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Effect of NPK Fertilizers, Farmyard Manure (FYM) and Bio-fertilizers on Quality Parameters of Onion (*Allium cepa L.*) Grown in Jaipur, Rajasthan

Ajad Kumar [a*], Hoshiyar Singh [b] and Anil Kumar [c]

[a] Department of Horticulture, Vivekanand Global University, Jaipur, Rajasthan-303905, India.
[b] Department of Plant Breeding and Genetics, Vivekanand Global University, Jaipur, Rajasthan-303905, India.
[c] Department of Plant Pathology, B. R. College of Agriculture, Sahwa, Churu, Rajasthan-331302, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The current experiment was conducted in loamy sand soils of the Horticulture farm, Vivekanand Global University Jaipur, during Rabi season of 2020-21 and 2021-22. The experiment comprised of 32 treatment combinations replicated three times, was laid out in split-plot design (SPD) with four fertility levels of NPK (0, 50, 75 and 100% of recommended dose of NPK) and two levels of FYM (without FYM and with FYM @ 25 t ha-1 were added in main plots. Four bio-fertilizer levels (No inculcation N2 fixer Azotobacter, PSB inculcation and N2 fixer Azotobacter + PSB inoculation) were

**Corresponding author: E-mail: ajadsaharan@mail.com;*

added in sub plots. The results of the study have clearly shown that application of chemical fertilizer up to 100% RDF increased all the quality attributes (pungency, chlorophyll content and TSS), NPK and S content and uptake and availability of N, P and K in soil after harvest the crop. With application of FYM @ 25 t ha-1 significantly improved all quality attributes (Allyl propyl disulphide, chlorophyll and TSS), N, P, K and S content and uptake and availability of N, P and S in soil after harvest the crops. Use of biofertilizers (N2 fixers and PSB) alone or in combination increased all the quality attributes (Allyl propyl disulphide, chlorophyll and TSS content), NPK and S content and uptake and availability of N, P and K in soil after harvest the crop.

Keywords: FYM; bio-fertilizer; allyl propyl disulphide; chlorophyll and TSS content; NPK fertilizer; harvesting; onion.

1. INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important commercial vegetable crops belongs to family Alliaceae cultivated extensively in India and it is native of the Central Asia and Mediterranean region [1]. Onion is considered to be the second most important vegetable crop grown in the world after tomato [2]. Onion is liked for its flavor and pungency in onion is due to presence of a volatile oil 'allyl propyl disulphide'- organic compound rich in Sulphur [3]. The beneficial compound called 'quercetin' present in onion is a powerful antioxidant [4]. India is second largest producer of onion after china in the world, cultivating onion over an area of 1173.4 thousand hectare with total production of 203.3 lakh tonnes [5].

In Rajasthan, onion occupies an area 64.76 thousand ha with the production 996.73 thousand ton and productivity 15.39 MT/ha [6]. In Rajasthan, major onion producing districts are Jodhpur, Sikar, Nagaur, Alwar, Jaipur etc. It is a unique vegetable that is used throughout the year in the from the salador condiment or for cooking with other vegetables. Onion is also used in preparing souyps, sauces, curries, pickles and for flavouring or seasoning food [7].

Further, knowing the deleterious effect of using only chemical fertilizers on soil health, use of chemical fertilizers supplemented with organic waste and biofertilizers will be environmentally benign. Therefore, biofertilizers are widely accepted as low cost supplements to chemical fertilizers with no deleterious effect on either soil health or environment Bhagyaraj and Suvarna [8]. Availability of nitrogen is important for growing plants as it is major indispensable constituent of protein and nucleic acid. The application of nitrogen with different doses increased plant growth and yield of onion [9]. Phosphorus has its beneficial effect on early root development, plant growth, yield and quality. Potassium plays an important role in crop productivity [10]. Keeping in view the significance of above aspects, the main objectives of study is to work out the possibility of reducing the use of chemical fertilizers by application of organic manures and bio- fertilizers.

FYM is the commonly used organic manure but its supply is limited. It contains low and widely varying nutrient concentration. Combined use of FYM and inorganic fertilizers is of special significance under intensive cropping system as these are complementary and supplementary to each other in sustaining crop yields and soil productivity [11]. Biofertilizers are the inoculation of microorganism, which are capable of mobilizing nutrient element from unavailable to available form through biological processes [12]. These are biologically active strains or products containing active form of microorganisms. These may be helpful for increasing the crop production by way of enhancing the soil fertility. Use of biofertilizers not only supplement the nutrient but also improve the efficiency of applied nutrients [13]. Studies have also shown that integrated use of chemical fertilizers, organic residues such as FYM, compost etc. and biofertilizers resulted in reduced losses of nutrients and environmental pollution [14]. Balanced fertilization has to be made for different crops based on soil testing for attaining maximum yield and profit. There is meager information on the balanced use of chemical fertilizers with FYM and biofertilizers for onion crop grown in Rajasthan. So in last few years, a greater concern regarding use of biofertilizers and organic sources as an alternative/supplement to chemical fertilization has been derived to reduce the high cost that inorganic fertilizers represent in agricultural production.

Application of fertilizers is imperative to maintain the desired pace of crop production [15]. It needs

to be used with caution by alleviating consequent hazards in soil with the help of supplemental organic manuring. Continuous use of inorganic fertilizers has depleted soil organic matter, resulting into inherent loss of native soil N, available P, available K and ultimately lowered the productions [16]. The repeated and excessive application of chemical fertilizers is harmful to the plants. Microflora of the soil, which is extremely essential for maintaining biological health, texture and structure of soil, also gets affected [17]. The alternative nutrient sources e.g., organic fertilizers have been applied to reduce the load of chemical fertilizers. In recent years, organic manures and biofertilizers used as an important component of nutrient supply system and to improve crop yield Shah et al. [18].

2. MATERIALS AND METHODS

2.1 Experimental Area

The present experiment was conducted at Horticulture farm, Vivekanand Global University, Jaipur, during *Rabi* season of 2020-21 and 2021-22 was laid out in split-plot design (SPD) in both the years with 32 treatment combinations replicated thrice. Jobner in situated at 26.5^0 North latitude, 75.20^0 East longitude and an altitude of 427 meters above mean sea level, in Jaipur district of Rajasthan. This region falls under Agro-climatic zone IIIA (Semi- Arid Eastern Plain) of the state. The climate of Jobner is typically semi-arid characterized by extremes of temperature in both summer and winter with low rainfall and moderate relative humidity. Maximum temperature in summers is as high as 45^0C and minimum temperature in winters fall around 0^0C. To find out the effect of conjoint use of NPK through chemical fertilizers with FYM and bio-fertilizers quality parameters of onion. The soil of experimental field was loamy sand in texture, slightly alkaline in reaction, poor in organic carbon with low available nitrogen, phosphorus and sulphur and medium in potassium status.

2.2 Treatments Used

The treatments comprised of Chemical fertilizers, FYM and biofertilizers with ten treatments *Viz.,* F_0- Control, F_1-50% of recommended dose of NPK, F_2-75% of recommended dose of NPK, F_3-100% of recommended dose of NPK, M_0-Without FYM, M_1- With FYM @ 25 t ha^{-1}, B_0- No inoculation, B_1- N_2 fixer *Azotobacter,* B_2- PSB inoculation and B_3- N_2 Fixer *Azotobacter* + PSB inoculation, respectively.

The treatments of chemical fertilizers, FYM, and bio-fertilizers were applied as per treatment in respective plot. The spacing 15 cm row to row and 10 cm plant to plant was maintained. The seedlings were transplanted in cool evening according to the layout plan. A light irrigation was applied just after the transplanting and subsequent irrigation was given at an interval of 10-12 days depending upon the soil condition. Harvesting of onion was done on last week of May, 2020 and 2021.

2.3 Statistical Analysis

The data recorded during the course of investigation was subjected to statistical analysis by analysis of variance (ANOVA) using SPSS statistical software version 22. Treatment means were separated using Fisher's Least Significant Difference (LSD) test at 5% probability level.

3. RESULTS AND DISCUSSION

3.1 Quality Attributes

Data pertaining to pungency for both study years and their pooled mean presented in Table 1 that different level of fertility significantly influenced the pungency in bulb. Progressive increase in level of fertility from control to 100% RDF brought about significant improvement in pungency in onion bulb over preceding levels. Application of 100% RDF attained the maximum mean pungency (6.34 mg/100 g) among all the treatment and it registered 16.13, 8.94 and 3.85 per cent increase in pungency over control, 50 and 75% RDF, respectively. Data given in same table also indicating that application of FYM @ 25 t ha^{-1} significantly increased the pungency in onion bulb to the extent of 5.58 per cent over no FYM application in pooled analysis. It is also evident from the data (Table 1) that use of biofertilizers *viz*., *Azotobacter* and PSB or in combination significantly increased the pungency. Use of *Azotobacter* and PSB increased the pungency to the tune of 4.40 and 3.61 per cent over no inoculation, respectively. Combined application of *Azotobacter* and PSB represented the maximum increase of 8.97 per cent over control.

Table 1. Effect of NPK, FYM and bio-fertilizers on Pungency (Allyl Propyl Disulphide mg/100 g) of Onion (*Allium cepa* L.)

Treatment	Pungency (Allyl Propyl Disulphide mg/100 g)		
	2021-22	2022-23	Pooled mean
Fertilizers			
F_0 = Control	5.50	5.41	5.46
F_1 = 50 % RDF	5.86	5.77	5.82
F_2 = 75 % RDF	6.15	6.05	6.10
F_3 = 100 % RDF	6.38	6.29	6.34
SEm+	0.12	0.09	0.07
CD (p=0.05)	0.35	0.28	0.22
FYM			
M_0 = Control	5.82	5.69	5.76
M_1 = 25 t ha^{-1}	6.12	6.07	6.10
SEm+	0.08	0.07	0.05
CD (p=0.05)	0.24	0.20	0.15
Biofertilizers			
B_0 = Control	5.73	5.64	5.69
B_1 = *Azotobacter*	5.98	5.89	5.94
B_2 = PSB	5.92	5.86	5.89
B_3 = *Azotobacter* + PSB	6.26	6.13	6.20
SEm+	0.10	0.09	0.07
CD (p=0.05)	0.29	0.26	0.19

It is evident from Table 2 that different levels of fertility significantly affected chlorophyll content of leaves during both the years and in pooled analysis. The mean maximum chlorophyll content (0.967 mg/g fresh weight of leaves) was observed with 100 % RDF followed by 75 % RDF (0.965 mg/g fresh weight of leaves) but these were at par with each other. Minimum chlorophyll content was recorded in control (0.942 mg/g fresh weight of leaves), which was 2.65, 1.15 and 0.26 per cent less as compared to 50, 75 and 100 % RDF, respectively in pooled analysis. Application of FYM also had significant effect on chlorophyll content in both the study years as well as in pooled analysis. Application of FYM @ 25 t ha^{-1} increased the chlorophyll content by 0.78 per cent during individual's years and pooled analysis respectively, over control. Data from Table 2 further showed that use of biofertilizers alone or in combination significantly increased the chlorophyll content of leaves. Use of *Azotobacter* and PSB increased the chlorophyll content with the tune of 1.37 and 1.11 per cent respectively over control. Application of *Azotobacter* and PSB in combination represented the maximum increase of 2.38 per cent over no inoculation in pooled analysis.

Data pertaining to the effect of integrated nutrient management or total soluble solids of bulb are presented in Table 3. Application of different levels of fertility had significant influence on TSS % in both year of experiment as well as in the pooled analysis. The mean maximum TSS (12.88%) was recorded in 100 % RDF treatment as followed by 75% RDF (12.71%). However, it was found at par with each other.

The application of 100% RDF registered an increase of 5.71, 2.96 and 1.34 per cent over control, 50 and 75% RDF, respectively in pooled analysis. TSS % of bulb was also significantly affected by application of FYM @ 25 t ha^{-1} in comparison to control. It registered 4.44 per cent more TSS per cent over no application of FYM. Data from Table 3 further indicate that inoculation of biofertilizers had significant effect on TSS % of bulb in both the years as well as in pooled analysis. The maximum mean of TSS % in bulb (12.89%) was recorded with the combined use of *Azotobacter* and PSB which led to an increase of 6.71, 1.82 and 1.94 per cent over control, *Azotobacter* and PSB, respectively. However, the treatment with *Azotobacter* and PSB were at par with each other in pooled analysis. The similar results have also been reported by Sharma et al. [19], Soni [20], Pandey et al. [21], Vachhani and Patel [22], Sreenivas et al. [23], Sharma et al. [17], Thilakavathy and Ramaswamy [24] that inoculation of biofertilizers had significant effect on TSS % of bulb of onion.

Table 2. Effect of NPK, FYM and bio-fertilizers on chlorophyll content (mg/g fresh weight of leaves) of Onion (*Allium cepa* L.)

Treatment	Chlorophyll content (mg/g fresh weight of leaves)		
	2021-22	2022-23	Pooled mean
Fertilizers			
F_0 = Control	0.945	0.939	0.942
F_1 = 50 % RDF	0.958	0.954	0.956
F_2 = 75 % RDF	0.967	0.962	0.965
F_3 = 100 % RDF	0.970	0.964	0.967
SEm±	0.001	0.001	0.001
CD (p=0.05)	0.004	0.004	0.003
FYM			
M_0 = Control	0.957	0.950	0.954
M_1 = 25 t ha^{-1}	0.963	0.959	0.961
SEm±	0.001	0.001	0.001
CD (p=0.05)	0.003	0.003	0.002
Biofertilizers			
B_0 = Control	0.949	0.943	0.946
B_1 = *Azotobacter*	0.962	0.956	0.959
B_2 = PSB	0.959	0.954	0.957
B_3 = *Azotobacter* + PSB	0.971	0.966	0.969
SEm+	0.001	0.001	0.001
CD (p=0.05)	0.004	0.004	0.002

Table 3. Effect of NPK, FYM and bio-fertilizers on total soluble solids of bulb

Treatment	Total soluble solids (%)		
	2021-22	2022-23	Pooled mean
Fertilizers			
F_0 = Control	12.22	12.15	12.18
F_1 = 50 % RDF	12.55	12.47	12.51
F_2 = 75 % RDF	12.74	12.68	12.71
F_3 = 100 % RDF	12.90	12.86	12.88
SEm±	0.15	0.16	0.11
CD (p=0.05)	0.43	0.47	0.31
FYM			
M_0 = Control	12.31	12.25	12.28
M_1 = 25 t ha^{-1}	12.89	12.82	12.85
SEm±	0.10	0.11	0.08
CD (p=0.05)	0.31	0.33	0.22
Biofertilizers			
B_0 = Control	12.10	12.06	12.08
B_1 = *Azotobacter*	12.68	12.64	12.66
B_2 = PSB	12.66	12.63	12.65
B_3 = *Azotobacter* + PSB	12.96	12.82	12.89
SEm+	0.13	0.13	0.09
CD (p=0.05)	0.35	0.36	0.25

4. CONCLUSION

Maximum TSS in bulb, allyl propyl disulphide content in bulb chlorophyll content in leaves, n content and uptake, P content and uptake, K content and uptake, S content and uptake in onion were recorded with 100% RDF levels of fertility. The maximum available N, P and K in soil after harvest were also recorded in same level of fertility. with the application of FYM @ 25 t ha-1 has exhibited maximum TSS, chlorophyll content, pungency content, n content and

uptake, p content and uptake, k content and uptake by onion crop. Available NPK content in soil after harvest was maximum in m1 (FYM @ 25 t ha^{-1}) treatment. Maximum TSS in bulb, allyl propyl disulphide content in bulb chlorophyll content in leaves, NPK and s content in onion bulb as well as in leaves, NPK and s uptake by onion crop was recorded under f3-combined application of *Azotobacter* and PSB.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Etana MB, Aga MC, Fufa BO. Major onion (*Allium cepa* L.) production challenges in Ethiopia: A review. Journal of Biology, Agriculture and Healthcare. 2019;9(7):42-7.
2. Gulati A, Wardhan H, Sharma P. Tomato, Onion and Potato (TOP) value chains. Agricultural value chains in India. 2022:33.
3. Sharma K, Almulla S, Mahato N, Pradhan S, Mateen S, Pashikanti S. 16 Metabolomics of Allium. Edible Alliums: Botany, Production and Uses. 2022:270.
4. Črnivec IG, Skrt M, Šeremet D, Sterniša M, Farčnik D, Štrumbelj E, Poljanšek A, Cebin N, Pogačnik L, Možina SS, Humar M. Waste streams in onion production: Bioactive compounds, quercetin and use of antimicrobial and antioxidative properties. Waste management. 2021;126:476-86.
5. Anonymous; 2016.
   Available: www.indiastat.com.
   Accessed on: 22 March, 2024.
6. Anonymous. Indian Horticulture database, Ministry of Agriculture, Government of India; 2018.
7. Ramkumar TR, Karuppusamy S. Plant diversity and ethnobotanical knowledge of spices and condiments. Bioprospecting of Plant Biodiversity for Industrial Molecules. 2021;19:231-60.
8. Bhagyaraj DJ, Suvarna CV. Biofertilizers and their application. Agrieast. 1999;1:16-21.
9. Patel KP, Patel JC, Patel BS, Sadaria SG. Yield and nutrient uptake by onion (*Allium cepa*) as influenced by irrigation, Nitrogen and phosphorus, Indian Journal of Agronomy. 1992;37:395-396.
10. Ali MM, Petropoulos SA, Selim DA, Elbagory M, Othman MM, Omara AE, Mohamed MH. Plant growth, yield and quality of potato crop in relation to potassium fertilization. Agronomy. 2021;11 (4):675.
11. Abid M, Batool T, Siddique G, Ali S, Binyamin R, Shahid MJ, Rizwan M, Alsahli AA, Alyemeni MN. Integrated nutrient management enhances soil quality and crop productivity in maize-based cropping system. Sustainability. 2020;12 (23):10214.
12. Singh D, Thapa S, Geat N, Mehriya ML, Rajawat MV. Biofertilizers: Mechanisms and application. In Biofertilizers Woodhead Publishing. 2021;151-166.
13. Bayu T. Review on contribution of integrated soil fertility management for climate change mitigation and agricultural sustainability. Cogent Environmental Science. 2020;6(1):1823631.
14. Sharma T, Arya VM, Sharma V, Sharma J, Gulshan T, Bera A, Laskar YA. Integrated nutrient management: A long-term approach towards sustainability. International Journal of Plant & Soil Science. 2022;34(20):433-46.
15. Kumar A, Singh H & Kumar A. Effect of NPK through Chemical Fertilizers Combination with Farm Yard Manure (FYM) and Bio-fertilizers on Yield Attributes of Onion (*Allium cepa* L.) in Jaipur Region of Rajasthan, India. Journal of Experimental Agriculture International. 2024;46(5):387–398.
    Available:https://doi.org/10.9734/jeai/2024/v46i52389
16. Das D, Sahoo J, Raza MB, Barman M, Das R. Ongoing soil potassium depletion under intensive cropping in India and probable mitigation strategies. A review. Agronomy for Sustainable Development. 2022;42(1):4.
17. Sharma OL, Katole NS and Gautam KM. Effect of irrigation schedules and nitrogen levels on bulbs yield and water use by onion. Agric. Sci. Digest-Karnal. 1994;14: 15-8.

18. Shah KN, Chaudhary IJ, Rana DK, Singh V. Research Article Impact Assessment of Different Organic Manures on Growth, Morphology and Yield of Onion (*Allium cepa* L.) Cultivar. Asian Journal of Agricultural Research. 2019;13(1):20-27. Available:https://doi.org/10.3923/ajar.2019.20.27
19. Sharma RP, Datt N and Sharma P. Combined application of nitrogen, phosphorus, potassium and farm yard manure in onion under high hill, dry temperature conditions of North Western Himalayan. Indian J. Agril. Sci. 2003;73(4) :225-227.
20. Soni AK. Effect of crop geometry and fertility levels on growth, yield and quality of *kharif* onion (*Allium cepa* L.) cv. N- 53 in semiarid conditions. Ph. D. Thesis, RAU, Bikaner;2005.
21. Pandey UB, Singh L, Singh RK, Singh L, Kumar R and Chaudhary SP. Response of different levels of N, P and K on the yield and quality of *kharif* onion. Recent advances in medicinal aromatic and spice crops. Vol. 1 International conference held 1989 at New Delhi. 1989;231-234.
22. Vachhani MU and Patel ZG. Effect of nitrogen, phosphorus and potash on bulb yield and quality of onion (*Allium cepa*). Indian J. Agronomy. 1993;38(2): 333-334.
23. Sreenivas CH, Muralidhar S and Singh, M. Yield and quality of ridge gourd fruits as influenced by different levels of inorganic fertilizers and vermicompost. Ann. Agric Res. 2000;2(1):262-266.
24. Thilakavathy S and Ramaswamy N. Effect of inorganic and bio fertilizers treatments on yield and quality parameters of multiplier onion (*Allium cepa* L. *var aggregatum*). News Letter. Nat. Hort. Res. Devt. Foundation. 1998;18(2):18-20.

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