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IMPACT OF CHEMICAL FERTILIZER, BIODYNAMIC AND ORGANIC MANURE ON GROWTH, YIELD, QUALITY AND PROFITABILITY OF LATE *KHARIF* ONION (*ALLIUM CEPA* L.)

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ABSTRACT

A field experiment was conducted at the Instructional Farm, Krishi Vigyan Kendra, Karda, Washim during the late *kharif* season of 2019-20 and 2020-21 to study the effect of integrated use of inorganic fertilizer with FYM on yield, uptake of nutrients and economics of onion (*Allium cepa* L.). The experiment was laid out in randomized block design with thirteen treatments and three replications. The results revealed that the maximum bulb diameter (5.45 cm), weight of bulb (77.35g), bulb yield per ha. (294.81q), N, P and K uptake (35.40, 12.82 and 25.20 kg/ha), highest micronutrient content (zinc 25.61 mg/kg, iron 76.70 mg/kg, copper 21.25 mg/kg, manganese 57.18 mg/kg was found in T_9 *i.e.* 50% RDN through FYM (qha^{-1}) + 50% RDN through Vermicompost (qha^{-1}) + Azatobactor (kgha^{-1}) + PSB (kgha^{-1}) (T^9). In T_9 treatment the maximum cost benefit ratio was found to be 10.90.

Key words : Economics, Integrated nutrient management, Nutrient uptake, Onion, Yield.

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.Integration nutrient is sources of chemical and organic fertilizer and shown their efficient management in notonly increasing the productivity and health of soil, but also in meeting a part of crops requirement in terms of nutrients (Aulakh, 2011). The adequate and balanced amount of all the essential nutrients improves the soil productivity which also depends upon the inclusion of the secondary nutrients andmicronutrients. The continuous use of chemical fertilizers has remarkably increased in production but simultaneously carried the problems related to secondary and micronutrient deficiencies, particularly those of sulphur and zinc in soils. Sulphur performs many physiological functions like synthesis of sulphur containing amino acids which have a positive role in improving quality of bulbs. Zinc is also important micronutrient reported deficient in Indian soils and plays a significant role in various enzymatic and physiological activities of plant bodies. Response to applied zinc for better growth and yield of vegetable crops has been reported from almost all corners of the country (Solanki *et al*., 2010).

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 (Yogita and Ram, 2012). 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

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 (Maharashtra), 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 soil of experimental plot was medium black having uniform texture and structure with good drainage.

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 × 2 m (5 m^2). The distance between blocks was 2 meters whereas the distance between plots was 1 m 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 qha^{-1}) + 50% RDN through Neem cake (13.1 q ha^{-1}), T_2 (50% RDN through FYM (43.6 qha^{-1}) + 50% RDN through Poultry manure (37.2 qha^{-1}), T_3 (50% RDN through FYM (43.6qha^{-1}) + 50% RDN through Vermicompost (31.0 qha^{-1}), T_4 (50% RDN through FYM (43.6 qha^{-1}) + Azatobactor (5 $kgha^{-1}$) + PSB (5 $kgha^{-1}$), T_5 (50% RDN through Neem cake (13.1qha^{-1}) + Azatobactor (5 $kgha^{-1}$) + PSB (5 $kgha^{-1}$), T_6 (50% RDN through Poultry manure (37.2 qha^{-1}) + Azatobactor (5 $kgha^{-1}$) + PSB (5 $kgha^{-1}$), T_7 (50% RDN through FYM (43.6 qha^{-1}) + 50% RDN through Neem cake (13.1 qha^{-1}) + Azatobactor (5 $kgha^{-1}$) + PSB (5 $kgha^{-1}$), T_8 (50% RDN through FYM (43.6 qha^{-1}) + 50% RDN through Poultry manure (37.2 qha^{-1}) + Azatobactor (5 $kgha^{-1}$) + PSB (5 $kgha^{-1}$), T_9 (50% RDN through FYM (43.6 qha^{-1}) + 50% RDN through Vermicompost (31.0 qha^{-1}) + Azatobactor (5 $kgha^{-1}$) + PSB (5 $kgha^{-1}$), T_{10} (Biodynamic 501&500 + solution S_9 (cow pat pit) + Biodynamic manure (91.0 qha^{-1}), T_{11} (Biodynamic 501&500 + solution S_9 (cow pat pit), T_{12} (Recommended dose of fertilizer (100:50:50 $kgha^{-1}$) and T_{13} (Control).

The high yielding onion variety Bhima Super developed by ICAR-Directorate of Onion and 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 2^{nd} 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 month of both years of experiments. Experimental plots of 2.5 m × 2 m were prepared. The recommended dose of nitrogen (RDN-100 $kgha^{-1}$) was applied through organic manure one month before the transplanting of plant. Chemical fertilizers were applied at the rate of 100 $kgha^{-1}$ N, 50 $kgha^{-1}$ P_2O_5 and 50 $kgha^{-1}$ 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 S9 (cow pat pit) was applied at rate of 22.23 $kgha^{-1}$. 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. The observations were recorded for growth parameters *viz*., bulb diameter (cm), weight of bulb (g), bulb yield per ha (q) oleoresin content (Thimmaiah, 1999) and sulphur content was computed as per turbidimetric method (Chesnin and Yein, 1951). The uptake of nutrients was also computed from their concentration in bulb. The nitrogen uptake was measured kedjal method, phosphorus uptake measured by Vanadomolybdo phosphoric yellow colour method and potassium uptake by leaves, bulb and total uptake by plant is determined by Flame photometer method (Bhargava and Raghupathi, 1993). The micronutrient *viz*., DTPA extractable zinc, copper, iron and manganese is determined by using Atomic absorption spectrophotometer method (Lindsay and Norvell, 1978). The economics of onion production was worked out on the basis of prevailing market price of different inputs and final produce. The trend of results was similar during both the years hence; data were subjected to pooled analysis for results and discussion. The data were statistically analyzed using analysis of variance (ANOVA) under RBD following the procedure suggested by Panse and Sukhatme (1985).

Results and Discussion

The yield and quality parameters of late kharif onion was significantly affected by the application of integrated nutrient management at different stages of plant growth (Table 1).

Bolting (%) in onion

The 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). The premature flower stalk emergence is known as boltingin onion. Bolting is undesirable since it affects bulb quality and the bulbs are fibrous with very low keeping quality. It is mentioned that in adequate nutrition is one of the factor in the induction of bolting in onion.

Bulb Diameter (cm)

The data pertaining to diameter of bulb is significantly influenced by various treatments and is presented in Table 1. The 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). This may be due to combined application of bio-fertilizers with organic and inorganic fertilizers, which attributed to the fact that bio-fertilizers 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) and Kumar *et al*. (2010).

Weight of bulb (g)

The maximum weight of bulb (77.35 g) was note in T_9, it was at par over T_7 (74.29 g) and T_8 (74.00 g). 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), resulting in the increased average bulb weight. These results are in confirmation with the findings of Yogita *et al.* (2012) and Meshram and Shende (1990).

Yield per ha (q)

The pooled data indicated the significantly highest bulb yield per ha. (294.81 q) 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 (253.07 q). However, the lowest yield (186.15 q) pertaining to this observation was recorded in absolute control (T_{13}) (Table 1). This increase in yield is due to 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), Yadav *et al*. (2012) and Yogita *et al*. (2012).

Oleoresin content (%), Dry matter content (%) and Sulphur content (%)

The data regarding the oleoresin content (%), dry matter content (%) and sulphur content of onion bulbs as influenced by various treatments of organic manure and bio-fertilizers is presented in Table 1. From Table 1, it revealed that, an oleoresin content of onion bulbs was maximum (10.61 and 10.53 %) after curing of onion bulb was recorded T_9 and T_7. The increased accumulation of dry mater (%) in the bulbs could be attributed to increased accumulation of chemical constituents like sulphur and phosphorus and also decrease in moisture content of the bulbs. These results are in agreement with the findings of Singh and Dhanakar (1995), Meshram and Shende (1990) and Madhan and Sandhu (1983) in onion. The increase in sulphur content after curing of bulb (0.42%) with treatment T_9 and it was at par with T_7 (0.41%), however lowest sulphur content after curing of bulb (0.21%) was noticed in control treatment (Table 1).

Table 1 : Effect of INM on yield and quality parameters of late *kharif* onion.

Treatments	Bolting (%)	Bulb diameter (cm)	Weight of bulk (g)	Yield ha^{-1} (q)	Oleoresin (%)	Dry matter (%)	Sulphur (%)
T_1	1.40	5.02	67.73	253.07	10.28	10.33	0.34
T_2	1.20	4.94	65.47	237.45	10.32	8.91	0.33
T_3	1.25	4.56	63.78	236.99	10.35	11.04	0.34
T_4	1.50	4.18	56.59	224.25	10.39	11.84	0.28
T_5	1.35	4.22	53.43	194.89	10.42	8.60	0.32
T_6	1.24	4.50	60.56	219.10	10.33	10.47	0.32
T_7	1.10	5.34	74.29	265.90	10.53	11.55	0.41
T_8	0.82	5.29	74.00	262.63	10.45	13.71	0.37
T_9	0.76	5.45	77.35	294.81	10.61	14.01	0.42
T_{10}	1.27	4.78	61.08	226.91	10.30	9.84	0.28
T_{11}	1.35	4.10	52.52	187.91	10.33	10.03	0.26
T_{12}	1.00	4.22	65.48	245.50	10.29	10.19	0.26
T_{13}	1.59	3.85	51.70	186.15	10.22	8.55	0.21
F test	Sig	Sig.	Sig.	Sig	Sig.	Sig.	Sig.
SE(m) ±	0.02	0.02	0.66	4.33	0.03	0.07	0.00
CD @5%	0.05	0.06	1.93	12.65	0.08	0.22	0.01
CV	2.57	0.78	1.81	3.21	0.48	1.21	2.29

Nutrient uptake and micronutrient content

The data of nutrient uptake by onion bulb as influenced by various treatments are presented in Table 2.

The highest N, P and K uptake of onion bulb was observed in T_9 treatment that 35.40, 12.82 and 25.20 kg/ha and it was found to be at par with T_7 treatment N (33.17 kg/ha), P (11.91 kg/ha) and K (21.61kg/ha) however lowest N, P and K was observed in T_{13} (control) treatment 21.76, 7.58 and 10.97 kg/ha. The increase in N content uptake may be due to increased microbial population and subsequently, higher non symbiotic N-fixation by Azotobacter and dry matter yield. If the bulb shows higher dry matter yield, then it is sure that plant takes more nutrients (NPK) from the soil. The increased N uptake could be due to increased and prolonged availability of N to the plants in these treatments and also due to increased dry matter yield. Nutrient uptake is a positive function of dry matter yield (Ramakal *et al*., 1988 and Meena *et al*., 2014b).

The organic manures have recorded larger uptake of phosphorus. This could be attributed to their chelating action in making ions available and maintaining soil physical condition. Bio-fertilizers like PSB would have caused more mobilization and solubilization of insoluble P in the soil and improved the availability of phosphorus, which would have caused an increase uptake of phosphorus of plants. It could also be due to the increased availability of P due to the solubility effect of organic acids which were produced from the decomposing organic manures. Further FYM and vermicompost might also have reduced the fixation of P and increased the availability of P in soil solution for its better absorption resulting in increased uptake of P in onion More over organic manure might have enriched the soil with additional phosphorus and improved the water retention capacity of the soil and there by maintained a conducive environment in the soil for making phosphorus more available to the plants in higher quantities. The results are in confirmation with finding of Somashekar (2014). Nitrogen possibly might have influenced the potassium uptake by virtue of its complementary action with potassium. The increase in K uptake was due to the increased availability of nutrients from the native, as well as from the mineralized organic manures which might have increased the concentration of K in soil solution making it readily available for absorption. Similar trend was recorded in onion by Geetha (1994).

The highest micronutrient content was observed in T_9 treatment *viz*., zinc (25.61 mg/kg), iron (76.70 mg/kg), copper (21.25 mg/kg), manganese (57.18 mg/kg) lowest zinc (18.70 mg/kg), iron (73.13 mg/kg), copper (15.64 mg/kg) and manganese content (52.77 mg/kg) were reported in control (T_{13}). Organic manure improves soil organic carbon level, soil physical environment and soil microbial activity. It releases organic acid which solubilised soil native or applied micronutrients and make

Table 2 : Effect of INM on nutrient uptake by late kharif onion bulb.

Treatments	Nutrient uptake (kg/ha)			Micronutrient uptake (mg/kg)			
	Nitrogen	Phosphorus	Potassium	Zinc	Iron	Copper	Manganese
T_1	31.48	10.25	18.74	23.04	74.23	17.67	55.23
T_2	30.89	10.02	16.97	24.36	74.40	18.31	55.45
T_3	29.88	9.64	15.15	23.76	74.09	18.33	55.47
T_4	29.36	9.20	14.12	21.06	74.59	16.57	53.79
T_5	29.47	8.73	14.81	20.15	74.15	15.97	54.45
T_6	28.32	8.55	14.62	20.57	73.53	17.01	54.71
T_7	33.17	11.91	21.61	22.51	74.76	19.85	56.58
T_8	32.71	10.95	19.18	24.74	74.68	20.00	56.05
T_9	35.40	12.82	25.20	25.61	76.70	21.25	57.18
T_{10}	30.46	10.04	16.54	21.31	74.71	16.98	54.31
T_{11}	30.51	9.83	15.65	19.23	73.38	16.29	53.27
T_{12}	33.03	12.62	22.2	21.26	74.07	17.20	54.48
T_{13}	21.76	7.58	10.97	18.70	73.13	15.64	52.77
'F'test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.36	0.08	0.29	0.24	0.44	0.44	0.42
CDat5%	1.04	0.24	0.84	0.69	1.28	1.29	1.22
CV	2.02	1.40	2.87	1.85	1.03	4.30	1.32

Table 3 : Effect of INM on economics of late kharif onion cultivation.

Treatments	Yield per ha	Gross return Rs/ha	Cost of cultivation Rs/ha	Net return	B:C ratio
T_1	253.07	664303	72730	591573	9.13
T_2	237.45	623311	70515	552796	8.84
T_3	236.99	622106	69470	552636	8.96
T_4	224.25	588660	64870	523790	9.07
T_5	194.89	504758	69920	434838	7.22
T_6	219.10	575144	67595	507549	8.51
T_7	265.90	697992	71230	626762	9.80
T_8	262.63	689412	70915	618497	9.72
T_9	294.81	773868	70965	702903	10.90
T_{10}	226.91	595645	72642	523003	8.20
T_{11}	187.91	485760	64584	421176	7.52
T_{12}	245.50	644425	67691	576734	9.52
T_{13}	186.15	479888	60900	418988	7.88

it available to plants (Zhang, 2015).

Economics

The data regarding effect of organic nutrient management on economics of onion production revealed that, the highest gross monetary returns of Rs.773868 with highest net return of Rs.702903/- and BC ratio of 10.90 were obtained in treatment T_9 which was followed by treatment T_7 with gross monetary returns of Rs. 697992/-, net return of Rs. 626762/- and BC ratio of 9.80 and treatment T_8 with gross monetary returns of Rs. 689412/-, net return of Rs. 618497/- and BC ratio of 9.72. Whereas lowest gross monetary return of Rs. 479888/-, net return of Rs. 418988/- and BC ratio of 7.88 was noticed in T_{13} treatment (Table 3). Bybordi and Malakouti (2007) and Sharma *et al.* (2003) reported the highest net returns and B:C with the application of FYM and vermicompost in onion. Though, plots treated with organics have higher cost of cultivation, the benefits in terms of quality, nutritional values, improvement of soil physico-chemical properties and the biological properties due to addition of organic manures should not be over looked. By producing Farmyard manure, vermicompost, neem cake and poultry manure at farmer's level, cost of organic cultivation can be reduced.

Conclusion

In late *kharif* onion, the maximum average weight of bulb, yield per ha, dry matter, oleoresin content and sulphur and minimum bolting (%) was recorded with application of 50% RDN through FYM (43.6 qha^{-1}) + 50% RDN through Vermicompost (31.0 qha^{-1}) + Azatobactor (5 kg ha^{-1}) + PSB (5 kgha^{-1}). The highest uptake of nitrogen, phosphorus and potassium by bulb and the maximum content of micronutrients like zinc, copper, iron and manganese in bulb of onion and maximum B: C ratio was observed with application of 50% RDN through FYM (43.6 qha^{-1}) + 50% RDN through Vermicompost (31.0 qha^{-1}) + Azatobactor (5 kgha-

^{1}) + PSB (5 kgha^{-1}).

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