Annals of Plant and Soil Research 24(2):337-341 (2022)
https://doi.org/10.47815/apsr.2022.10172

Impact of integrated nutrient management on soil fertility and yield of onion (Allium *cepa*) on an alluvial soil

VINAY SINGH

Department of Agricultural Chemistry and Soil Science, Raja Balwant Singh College Bichpuri, Agra (U.P.) 283 105

Received: July, 2021; Revised accepted: September, 2021

ABSTRACT

A field experiment was conducted during rabi season of 2015-2017 at Panwari village of Agra district with a view to investigate the effect of integrated nutrient management on soil fertility, productivity and uptake of nutrients by onion (Allium cepa). Eight treatments were evaluated in randomized block design with three replications. Results indicated that the availability of N (222.0 kg ha^{-1}), P (13.1 kg ha^{-1}), K (150 kg ha^{-1}) and Zn (0.55 mg kg^{-1}) was improved with the conjoint use of organics and fertilizers. However use of 75% NPK along with 40 kg S ha^{-1} resulted in substantial increase in sulphur status of soil (18.0 kg ha^{-1}). Minimum amounts of these nutrients in post harvest soil were recorded in control. Application of 75% NPK + 10 t FYM ha^{-1} significantly increased the growth, yield attributes, bulb yield (34.02 t ha^{-1}) and dry matter yield of bulb (5.34 t ha^{-1}). The increase in bulb yield due to 75% NPK + 40 kg S ha^{-1}) was 44.6 % over control. The content and yield of protein also improved with conjoint use of NPK fertilizers and FYM and sulphur. The minimum values of content and yield of protein were recorded in control. The uptake of nutrients increased with increasing level of NPK fertilizers and showed further increase in the presence of 10t FYM ha^{-1}. The residual soil fertility was recorded minimum under control treatment.

Keywords: Integrated nutrients management, soil fertility, yield, nutrients uptake, onion

INTRODUCTION

Onion (*Alluim cepa* L) is one of the most important bulb crops of India. It is consumed daily by all sections of the society in the form of salad, cooked in curries, boiled, fried baked and pickled. It has several medicinal values and is known to prevent heat. The productivity of onion can be enhanced through the adoption of improved agronomic technologies and balanced use of fertilizers. The fertilizers no doubt played a key role in agricultural production. One of the alternatives to achieve their goal is to increase, the crop productivity through improved production technology to sustain soil fertility and crop productivity. Integrated use of manure and fertilizer showed promise not only for maintaining higher productivity but also for greater yield stability. This may be achieved through combined use of all natural resources and nutrients and their scientific management for optimum growth of the crops (Sharma *et al.* 2021). It is well known that addition of FYM has shown considerable increase in crop yield and exert significant influence on physical, chemical and biological properties of soil. Addition of FYM may help in increasing nutrients availability both from applied and native sources. The onion being the exhaustive crop depletes nutrients heavily and causes negative balance when practiced with non judicious fertilization. Therefore, there is a need to improve nutrient supply system for sustaining crop productivity and soil fertility. It order the study the effect of manures and fertilizer on soil fertility, crop productivity and sustainability, the present experiment was conducted with onion on an alluvial soil.

MATERIAL AND METHODS

A field experiment was conducted at Panwari village of Agra district during rabi season of 2015-16 and 2016-17. The soil of experimental site was sandy loam in texture. The initial analysis indicated that the soil was low in organic carbon (3.2 g kg^{-1}), available N (165 kg ha^{-1}), P (8.5 kg ha^{-1}) and K (110 kg ha^{-1}). The soil was low in available S (15.5 kg ha^{-1}) and zinc (0.54 mg kg^{-1}) status. Eight treatments i.e. T_1 control, T_2 50% RDF, T_3 50% RDF +10 t FYM ha^{-1}, T_4 50% RDF + 40 kg S ha^{-1}, T_5 75% RDF, T_6 RDF +10 t FYM ha^{-1}, T_7 75% RDF + 40 kg S ha^{-1} and T_8 100 % RDF were evaluated in randomized block design with three replications. The 100% RDF for onion was 150:100:50 kg N, P_2O_5 and K_2O ha^{-1}. The levels of NPK and FYM (0.58% N, 0.18% P, and 0.60% K) were applied as per treatments. The levels of N, P, K fertilizers were applied through urea, single super phosphate and muriate of potash, respectively. The seedlings of onion variety Nasik red N-55 were transplanted in first week of December during both the years. Appropriate management practices were adopted to raise the crop. Fresh weight and bulb yield of onion was recorded at harvest. Dry matter yield was recorded after drying in oven at 60^0C. Onion bulb sample were analyzed for N, P, K, S and Zn by adopting standard procedures. Soil samples collected at harvest were analyzed for various nutrients following standard procedures (Jackson 1973). The uptake of nutrients was obtained as product of their concentrations and yield. The data generated for both the growing seasons were pooled and statistically analyzed (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Soil fertility

Data (Table 1) indicated a decline in available N status (140 kg ha^{-1}) from the initial value (165 kg ha^{-1}) in control treatment. This decrease may be due to removal of soil N in the absence of external supply of N through fertilizers and manures. There was a significant increase in the status of available N with increasing levels of NPK fertilizers and maximum value (222 kg ha^{-1}) was recorded with 100 % NPK. The available N content of the soil was found to increase over the control in all the INM treatments. This increase may be attributed to higher microbial activity in the INM treatments which favoured the conversion of the organically bound nitrogen to inorganic form. Similar results were reported by Verma *et al.* (2014). Available P content in post harvest soil was minimum (7.8 kg ha^{-1}) in control. Addition of NPK fertilizers raised the available P content in soil and maximum amount (13.0 kg ha^{-1}) was recorded with 100% NPK. Similar findings have also been reported by Verma *et al* (2014). Incorporation of FYM along with 50 and 75% NPK fertilizers recorded significantly higher available P as compared to other treatments. The increased availability of P with organics may be ascribed to their solubilizing effect on the native insoluble P fractious through release of various, organic acids (Singh *et al.* 2019). Inclusion of sulphur with 75% NPK and FYM also improved the status of available P in post harvest soil over control. Available K status in post harvest soil declined in control over its initial value. Application of 100% NPK significantly improved the status of available K in soil over 50% NPK and control. The increase in available K under integrated treatments might be due to addition of FYM. The beneficial effect of FYM on available K may be ascribed to the reduction in potassium fixation, solubilization and release of potassium due to interaction of FYM with clay fraction (Singh *et al.* 2019). Addition of S also improved the status of available K but the effect of S was much less than that of FYM in improving availability of K in soil. Since, the experimental soil was deficient (15.5 kg ha^{-1}) in available S content, addition of S in INM increased significantly the status of available S in post harvest soil. The maximum value of available S (18 kg ha^{-1}) was recorded in 75% NPK + 40 kg S ha^{-1} treatment .Similar results were reported by Singh *et al.* (2019). The highest available zinc was recorded in 75% NPK + 10t FYM ha^{-1} (0.55 mg kg^{-1}) and was significantly superior to most of the treatments except 50% NPK + 10t FYM ha^{-1}. The lowest value (0.48 mg kg^{-1}) was recorded in control. Addition of S along with 75% NPK also improved the status of Zn in soil but the effect was much less pounced than FYM.

Yield

Higher yields of onion bulb and dry matter production were recorded with balanced use of NPK fertilizers (100% NPK). A better supply of nutrients has been associated with root growth resulted in enhanced nutrient absorption by the crop. Similar response of yield to addition of NPK fertilizers has been reported by Singh *et al.* (2019). Application of sub-optimal doses of fertilizers recorded lower yield of onion bulb. The bulb yield and dry matter yield of onion significantly increased by 53.1 and 57.3 % over control with 75 % NPK + 10t FYM ha^{-1}. The yield obtained with 75% NPK + 10t FYM ha^{-1} was statistically at par to 100% NPK alone indicating saving of 25% of RDF. Benefits occurring from the integrated use of fertilizers and FYM might be attributed to control release of nutrients in the soil through mineralization of organic manure which might have facilitated better crop growth (Singh *et al.* 2015). Application of S along with 50 and 75 % NPK fertilizers increased the bulb yield over control, emphasizing the importance of sulphur in balanced nutrition of crop for increasing the yield. Addition of S in INM treatments might have increased the level of available S, which helped in augmenting the productivity of onion. Similar results were reported by Singh *et al.* (2016) and Uikey *et al.* (2015).

Table 1: Effect of various treatments on status of available nutrients in post harvest soil

Treatment	Nitrogen (kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})	Sulphur (kg ha^{-1})	Zinc (mg kg^{-1})
Control	140	7.8	90	13.5	0.48
50% RDF	168	9.0	115	14.0	0.50
50% RDD + 10 t FYM ha^{-1}	190	12.0	125	15.2	0.54
50% RDF + 40 kg S ha^{-1}	172	9.5	117	17.0	0.51
75% RDF	195	10.7	130	14.0	0.52
75% RDD + 10 t FYM ha^{-1}	217	13.0	150	14.7	0.55
75% RDF + 40 kg S ha^{-1}	175	11.2	122	18.0	0.52
100%RDF	222	13.0	145	16.O	0.53
SEm$\pm$	3.90	0.37	3.79	0.17	0.06
CD (P=0.05)	8.10	0.77	7.92	0.36	0.13

Protein content

The data (Table 1) indicated that the application of N,, P and K fertilizers (50, 75% and 100%) increased the protein content significantly over control and relatively higher value (5.65%) was recorded with 100% NPK fertilizers. Conjunctive use of NPK fertilizers and FYM resulted is an increase in protein content in onion bulbs over control. This may be due to accumulation of more nitrogen with these treatments and ultimately showing more protein content (Laxminarayan*et al.* 2011). Application S along with NPK fertilizers significantly increased the protein content in bulbs from 4.37 to 5.44% which may be attributed to role of sulphur in protein synthesis and nitrogen metabolism in plants. Similar results were reported by Singh *et al.* (2020). There was a consistent and significant increase in protein yield of onion with all the treatments over control. Application of NPK fertilizers improved the protein yield and relatively higher values were recorded with 100% NPK over 50% NPK and control. Application of 75% NPK +10t FYM ha^{-1} also improved the protein yield. Similarly addition of 40 kg S ha^{-1} + 75% NPK enhanced the protein yield significantly over control This increase may be attributed to increased protein content and bulb yield of onion (Singh *et al.* 2020).

Table 2: Effect of various treatments on yield and quality of onion bulbs (mean of 2 years)

Treatment	Fresh weight of bulb (g)	Bulb yield (t ha^{-1})	Drymatter (t ha^{-1})	Protein content (%)	Protein yield (kg ha^{-1})
T_1 Control	40.4	22.22	3.40	4.37	148.6
T_2 50% RDF	46.0	27.57	4,20	4.75	199.5
T_3 50% RDD + 10 t FYM ha^{-1}	49.8	31.00	4.85	5.12	248.3
T_4 50% RDF + 40 kg S ha^{-1}	48.5	29.10	4.55	5.00	227.5
T_5 75% RDF	49.0	30.85	4.76	5.25	250.0
T_6 75% RDD + 10 t FYM ha^{-1}	54.8	34.02	5.32	5.62	299.0
T_7 75% RDF + 40 kg S ha^{-1}	53.6	32.15	4.93	5.44	268.2
T_8 100%RDF	54.6	33.00	5.21	5.65	294.3
SEm$\pm$	1.17	1.41	0.35	0.12	9.11
CD (P=0.05)	2.44	2.89	0.71	0,25	18.5

Nutrient uptake

Application of balanced fertilization of N, P and K led to significantly high N uptake in comparison to control. The integrated nutrient management treatments increased N uptake by onion bulbs and highest uptake of N was noted with 75% NPK + 10t FYM ha^{-1}. This increase in N uptake may be attributed to solubilization of nitrogen from organic form to inorganic form. These results are in agreement with the findings of Singh *et al.* (2015). Addition of S along with 75% NPK also improved the utilization of N by onion bulb. This increase may be attributed to increased N content and bulb yield of onion with sulphur (Singh *et al.* 2020). Application of NPK fertilizers significantly increased the P uptake by onion bulb over control, which may be attributed to increased availability of P in soil with its application (Verma *et al.*2014). Phosphorus uptake by onion bulb was also influenced by combined application of inorganic fertilizers and organic manure. The maximum uptake of P (13.0 kg ha^{-1}) was recorded with 75% NPK + 10t FYM ha^{-1}. The solubilization action of organic acids produced during decomposition of FYM might have increased the release of P which had finally led to increased P uptake by onion. Singh *et al.* (2019) also recorded higher P uptake due to combined application of fertilizers and FYM. Phosphorous uptake by onion also improved with 75% NPK + 40 kg S ha^{-1} mainly due to increased availability of P in soil (Singh *et al.*2020). Potassium uptake by onion bulb was found significantly higher in all the treatments over control (Table 3).

Table 3 Effect of various treatments on uptake of nutrients in onion bulbs (mean of 2 years)

Treatment	Nitrogen (kg ha^{-1})	Phosphorous (kg ha^{-1})	Potassium (kg ha^{-1})	Sulphur (kg ha^{-1})	Zinc (g ha^{-1})
Control	23.5	6.0	20.0	7.0	134.0
50% RDF	31.0	6.9	25.7	8.1	150.5
50% RDD + 10 t FYM ha^{-1}	38.1	8.2	31.0	10.0	181.6
50% RDF + 40 kg S ha^{-1}	35.5	7.0	29.0	10.1	149.5
75% RDF	39.0	8.8	30.0	9.8	185.0
75% RDD + 10 t FYM ha^{-1}	46.6	9.5	34.7	10.8	210.0
75% RDF + 40 kg S ha^{-1}	43.0	8.7	32.8	11.2	161.5
100%RDF	46.1	9.0	34.2	10.0	227.5
SEm$\pm$	1.40	0.73	1.20	0.45	8.5
CD (P=0.05)	2.94	1.53	2.50	0.94	17.6

The magnitude of increase in K uptake due to 100% NPK over control was 71 per cent. Potassium uptake by onion bulbs also improved significantly over control with 75% NPK + 40 kg S ha^{-1} indicating beneficial effects of NPK and S on availability of K in soil (Singh *et al.*2016). Conjoint use of NPK fertilizers and FYM also improved the utilization of K by onion bulbs. The increased K uptake by onion may be attributed to the release of K from K bearing minerals by complexing agents and organic acids produced during decomposition of FYM. Similar results were reported by (Uikey *et al.* 2015). Sulphur uptake by onion bulbs was noted minimum in control. A significant increase in S uptake was noted with NPK levels. Application of 75% NPK + 40 kg S ha^{-1} resulted in significant increase in S uptake by onion bulbs over control and NPK levels alone (Singh *et al.* 2016). Conjoint use of NPK fertilizers and 10t FYM ha^{-1} also proved significantly superior over control in respect of S uptake by onion. This might be owing to increased supply of nutrients to crop. Similar findings were also reported by Verma *et al.* (2014). The lowest value of Zn uptake by onion bulbs was obtained in control while the highest value was found with 75% NPK + 10 t FYM ha^{-1} treatment. The uptake of Zn was also improved with the application of NPK fertilizers. The increase in Zn uptake by onion bulb with integrated application of nutrients may be due to release of zinc, chelating of zinc with organic molecules produced during decomposition of FYM.

It may be concluded from the present study that application of 75% NPK + 10t FYM ha^{-1} produced the higher yield of onion bulb, but also improved the soil fertility as compared to NPK fertilizers alone. The quality and uptake of nutrients by onion bulbs also improved with conjoint use of NPK fertilizers and FYM.

REFERENCES

Gomez, K.A. and Gomez,A.A.(1984) Statistical procedures for Agricultural Research. John Wiley and Sons, New York, USA.

Jackson, M.L. (1973) Soil Chemical Analysis Prentice Hall of India Private Limited, New Delhi.

Laxminarayan, K., Susan Johr, K., Ravindran, C.S. and Naskar, S.K.(2011) Effect of lime, inorganic and organic sources on soil fertility, yield, quality and nutrient uptake of sweet potato in Alfisols. *Communications in Soil Source and Plant Analysis* **42**: 515-2525.

Sharma, A., Asati, K. P. , Yaday, S. S. AND Namdeo, K.N. (2021) Impact of organic and inorganic fertilizers on growth, yield and economics of garlic (*Allium sativum* L.). *Annals of Plant and Soil Research* **23**(4): 477-480

Singh, H., Singh, V. and Singh, J.P. (2019) Effect of organic and inorganic nutrient sources on productivity profitability and soil fertility in onion (Allium cepa) under Entisoil. *Indian Journal of Agricultural Sciences* **89** (5): 851-855.

Singh, S., Verma, D., Singh,H., Singh, N. and Singh,V.(2015) Integrated nutrient management for higher yield, quqlity and profitability of onion(Allium cepa).*Indian Journal of Agricultural Sciences* **85** (4): 214-218.

Singh, U.N., Pandey, M. and Singh, O.P. (2020) Soil sulphur status and response of onion (Allium cepa) to sources levels of sulphur. *Annals of Plant and Soil Research* **22** (2): 115-118.

Singh,D.P., Seema, Ali, J., Singh, S.P.and Singh, V.(2016) Effect of sulphur on yield, uptake of nutrients and economics of garlic (*Allium sativum*) onion (*Allium cepa*) and potato (*solanum tuberosum*) in alluvial soil. *Indian Journal of Agricultural Sciences* **86** (5): 661- 665.

Uikey,D., Chittora, A., Birla, D. and Tambi, K. (2015) Effeect of potassium and sulphur on growth yield and quality of onion. *Annals of Plant and Soil Research* **17** (4): 356-361.

Verma, D., Singh, H., Singh, N. and Sharma,Y.K. (2014) Effect of inorganic fertilizers and FYM on onion productivity and soil fertility. *Annals of Plant and Soil Research* **16** (2): 117- 120.

Verma,D. and Singh, H.(2012) Response of varying levels of potassium and sulphur on yield and uptake of nutrients by onion. *Annals of Plant and Soil Research* **14**: 142-146.