growth by increasing the population of beneficial microorganisms [5]. Farmyard manure serves as a prominent organic component within an integrated nutrient supply system contributing to improved soil health, increased productivity and releases macro and micronutrients. Vermicompost is a nutrient-rich source containing essential macro and micronutrients, as well as vitamins and growth hormones [6]. Compost plays a crucial role in enhancing topsoil fertility and increasing crop productivity. It was earlier reported that the application of compost has led to improvements in the quality of onions and their storage longevity [7]. The synergistic use of both organic manure and inorganic fertilizers presents excellent opportunities to address nutrient imbalances, improve soil health and enhance crop production. This approach optimizes the benefits derived from various sources of plant nutrients in an integrated manner.

2. MATERIAL AND METHODS

The proposed field experiment conducted during the *Rabi* season 2021-22 in the research farm of the Regional Research Center, Raiya (Jhajjar) of Maharana Pratap Horticultural University, Karnal, Haryana. It is situated between $28^0 33'$ to $28^0 55'$ North latitude and $76^0 36'$ to $76^0 61'$ East longitude with an elevation of 222 m above the mean sea level. The area is characterized by a typical semi-arid climate, featuring hot and dry summers and extremely cold winters. The region experiences an average rainfall of 456 mm. The experimental site has a uniform topography with a flat and leveled field. The soil composition was sandy loam and characterized by a moderate water-holding capacity. Experimental material consists of eight treatments of different nutrient status and two different varieties of onion *i.e*, Hisar Onion-2 and Hisar Onion-4 which have been released and notified for Haryana conditions. The experimental design employed for the study was a Factorial Randomized Block Design, comprising of four replications including one absolute control and one recommended dose of fertilizers (125:50:25 kg NPK/ha). Half of the recommended doses of nitrogen and entire doses of phosphorus and potash were applied at the time of transplanting. Remaining nitrogen dose's were given in two equal split doses, at 30 and 45 days after transplanting, while organic manures, namely farmyard manure, poultry manure and vermicompost were applied as per treatment during field preparation and mixed thoroughly in upper 15 cm of soil. The various treatment combinations with their symbols are presented in Table 1. Eight week old onion seedlings were immersed in a solution of phosphorous-solubilizing bacteria for 30 minutes as per the treatment excluding the control. Subsequently, these treated seedlings were transplanted into flat beds measuring 3 m x 3 m with spacing of 15 cm x 10 cm. The observations were systematically recorded for growth, bulb yield quality characteristics by selecting and tagging five plants at random for each treatment within each plot in every replication. The parameters for growth such as leaf length at final harvest (cm), number of leaves at final harvest, neck diameter, days to maturity, bolting (%),twin bulb (Doubles) (%), polar diameter of bulbs (cm), equatorial diameter of bulbs (cm) and for yield parameters it includes average weight of fresh bulb (g), number of bulbs per kg, yield per plot (kg), yield per hectare (tonnes), grading of bulbs (%) (on weight basis such as A>65 g, B=45-65 g, C<45 g). The data concerning various parameters were subjected to statistical analysis using the Analysis of Variance (ANOVA) technique as outlined by Panse and Sukhatme [8].

Table: -1 Treatments detail of various organic and inorganic fertilizers and their combination

Treatment symbols	Treatment details
T1	Recommended dose of fertilizer (125:50:25 kg/ha)
T2	Recommended dose of nitrogen supplied through farmyard manure
T3	Recommended dose of N supplied through vermicompost
T4	Recommended dose of N supplied through poultry manure
T5	50% Recommended dose of NPK + 50% Recommended dose of N supplied through FYM
T6	50% Recommended dose of NPK + 50% Recommended dose of N supplied through vermicompost

T7	50% Recommended dose of NPK + 50% Recommended dose of N supplied through poultry manure
T8	Control (Without any fertilizers)

3. RESULTS AND DISCUSSION

The data providing to leaf length and number of leaves per plant at final harvest was noted maximum in treatment (50% RDF through NPK + 50% RDN through VC), which were 52.72 cm and 10.28, as compared to control (33.55 cm) and (7.56), respectively at final harvest. The observed increase in leaf length and the number of leaves could be attributed to a continuous and sustained supply of nutrients to the plants throughout the entire growth period. The outcomes of the current study are supported by the results recorded by Singh *et al*. (2020). Regarding response of onion varieties, Hisar Onion-2 recorded higher number of leaves (9.44) as compared to Hisar Onion-4 (9.18) at harvest while in case of leaf length effect of varieties was found non- significant. The neck thickness recorded significantly narrow (6.52 mm) in control treatment whereas more neck diameter (9.66 mm) was observed in treatment RDF. The observed increase in neck diameter can be attributed to the significant impact of nitrogen on vegetative growth. Kumar *et al*. [9] also recorded less neck diameter at absolute control. Yogita and Ram [10] also reported the maximum neck thickness with the application of (NPK 100%). When varietal mean was compared, non-significant difference was obtained in neck diameter.

The plot receiving no manure and fertilizer, *i.e.,* T8 resulted in the minimum bolting percentage (2.17%) which was statistically at par with application of 50% RDF through NPK + 50% RDN through VC and PM, *i.e.,* T6 (2.28%) and T7 (2.44%) whereas, the maximum bolting percentage (4.00%) was recorded in treatment T1 (RDF). These results contradict the findings of Diaz-Perez *et al*. [11], who reported a steady decline in bolting incidence with increasing nitrogen fertilization rates up to 197 kg/ha N. The effect of different varieties and their interaction on bolting percentage was observed to be non- significant.

Table: -2 Effect of organic manures and inorganic fertilizers on growth characteristics of onion

Treatments	Leaflength(cm)			No.ofleavesperplant			NeckDiameter(mm)			Bolting(%)		
	Varieties		Mean	Varieties		Mean	Varieties		Mean	Varieties		Mean
	HO-2	HO-4		HO-2	HO-4		HO-2	HO-4		HO-2	HO-4	
T_1	50.67	51.20	**50.94**	10.22	9.94	**10.08**	9.58	9.75	**9.66**	4.15	3.86	**4.00**
T_2	43.72	44.77	**44.24**	8.89	8.63	**8.76**	8.7	8.73	**8.71**	3.82	3.62	**3.72**
T_3	45.05	45.4	**45.22**	9.04	8.74	**8.89**	8.38	8.56	**8.47**	3.21	3.12	**3.16**
T_4	44.79	45.12	**44.95**	8.92	8.72	**8.82**	8.53	8.75	**8.64**	3.36	3.18	**3.27**

T_5	49.38	50.38	**49.88**	10.04	9.78	**9.91**	7.50	7.69	**7.59**	2.95	2.81	**2.88**
T_6	52.31	53.13	**52.72**	10.42	10.13	**10.28**	7.23	7.4	**7.31**	2.33	2.23	**2.28**
T_7	51.08	52.64	**51.86**	10.32	10.03	**10.17**	7.34	7.54	**7.44**	2.54	2.33	**2.44**
T_8	33.03	34.08	**33.55**	7.68	7.44	**7.56**	6.43	6.62	**6.52**	2.21	2.14	**2.17**
Mean	**46.25**	**47.09**		**9.44**	**9.18**		**7.96**	**8.13**		**3.07**	**2.91**	
Factors	**Factor(T)**	**Factor(V)**	**Factor(TXV)**	**Factor(T)**	**Factor(V)**	**Factor(TXV)**	**Factor(T)**	**Factor(V)**	**Factor(TXV)**	**Factor(T)**	**Factor(V)**	**Factor(TXV)**
C.D.at5%	1.83	NS	NS	0.46	0.23	NS	0.52	NS	NS	0.34	NS	NS

T1: RDF, T2: RDN through FYM, T3: RDN through VC, T4: RDN through PM, T5: 50% RDF through NPK + 50% RDN through FYM, T6: 50% RDF through NPK + 50% RDN through VC, T7: 50% RDF through NPK + 50% RDN through PM, T8: Control

The table 3 shows that the minimum twin bulb percentage (2.99%) was recorded in T8 (control), which was statistically at par with 50% RDF through NPK + 50% RDN through VC (3.16%) and 50% RDF through NPK + 50% RDN through PM (3.20%) whereas the maximum twin bulb percentage (4.88%) was observed in T1 (RDF). The production of twin bulbs could be attributed to the activation of multiple growth centers in the basal plate of the bulb leading to the formation of a greater number of smaller plates. These results are supported by study carried out by Bhujbal [12] and Birajdar [13]. In case of onion varieties the lowest twin bulb percentage was observed in Hisar Onion-4 (3.82%) in comparison to Hisar Onion-2 (4.02%). Among different treatments, early maturity (114.37 days) was reported in control. Treatment consisting 100% RDN through FYM, which was statistically at par with treatment control recorded maturity of 115.37 days. Probable reasons for this occurrence can be attributed to the inherent genetic makeup of the onion genotypes. or slow and continuous release of nutrient by organic and inorganic treatment combinations for long period. As a consequence, the plant remained in the vegetative phase, leading to an imbalance in the C:N ratio and subsequently causing delayed maturity at higher nutrient levels. These findings are also found identical to the findings of Dhakad*et al*. [14]. Among the varieties, Hisar Onion-4 (117.90 days) matured earlier than Hisar Onion-2 (119.15 days).

It was reported that polar diameter and equatorial diameter were observed maximum in T6 (50% RDF through NPK + 50% RDN through VC), which were 5.16 and 6.09 cm, respectively and reported statistically at par with 50% RDF through NPK + 50% RDN through PM (5.07 and 5.98 cm) and RDF (4.95 and 5.88 cm) as compared to control treatment 3.81 and 4.49 cm at harvest. Gebremichael *et* al.[15] findings indicate that the application of 5 t ha^{-1} of Vermicompost along with 50% nitrogen resulted in approximately a 58% increase in bulb diameter compared to the control treatment. Regarding the effect of varieties, Hisar Onion-4 recorded maximum polar diameter (4.79 cm) and equatorial diameter (5.67 cm) as well in comparison to Hisar Onion-2 (4.66 and 5.51 cm) at harvest.

Table: -3 Effect of organic manures and inorganic fertilizers on growth characteristics and maturity period of onion

Treatments	Twinbulbs(%)			PolarDiameter(cm)			EquatorialDiameter(cm)			Daystomaturity (days)		
	Varieties		Mean	Varieties		Mean	Varieties		Mean	Varieties		Mean
	HO-2	HO-4		HO-2	HO-4		HO-2	HO-4		HO-2	HO-4	

T_1	5.08	4.67	**4.88**	4.88	5.02	**4.95**	5.72	6.04	**5.88**	121.25	119.75	**120.50**
T_2	4.81	4.42	**4.61**	4.53	4.66	**4.59**	5.42	5.47	**5.45**	116.5	114.25	**115.37**
T_3	4.55	4.32	**4.44**	4.59	4.76	**4.67**	5.51	5.64	**5.58**	118.00	117.50	**117.75**
T_4	4.65	4.4	**4.53**	4.64	4.70	**4.67**	5.53	5.61	**5.57**	117.00	115.75	**116.37**
T_5	3.63	3.52	**3.58**	4.8	4.95	**4.88**	5.67	5.75	**5.71**	119.75	119.50	**119.62**
T_6	3.19	3.14	**3.16**	5.07	5.26	**5.16**	5.95	6.23	**6.09**	123.25	121.75	**122.50**
T_7	3.25	3.15	**3.2**	5.00	5.14	**5.07**	5.85	6.12	**5.98**	122.75	120.75	**121.75**
T_8	3.04	2.94	**2.99**	3.75	3.87	**3.81**	4.46	4.52	**4.49**	114.75	114.00	**114.37**
Mean	**4.02**	**3.82**		**4.66**	**4.79**		**5.51**	**5.67**		**119.15**	**117.9**	
Factors	**Factor(T)**	**Factor (V)**	**Factor(TXV)**	**Factor (T)**	**Factor(V)**	**Factor(TXV)**	**Factor(T)**	**Factor(V)**	**Factor(TXV)**	**Factor(T)**	**Factor(V)**	**Factor(TXV)**
C.D.at5%	0.3	0.15	NS	0.24	0.12	NS	0.27	0.13	NS	1.88	0.94	NS

T1: RDF, T2: RDN through FYM, T3: RDN through VC, T4: RDN through PM, T5: 50% RDF through NPK + 50% RDN through FYM, T6: 50% RDF through NPK + 50% RDN through VC, T7: 50% RDF through NPK + 50% RDN through PM, T8: Control

Table 4 clearly indicates that application of 50% RDF through NPK + 50% RDN through VC significantly produced the maximum average fresh weight of bulb (82.39 g), which was observed statistically at par with the application of 50% RDF through NPK + 50% RDN through PM (80.38 g) and RDF (79.98 g). The control treatment produced the minimum average fresh weight of bulb (54.63 g). Within the varieties, Hisar Onion-4 (73.60 g) produced significantly higher fresh weight of bulb than Hisar Onion- 2 (71.78 g). Application of 50% RDF through NPK + 50% RDN through VC produced significantly maximum yield per plot (26.74 kg) and yield per hectare (29.71 t), which was observed statistically at par with the application of 50% RDF through NPK + 50% RDN through PM (26.20 kg and 29.11 t) and RDF (25.57 kg and 28.42 t). The control treatment produced the minimum yield per plot and yield per hectare (16.95 kg and 17.23 t). Within the varieties, Hisar Onion-4 (24.18 kg and 26.68 t) produced significantly more yield per plot and yield per hectare than the Hisar Onion-2 (23.08 kg and 25.46 t).

Table: -4 Effect of organic manures and inorganic fertilizers on yield characteristics of onion

Treatments	**Averagefreshweightofbulb(g)**			**Yield perplot(kg)**			**Yieldperhectare(t)**		
	Varieties		**Mean**	**Varieties**		**Mean**	**Varieties**		**Mean**
	HO-2	**HO-4**		**HO-2**	**HO-4**		**HO-2**	**HO-4**	
T_1	78.96	80.99	**79.98**	25.11	26.04	**25.57**	27.9	28.93	**28.42**
T_2	67.03	68.06	**67.55**	21.87	22.9	**22.38**	24.3	25.44	**24.87**

T_3	69.27	71.12	**70.19**	22.69	23.76	**23.23**	25.27	26.65	**25.96**
T_4	68.39	70.22	**69.3**	22.3	23.35	**22.82**	24.78	25.94	**25.36**
T_5	76.22	78.02	**77.12**	24.64	25.65	**25.15**	27.38	28.5	**27.94**
T_6	81.52	83.27	**82.39**	26.02	27.46	**26.74**	28.91	30.51	**29.71**
T_7	79.18	81.58	**80.38**	25.62	26.77	**26.2**	28.47	29.75	**29.11**
T_8	53.68	55.58	**54.63**	16.36	17.53	**16.95**	16.69	17.77	**17.23**
Mean	**71.78**	**73.6**		**23.08**	**24.18**		**25.46**	**26.68**	
Factors	Factor (T)	Factor (V)	Factor (TXV)	Factor (T)	Factor (V)	Factor (TXV)	Factor (T)	Factor (V)	Factor (TXV)
C.D. at5%	**3.25**	**1.63**	**NS**	**1.54**	**0.77**	**NS**	**1.71**	**0.85**	**NS**

T1: RDF, T2: RDN through FYM, T3: RDN through VC, T4: RDN through PM, T5: 50% RDF through NPK + 50% RDN through FYM, T6: 50% RDF through NPK + 50% RDN through VC, T7: 50% RDF through NPK + 50% RDN through PM, T8: Control

The maximum number of A grade bulbs (73.55%) was recorded in treatment T6 (50% RDF through NPK + 50%) RDN through VC. On the other hand, same treatment recorded the minimum number of grade B bulbs (13.84%) whereas maximum number of grade B and grade C bulbs were recorded in treatment control (T8), which is 31.74% and 32.97%, respectively. Treatment RDF (T1) noted the minimum number of grade C bulbs (12.43%) as presented in table 5. The increase in yield contributing characters as mentioned in Table. 3 are due to the fact that organic manures are advantageous to plants because they are source of many crucial macro and micronutrients. They are also rich in organic matter and enhance the availability and uptake of nitrogen, phosphorus, and potassium. This stimulation positively influences photosynthesis and metabolic activities promoting plant cell division and elongation. Consequently, this will result in increase in size and fresh weight of bulbs which, ultimately contributes to an overall improvement in the yield of onion bulbs. Banjare, *et al.* [16], Kumar *et al.* [9] and Singh *et al*., [17] also have similar findings.

Table: -5 Effect of organic manures and inorganic fertilizers on grading of onion bulbs

Treatments	**Agradebulb(>60 g)**			**Bgradebulbs(45-60g)**			**Cgradebulbs(<45g)**		
	Varieties		**Mean**	**Varieties**		**Mean**	**Varieties**		**Mean**
	HO-2	**HO-4**		**HO-2**	**HO-4**		**HO-2**	**HO-4**	
T_1	71.01	71.88	**71.44**	15.49	16.77	**16.13**	13.5	11.35	**12.43**
T_2	60.11	61.22	**60.67**	19.88	21.21	**20.54**	20.02	17.57	**18.8**

T_3	62.32	63.17	**62.74**	18.84	20.11	**19.48**	18.84	16.72	**17.78**
T_4	61.34	62.38	**61.86**	19.16	19.78	**19.47**	19.50	16.84	**18.17**
T_5	68.91	69.8	**69.36**	15.84	16.11	**15.97**	15.25	14.09	**14.67**
T_6	72.7	74.41	**73.55**	13.27	14.41	**13.84**	14.03	11.18	**12.61**
T_7	71.54	72.73	**72.13**	14.27	15.64	**14.96**	14.19	11.63	**12.91**
T_8	33.95	36.64	**35.30**	31.13	32.34	**31.74**	34.92	31.02	**32.97**
Mean	**62.73**	**64.03**		**18.49**	**19.55**		**18.78**	**16.30**	
Factors	Factor (T)	Factor (V)	Factor (TXV)	Factor (T)	Factor (V)	Factor (TXV)	Factor (T)	Factor (V)	Factor (TXV)
C.D. at5%	**2.892**	**NS**	**NS**	**2.266**	**NS**	**NS**	**1.605**	**0.802**	**NS**

T1: RDF, T2: RDN through FYM, T3: RDN through VC, T4: RDN through PM, T5: 50% RDF through NPK + 50% RDN through FYM, T6: 50% RDF through NPK + 50% RDN through VC, T7: 50% RDF through NPK + 50% RDN through PM, T8: Control

4. CONCLUSION

Based on study, it could be concluded that the maximum bulb yield (29.71 t) and quality ofonion bulb was obtained when the nutrients were applied through 50% of recommended dose of NPK + 50% of recommended dose of nitrogen supplied through vermicompost in each onion varieties Hisar Onion-2 and Hisar Onion-4. Adoption of combined use of organic manure and inorganic fertilizers saves cost incurred by chemical fertilizers and environmental pollution caused by them. Among onion varieties Hisar onion-4 was found outstanding in term of growth, bulb yield quality characters when grown under climatic condition of Haryana.

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