



Effect of organic manures and inorganic fertilizers on dry matter yield, soil and plant nutrient content in onion (*Allium cepa*)

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ABSTRACT

An experiment was conducted to study the effect of different sources of organic manures [Farmyard manure (FYM), Vermicompost (VC) and Jeevamrut] and inorganic fertilizers (Urea, SSP and MOP) on soil and plant nutrient content in onion (*Allium cepa* L.) during 2017–18 and 2018–19 at Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh. The experiment was laid out in randomized block design with nine treatments replicated thrice. Soil samples from all the treatments during both the years were collected from 0–15 cm depth. At the end of the experiment, significantly high post-harvest fertility status of macronutrients (NPK), viz. 386, 1566 and 384.1 kg/ha, respectively, were recorded under recommended nutrient management practice (RDF) i.e. 125 N: 75 P: 60 K kg/ha + FYM @250 q/ha. Similarly, significantly highest concentration of bulb and leaf macronutrients and biomass yield of bulbs and leaves were recorded under RDF. The purely organic module besides excelling at par with RDF in build-up of macronutrients in soil also registered maximum organic carbon content in soil. From the study, it can be inferred that RDF + FYM @250 q/ha can be used for maintaining the soil fertility.

Keywords: Inorganic fertilizers, Macronutrients, Organic manures, Soil fertility

Onion (*Allium cepa* L.) is one of the oldest vegetables consumed worldwide. Like other condiments, it is widely used for culinary purposes and as a flavouring agent. Nowadays, it is available in fresh, frozen, canned, pickled and dehydrated forms. Onion is one of the fundamentals of Indian cooking and is used both in green and matured stages, in a variety of flavoured dishes and soups. In India, onion was grown on an area of 132 million hectares during 2017–18 with a total production of 22.1 million tonnes (Department of Agriculture, GoI 2018).

The cultivable land resources are shrinking with the increasing population and to meet the food demand of growing population, the productivity of agricultural land, and soil health must be improved. Green revolution in the post-independence era has shown path to developing countries for self-sufficiency in food but sustaining agricultural production against the finite natural resource base demands shift from resource degrading chemical agriculture to a resource protective organic agriculture. The occurrence of multinutrient deficiencies and overall decline in the productivity of the soil under extensive fertilizer use have been widely reported (Chhonkar 2003).

The sky-rocketing prices of fertilizers and their detrimental impact on soil health, environment and

increasing cost of cultivation urged the vegetable growers to adopt the alternate sources of nutrients for sustainability. Adoption of best nutrient management practice can properly address the current concept of farming for health, the sustainability of natural resource base particularly soil and ultimately the livelihood of the farming community (Kakar *et al.* 2020). Keeping in view the above-mentioned points, present investigation was taken up with the objective to assess the production of onion under low cost nutrient management practices.

MATERIALS AND METHODS

A field experiment was conducted at Research Farm of Department of Soil Science and Water Management, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Himachal Pradesh during winter (*rabi*) season of the year 2017–18 and 2018–19. The research farm of the department consists of two sites, viz. organic site and inorganic site. The experimental soils were sandy clay loam in texture and neutral to slightly saline in reaction. The soil of both the experimental sites i.e. organic as well as inorganic site was high in OC (13.5 and 11.1 g/kg, respectively), available P (48.9 and 53.6 kg/ha, respectively) and available K (327.4 and 343.7 kg/ha, respectively), whereas, it was low in available N content (211.2 and 220.1 kg/ha).

The experiment was laid down in randomized block design with three replications. The treatment comprised nine nutrient combinations, viz. T₁: Control, T₂: RDF +

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FYM @250 q/ha, T₃: Jeevamrut @5%, T₄: FYM @250 q/ha + RDF through FYM (on N equivalent basis), T₅: FYM @250 q/ha + Jeevamrut @5%, T₆: VC (on N equivalent basis of FYM) + RDF through FYM (on N equivalent basis), T₇: VC (on N equivalent basis of FYM) + Jeevamrut @5%, T₈: FYM @125 q/ha (50 %) + VC (on N equivalent basis of 50% FYM) + RDF through FYM (on N equivalent basis), T₉: FYM @125 q/ha (50 %) + VC (on N equivalent basis of 50 % FYM) + Jeevamrut @5%. RDF is recommended dose of fertilizer (NPK), which for onion is 125:75:65 kg/ha. The variety of onion used was Nasik Red.

Nitrogen, Phosphorus and Potassium were given as inorganic fertilizers in the form of urea, single super phosphate (SSP) and muriate of potash (MOP), respectively. In the inorganic plots, whole quantity of FYM, SSP and MOP fertilizers were applied at the time of field preparation, whereas, urea was applied in three split doses with half as basal dose and remaining quantity of N was applied in two equal splits at monthly interval after transplanting. Whole quantity of FYM (0.58% N, 0.31% P and 0.51% K) and VC (1.32% N, 0.48% P and 0.61% K) was given before transplanting as per the treatment of the experiment in the organic plots. The Jeevamrut (1.42% N, 0.98% P and 0.09% K) was prepared from 10 kg cow dung and 10 l cow urine added to 100 l of water, mixed and kept for about one week. It was applied to the soil at fortnightly interval along with the irrigation water @5% i.e. 5 ml in 100 ml of water or 500 ml in 10000 ml of water (per plot, per application) after establishment of the seedlings. For the control of insect, pests and diseases, 5% cow urine and 5% Jeevamrut were used alternatively as spray at weekly interval in organic site.

Representative soil samples from 0–15 cm depth were collected at the time of harvesting during both the years of study to ascertain the effect of different sources of organic manures and inorganic fertilizers on OC and available nutrients. Composite soil samples dried in shade were ground with the help of pestle and mortar, passed through 2 mm sieve and stored in polyethylene bags for further analysis. Leaves, bulb and root samples were collected at the time of harvest for chemical analysis. All the samples were washed with distilled water, dried in shade and then the samples were cut into pieces and oven dried at 60°C. Well ground samples of known weight of bulbs and leaves were digested in di-acid mixture prepared by mixing concentrated HNO₃ and HClO₄ in the ratio of 4:1 observing all relevant precautions as laid down by Piper (1966) for estimating P and K. Separate digestion was carried out for N estimation using concentrated H₂SO₄ and digestion mixture as suggested by Jackson (1973). Various methods were followed for the analysis of soil and plant samples. In soil, available N was analysed as per Alkaline potassium permanganate method (Subbiah and Asija 1956), available P using Olsen's method (Olsen *et al.* 1954), available K by Ammonium acetate method (Merwin and Peach 1951) and OC was measured by Walkley and Black wet digestion method (Walkley and Black 1934). In leaves and bulb N was measured by Microkjeldahl method (Jackson 1973), P

using Vando-molybdate phosphoric yellow colour method (Jackson 1973) and K by Flame Photometer method (Jackson 1973). The data for two seasons were pooled and subjected to analysis of variance (ANOVA) by OPSTAT program.

RESULTS AND DISCUSSION

Effect on dry matter yield of bulb and leaves: Dry matter yield of bulb and leaves differed significantly in all treatments and pooled data (Table 1) revealed that maximum dry matter yield in bulb (2805.38 kg/ha) was recorded under RDF + FYM @250 q/ha i.e. T₂ which was followed by) T₄ (2743.47 kg/ha. In similar way, significantly highest dry matter yield in leaves (2068.89 kg/ha) was recorded in T₂ which was followed by T₄ (1877.98 kg/ha). The effect of year was found to be non-significant in case of dry matter yield in bulb whereas, it was found to be significant in case of leaves. Interaction between year and treatment (Y × T) was significant. The improvement in dry matter yield with integrated use of organic manure and inorganic fertilizers might be due to control release of nutrients in the soil through mineralization of organic manures, which might have facilitated better crop growth (Mitra *et al.* 2010). The pooled data indicated that nutrient rich organic sources like FYM and vermicompost were comparatively more effective than jeevamrut. The lower yields under treatments receiving jeevamrut might be due to non-availability of nutrients (NPK) to plants in such treatments.

Effect on NPK content in bulb and leaves: The data recorded with respect to NPK content in onion bulb presented in Table 1 (pooled) showed significant effect of different treatments. Trend was similar in both the years and analysis of data showed that significantly highest NPK content in onion bulb (2.65, 0.35 and 1.85%, respectively) was recorded under plots receiving RDF + FYM @250 q/ha i.e. T₂. The effect of interaction between year and treatment (Y × T) was found to be significant. Significantly lower concentrations of NPK were observed in the plots applied with jeevamrut alone as compared to its application with other organic manures (FYM and vermicompost). This may be because individual application of liquid organic manure may not provide required quantity of nutrients for plants but they support the crop growth initially due to presence of animal dung, urine and activity of microflora and fauna. They may require additional organic sources for nutrient build up in plants (Gore and Sreenivasa 2011).

The pooled data pertaining to NPK content in onion leaves (Table 1) revealed that nutrient content in onion leaves was significantly affected by different organic and inorganic treatments during both the years of study. On pooling of two years data, significantly highest NPK content in onion leaves (2.54, 0.35 and 1.71%, respectively) was recorded in T₂ i.e. RDF + FYM @250 q/ha. The effect of year was found to be non-significant in case of N and significant in case of P and K whereas, the interaction between year and treatment (Y × T) was found to be significant in case of N and P and non-significant in case of K. Significantly highest NPK content in leaves of onion with the incorporation of

organic manure with inorganic fertilizers i.e. RDF + FYM @250 q/ha may be due to proper nutrition of crop and enhanced efficiency of chemical fertilizers. The present findings are in agreement with the findings of Jayathilake *et al.* (2002) in onion.

Effect on available soil N: There was a significant effect of different treatments on the availability of nutrients in soil after the onion harvest. The pooled analysis of data (Table 1) showed that there was a significant and positive effect of treatments on soil available N content. Significantly highest available N (386.0 kg/ha) was recorded under T₂ i.e. RDF + FYM @250 q/ha. The effect of year was found to be significant, whereas, the effect of interaction between year and treatment (Y × T) was found to be non-significant. The increase in available N in FYM amended plot (T₂) is attributed to accumulation of higher organic N due to addition of more organic carbon to the soil system (Choudhary *et al.* 2018). Further, it might also be explained in terms of residual effect of fertilizers and manures and build up of inorganic N fractions of soil due to biochemical degradation and mineralization.

Effect on available soil P: The similar pattern was also observed in available P content. The treatment comprising integration of FYM as well as inorganic fertilizers showed higher available P as compared to control. The pooled analysis of data (Table 1) showed that in surface soil, available P content was significantly highest (156.6 kg/ha) under treatment T₂ which was statistically at par with T₆. The effect of year was found to be significant, whereas, the effect of interaction between year and treatment (Y × T) was found to be non-significant. It is a well-known fact that the crop uses only 25 to 30% of applied P and the

remaining part which is not readily available remains in the soil. Addition of FYM along with inorganic fertilizers under T₂ would have acidified soil by releasing H⁺ ions into the soil as a result P availability would have increased (Adnan *et al.* 2019).

Effect on available soil K: The recommended nutrient management practice of RDF + FYM @250 q/ha (T₂) exhibited significantly highest available K content as compared to other treatments in both the seasons. On pooling of two years data (Table 1), significantly highest (384.1 kg/ha) available K was recorded under T₂. This was followed by treatments T₄ and T₈ and found at par with each other in surface soils after onion harvest. The effect of year was found to be significant, whereas, the interaction between year and treatment (Y × T) was found to be non-significant. Significantly highest available K under T₂ may be due to acidifying action of FYM on applied K at the time of decomposition making more K available due to reduction in K fixation. The higher available K content in soil under T₂ might also be due to the fact that with the passage of time, the K held in the interlayer spaces of minerals are made mobile by the decomposition of FYM applied with. Similar results were also obtained by Mohapatra *et al.* (2008) in potato and jute.

Effect on available OC content: The organic carbon content of soil improved significantly with the application of organic manures and inorganic fertilizers. Pooled analysis of data (Table 1) showed that the highest amount (20.3 g/kg) of OC content was recorded under T₆ i.e. VC (on N equivalent basis of FYM) + RDF through FYM (on N equivalent basis) which was found to be statistically at par with T₂, T₃, T₄, T₇, T₈ and T₉. The effect of year and interaction between

Table 1 Effect of INM on dry matter yield and NPK content of bulb and leaves, available NPK and OC in soil

Treatment	Dry matter yield (kg/ha)		N (%)	P (%)	K (%)	N (%)	P (%)	K (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)	OC (g/kg)
	Bulb	Leaves	Bulb			Leaves						
T ₁	1942.73	1254.43	1.16	0.2	1.34	1.37	0.2	1.36	193.6	39.1	288.7	16.3
T ₂	2805.38	2068.89	2.65	0.35	1.85	2.54	0.35	1.71	386	156.6	384.1	19
T ₃	1989.4	1339.33	1.27	0.22	1.43	1.54	0.2	1.4	198.6	45.7	291.8	19.4
T ₄	2743.47	1877.98	2.38	0.32	1.68	2.38	0.3	1.66	371.1	140.9	379.6	19
T ₅	2415.27	1619.18	2.13	0.23	1.47	1.96	0.22	1.44	295.6	96.1	349.5	17.1
T ₆	2049.83	1665.31	2.44	0.31	1.66	2.44	0.29	1.61	377.2	143.9	381.4	20.3
T ₇	2428.93	1563.82	1.75	0.26	1.55	1.93	0.24	1.36	301.6	96.6	343.2	18.9
T ₈	2669.22	1717.69	2.21	0.28	1.58	2.42	0.28	1.48	367.7	138.9	377.6	19.5
T ₉	2094.26	1369.51	2.1	0.24	1.51	2.36	0.26	1.39	289	90.4	342.8	20.1
CD (0.05)												
Y	NS	6.99	0.08	0.01	0.03	NS	0.01	0.04	3.4	6.7	3.8	0.7
T	12.55	14.82	0.16	0.01	0.06	0.11	0.02	0.08	7.2	14.2	8	1.5
Y × T	17.75	20.96	0.23	0.02	0.09	NS	0.03	NS	NS	NS	NS	2.1

Treatment details given under Materials and Methods.

*Pooled data over 2 years. Y is CD_(0.05) between the years, T is CD_(0.05) between the treatments and Y × T is the interaction between year and treatment.

year and treatment ($Y \times T$) was found to be significant. The increase in OC contents with application of VC and liquid manure might be due to the direct incorporation of organic materials and the decomposition which might have resulted in enhanced OC contents (Kumari 2019).

Based on the findings of the study, it can be inferred that application of RDF + FYM @250 q/ha proved effective in significantly enhancing the available nutrient status of soil and uptake. Nutrient supplied through organic sources alone was not as effective as that from inorganic fertilizers + FYM. Therefore, conjunctive use of inorganic fertilizers and organic manures can be suggested for sustainable production of onion.

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