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ASSESSMENT OF CLIMATE-RESILIENT ONION (*Allium cepa* L.) CV. NASIK RED (N-53) PRODUCTION THROUGH NATURAL FARMING PRACTICES IN BASTAR PLATEAU.

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ABSTRACT

A field experiment entitled “Assessment of Climate-Resilient Onion (*Allium cepa* L.) cv. Nasik Red (N-53) Production through Natural Farming Practices in Bastar Plateau” was conducted during the *Rabi* season of 2025–26 at the Research cum Instructional Farm of Krantikari Debridhur College of Horticulture and Research Station, Jagdalpur, Chhattisgarh. The experiment comprised ten natural farming treatments involving FYM, neem cake, Jeevamrut, Panchgavya, Vermiwash, Azotobacter, PSB and mulching, laid out in a Randomized Block Design (RBD) with three replications to evaluate their effect on onion growth, yield, quality, climate resilience and economics.

Among the treatments, T₉ (50% FYM + 50% Neem Cake + Jeevamrut + Panchgavya + Vermiwash) recorded the best performance, producing the highest plant height (62.05 cm), leaf length (58.07 cm), leaves per plant (11.80), fresh plant weight (248.23 g), bulb diameter (6.07 and 5.91 cm), fresh bulb weight (112.75 g), bulb yield (18.57 kg plot⁻¹; 330.44 q ha⁻¹), TSS (14.90 °Brix) and ascorbic acid (13.53 mg 100 g⁻¹). It also showed superior climate resilience with the highest relative water content (86.53%) and the lowest leaf wilting (1.40) and leaf scorching (4.77). Economic analysis revealed the highest gross income (Rs 594,804.6 ha⁻¹), net income (Rs 404,854 ha⁻¹) and benefit:cost ratio (3.13). The study demonstrated that the integrated application of FYM, neem cake, Jeevamrut, Panchgavya and Vermiwash is an effective natural farming strategy for improving onion productivity, quality, climate resilience and profitability under Bastar Plateau conditions.

Key words: Onion, Natural farming, Climate resilience, Jeevamrut, Panchgavya, Vermiwash, Neem cake, Yield, Quality, Economics.

Introduction

Onion (*Allium cepa* L.) is one of the most important commercial vegetable crops belonging to the family Alliaceae and is widely cultivated throughout the world. It is popularly known as the “Queen of the Kitchen” due to its indispensable role in culinary preparations. In addition to its culinary importance, onion is a rich source of carbohydrates, vitamins, minerals and bioactive compounds such as quercetin, which possess antioxidant and medicinal properties. Owing to its high domestic consumption, export potential and economic value, onion

occupies a prominent place among vegetable crops in India (Mahajan *et al.*, 2018).

Despite its importance, onion productivity is often limited by declining soil fertility, imbalanced nutrient management and increasing climatic variability. Continuous dependence on chemical fertilizers has resulted in deterioration of soil health, reduced nutrient-use efficiency and environmental concerns. Therefore, sustainable nutrient management practices are essential to maintain soil productivity and ensure stable crop yields.

Natural farming has emerged as an eco-friendly and

climate-resilient production system that completely avoids synthetic agrochemicals and utilizes locally available organic inputs such as Farmyard Manure (FYM), neem cake, Jeevamrut, Panchgavya, Vermiwash and beneficial microorganisms. These inputs improve soil organic matter, stimulate beneficial microbial activity, enhance nutrient availability and increase crop tolerance to abiotic stresses, thereby improving growth, yield and quality.

The Bastar Plateau of Chhattisgarh is characterized by lateritic soils, low soil fertility and erratic rainfall, making onion cultivation highly vulnerable to moisture stress and temperature fluctuations. Since onion is a shallow-rooted crop, its productivity is greatly influenced by soil moisture availability and nutrient management. However, scientific information on the effectiveness of natural farming practices for onion under Bastar Plateau conditions is limited. Therefore, the present investigation was undertaken to evaluate the effect of different natural farming practices on the growth, yield, quality, climate resilience and economics of onion (*Allium cepa* L.) cv. Nasik Red (N-53) under the agro-climatic conditions of the Bastar Plateau, Chhattisgarh.

Materials and Methods

The field experiment was conducted during the *Rabi* season of 2025–26 at the Horticultural Research Farm, Krantikari Debridgur College of Horticulture and Research Station, Jagdalpur, Chhattisgarh, India. The experimental site is situated in the Bastar Plateau.

The experiment comprised ten treatments of different natural farming practices involving Farmyard Manure (FYM), neem cake, Jeevamrut, Panchgavya, Vermiwash, Azotobacter, PSB and mulching. The treatments were

evaluated in a Randomized Block Design (RBD) with three replications. The onion cultivar Nasik Red (N-53) was used as the experimental material.

Healthy seedlings were raised in a nursery and transplanted 45 days after sowing into a well-prepared field. Transplanting was carried out at a spacing of 15 cm × 10 cm. Each experimental plot measured 3.0 m × 2.0 m (6 m²). All recommended agronomic practices were followed uniformly in all the treatments except for the nutrient management practices as per the treatment schedule. Jeevamrut, Panchgavya and Vermiwash were applied according to the treatment combinations, while Azotobacter and PSB were used as seedling root treatments before transplanting.

Observations on growth parameters (plant height, leaf length and number of leaves), yield attributes (bulb diameter, fresh and dry bulb weight, plant weight and bulb yield), quality parameters (total soluble solids and ascorbic acid), climate resilience traits (relative water content, leaf wilting and leaf scorching), soil properties and economics were recorded using standard procedures. The experimental data were statistically analyzed following the analysis of variance (ANOVA) for Randomized Block Design, and treatment means were compared at the 5% level of significance.

Results and Discussion

Growth Parameters

Plant Height (cm):

The data pertaining to plant height at 30, 60 and 90 DAT are presented in Table 1. The analysis of variance revealed significant differences among the treatments at all growth stages.

Table 1: Plant height, Leaf length, Number of leaves in different treatments.

	Plant height			Leaf length			Number of leaves		
	30 days	60 days	90 days	30 days	60 days	90 days	30 days	60 days	90 days
T ₁ -Control	26.857	36.93	43.827	20.9	31.667	36.267	3.333	5.5	7.767
T ₂ -50% FYM + 50% Neem Cake + PSB	36.777	44.53	51.227	25.4	40.733	45.267	3.9	6.233	8.633
T ₃ -50% FYM + 50% Neem Cake + Azotobacter	33.477	42.727	49.927	24.7	37.233	43.6	3.767	6.1	8.333
T ₄ -50% FYM + 50% Neem Cake + Jeevamrut	45.895	52.52	59.877	30.1	49.267	55.633	4.733	6.933	10.8
T ₅ -50% FYM + 50% Neem Cake + Panchgavya	44.4	51.747	57.12	29.167	47	53.1	4.633	6.867	10.533
T ₆ -100 % FYM + Jeevamrut + PSB	40.67	48.923	54.167	26.8	42.4	48.3	4.233	6.5	9.733
T ₇ -50% FYM + 50% Neem Cake + Vermiwash	43.397	50.817	55.633	27.067	46.367	52.867	4.4	6.767	10.233
T ₈ -50% FYM + Vermiwash + Azotobacter	30.677	40.163	47.65	23.1	35.5333	41.1	3.667	5.9	8.033
T ₉ -50% FYM + 50% Neem Cake + Jeevamrut + Panchgavya + Vermiwash	47.5	55.94	62.05	34.1	50.6	58.067	5.033	7.233	11.8
T ₁₀ -Mulching + FYM	38.727	47.67	52.87	26.033	42.062	48.1	4.133	6.4	9.367
CD	4.745	8.118	9.215	4.995	6.578	7.942	0.532	0.946	1.432
SE(m)±	1.585	2.711	3.078	1.668	2.197	2.652	0.178	0.316	0.478
C.V.	7.067	9.95	9.976	10.807	9.003	9.524	7.352	8.496	8.716

Table 2: Equatorial and Polar diameter in different treatments.

	Equatorial	Polar
T ₁ -Control	4.017	2.597
T ₂ -50% FYM + 50% Neem Cake + PSB	5.297	3.723
T ₃ -50% FYM + 50% Neem Cake + <i>Azotobacter</i>	5.267	3.7
T ₄ -50% FYM + 50% Neem Cake + Jeevamrut	5.76	4.71
T ₅ -50% FYM + 50% Neem Cake + Panchgavya	5.643	4.547
T ₆ -100 % FYM +Jeevamrut+PSB	5.36	4.267
T ₇ -50% FYM + 50% Neem Cake + Vermiwash	5.383	4.427
T ₈ -50% FYM+Vermiwash + <i>Azotobacter</i>	5.193	3.543
T ₉ -50% FYM + 50% Neem Cake + Jeevamrut +Panchgavya +Vermiwash	6.067	5.91
T ₁₀ -Mulching + FYM	5.353	4.427
C.D.	0.707	0.625
SE(m)±	0.236	0.209
C.V.	7.662	8.748

At 30 DAT, the maximum plant height (47.50 cm) was recorded in T₉ (50% FYM + 50% Neem Cake + Jeevamrut + Panchgavya + Vermiwash), which was statistically at par with T₄ (45.90 cm) and T₅ (44.40 cm). In contrast, the minimum plant height (26.86 cm) was observed in the control (T₁). A similar trend was observed at 60 DAT, where T₉ produced the tallest plants (55.94 cm), followed by T₄ (52.52 cm), while the lowest value was recorded under T₁ (36.93 cm). At harvest (90 DAT), T₉ maintained its superiority by recording the maximum plant height (62.05 cm), followed by T₄ (59.88 cm) and T₅ (57.12 cm), whereas the minimum height (43.83 cm) was observed in the control. These differences were statistically significant. These findings are in close agreement with the reports of Sundhariya *et al.*, (2017) and Rajesh *et al.*, (2025).

Leaf Length (cm):

Leaf length differed significantly among the treatments throughout the crop growth period. At 30 DAT, the maximum leaf length (34.10 cm) was recorded under T₉, followed by T₄ (30.10 cm), whereas the minimum value (20.90 cm) was observed in the control. At 60 DAT, T₉ produced the longest leaves (50.60 cm), closely followed by T₄ (49.27 cm), while T₁ recorded the shortest leaves (31.67 cm). Similar results were obtained at 90 DAT, where T₉ recorded the maximum leaf length (58.07 cm), followed by T₄ (55.63 cm) and T₅ (53.10 cm), whereas the minimum value (36.27 cm) was recorded in the control. Similar results were obtained by Rajesh *et al.*, (2025) and Omprakash *et al.*, (2024).

Table 3: Fresh weight of bulb, dry weight of bulb in different treatments.

	FWB	DWB
T ₁ -Control	48.503	7.629
T ₂ -50% FYM + 50% Neem Cake + PSB	87.17	11.376
T ₃ -50% FYM + 50% Neem Cake + <i>Azotobacter</i>	85.4	10.921
T ₄ -50% FYM + 50% Neem Cake + Jeevamrut	104.057	12.709
T ₅ -50% FYM + 50% Neem Cake + Panchgavya	96.853	12.015
T ₆ -100 % FYM +Jeevamrut+PSB	90.763	11.628
T ₇ -50% FYM + 50% Neem Cake + Vermiwash	92.807	11.809
T ₈ -50% FYM+Vermiwash + <i>Azotobacter</i>	80.713	9.64
T ₉ -50% FYM + 50% Neem Cake + Jeevamrut +Panchgavya +Vermiwash	112.75	13.046
T ₁₀ -Mulching + FYM	78.883	10.31
C.D.	12.742	1.868
SE(m)±	4.255	0.624
C.V.	8.396	9.726

FWB: Fresh weight of bulb; DWB: Dry weight of bulb

Number of Leaves per Plant:

The number of leaves per plant increased progressively with crop growth and was significantly influenced by different treatments. At 30 DAT, T₉ recorded the highest number of leaves (5.03), followed by T₄ (4.73), whereas the control produced the lowest number of leaves (3.33). At 60 DAT, T₉ again recorded the maximum number of leaves (7.23), while the control recorded only 5.50 leaves per plant. At 90 DAT, the highest number of leaves (11.80) was observed under T₉, followed by T₄ (10.80) and T₅ (10.53), whereas the minimum value (7.77) was recorded in the control.

The increased number of leaves under T₉ could be attributed to continuous nutrient availability, enhanced microbial activity and improved physiological processes associated with natural farming inputs. Jeevamrut and Panchgavya stimulate beneficial microbial populations and plant metabolic activity, while Vermiwash provides readily available nutrients and naturally occurring plant growth regulators. Together with FYM and neem cake, these inputs created favourable soil conditions that promoted vigorous vegetative growth and continuous leaf initiation. The present findings agree with the reports of Anand *et al.*, (2025) and Nancy *et al.*, (2021).

Yield Attributes and Yield

Bulb Diameter:

These inputs enhanced root growth, nutrient uptake

Table 4: Yield in different treatments.

	Yield/ plot	Yield q/ha
T ₁ -Control	6.577	109.61
T ₂ -50% FYM + 50% Neem Cake + PSB	15.14	252.347
T ₃ -50% FYM + 50% Neem Cake + <i>Azotobacter</i>	14.54	242.333
T ₄ -50% FYM + 50% Neem Cake + Jeevamrut	16.57	276.17
T ₅ -50% FYM + 50% Neem Cake + Panchgavya	16.01	266.83
T ₆ -100 % FYM +Jeevamrut+PSB	15.503	258.387
T ₇ -50% FYM + 50% Neem Cake + Vermiwash	15.737	262.257
T ₈ -50% FYM+Vermiwash + <i>Azotobacter</i>	10.20	170.12
T ₉ -50% FYM + 50% Neem Cake + Jeevamrut +Panchgavya +Vermiwash	19.83	330.44
T ₁₀ -Mulching + FYM	12.837	213.963
C.D.	2.576	43.197
SE(m)±	0.86	14.427
C.V.	10.426	10.489

and photosynthetic efficiency. The data about bulb diameter revealed significant differences among the treatments. The maximum equatorial and polar bulb diameters were recorded under T₉ (50% FYM + 50% Neem Cake + Jeevamrut + Panchgavya + Vermiwash) with 6.07 cm and 5.91 cm, respectively, which were significantly superior to all other treatments. This was followed by T₄ (5.76 and 4.71 cm) and T₅ (5.64 and 4.55 cm), whereas the minimum bulb diameter was observed in the control (T₁) with 4.02 and 2.60 cm, respectively. The increase in bulb diameter under T₉ could be attributed to improved nutrient availability, enhanced microbial activity and better translocation of photosynthates from leaves to developing bulbs due to the combined application of FYM, neem cake, Jeevamrut, Panchgavya and Vermiwash. Similar findings were reported by Anand *et al.*, (2025) and Rajesh (2025) in onion.

Fresh and Dry Bulb Weight:

Different natural farming treatments significantly influenced fresh and dry bulb weight. The highest fresh bulb weight (112.75 g) and dry bulb weight (13.05 g) were recorded under T₉, followed by T₄ (104.06 g and 12.71 g) and T₅ (96.85 g and 12.02 g). The lowest fresh and dry bulb weights were observed in the control (48.50 g and 7.63 g, respectively). The higher bulb weight obtained under T₉ may be attributed to balanced nutrient supply, improved soil physical conditions, increased microbial activity and continuous availability of essential nutrients throughout the crop growth period. Similar

Table 5: TSS and Ascorbic acid in different treatments.

	TSS	Ascorbic Acid
T ₁ -Control	11.033	10.2
T ₂ -50% FYM + 50% Neem Cake + PSB	12.5	11.567
T ₃ -50% FYM + 50% Neem Cake + <i>Azotobacter</i>	12.367	11.167
T ₄ -50% FYM + 50% Neem Cake + Jeevamrut	13.4	12.133
T ₅ -50% FYM + 50% Neem Cake + Panchgavya	13.167	12.033
T ₆ -100 % FYM +Jeevamrut+PSB	13.733	12.7
T ₇ -50% FYM + 50% Neem Cake + Vermiwash	12.6	11.733
T ₈ -50% FYM+Vermiwash + <i>Azotobacter</i>	12.267	10.7
T ₉ -50% FYM + 50% Neem Cake + Jeevamrut +Panchgavya +Vermiwash	14.9	13.533
T ₁₀ -Mulching + FYM	12.967	11.967
C.D.	0.502	0.851
SE(m)±	0.168	0.284
C.V.	2.252	4.179

observations were reported by Sundhariya *et al.*, (2017) and Rajesh *et al.*, (2025) in onion.

Bulb Yield:

Bulb yield varied significantly among the treatments. The highest bulb yield was recorded under T₉, producing 18.57 kg plot⁻¹Rs and 330.44 q ha⁻¹, followed by T₄ (16.57 kg plot⁻¹Rs and 276.17 q ha⁻¹) and T₅ (16.01 kg plot⁻¹Rs and 266.83 q ha⁻¹). The lowest yield was obtained from the control (6.58 kg plot⁻¹Rs and 109.61 q ha⁻¹). The superior yield recorded under T₉ was mainly due to its favourable effect on vegetative growth, bulb diameter and bulb weight, which collectively enhanced marketable yield. The integrated application of FYM, neem cake, Jeevamrut, Panchgavya and Vermiwash improved soil fertility, microbial activity, nutrient-use efficiency and photosynthetic performance, resulting in greater biomass production and efficient partitioning of assimilates towards bulb formation. A similar trend has been reported by Sundhariya *et al.*, (2017), Usha *et al.*, (2022).

Quality Parameters

Total Soluble Solids (TSS):

The data presented in Table 4 indicated that the total soluble solids (TSS) of onion bulbs were significantly influenced by different natural farming treatments. The highest TSS (14.90 °Brix) was recorded under T₉ (50% FYM + 50% Neem Cake + Jeevamrut + Panchgavya + Vermiwash), followed by T₆ (13.73 °Brix), T₄ (13.40 °Brix) and T₅ (13.17 °Brix), whereas the lowest TSS

Table 6: Climate stress (Relative water content).

	RWC (%)	LW	LC
T ₁ -Control	69.20	4.33	18.4
T ₂ -50% FYM + 50% Neem Cake + PSB	73.90	3.6	14.3
T ₃ -50% FYM + 50% Neem Cake + <i>Azotobacter</i>	75.46	3.3	12.76
T ₄ -50% FYM + 50% Neem Cake + Jeevamrut	77.83	3.1	6.7
T ₅ -50% FYM + 50% Neem Cake + Panchgavya	80.40	2.5	8.76
T ₆ -100 % FYM +Jeevamrut+PSB	83.40	2.0	10.2
T ₇ -50% FYM + 50% Neem Cake + Vermiwash	78.83	2.8	10.76
T ₈ -50% FYM+Vermiwash + <i>Azotobacter</i>	81.90	2.2	11.76
T ₉ -50% FYM + 50% Neem Cake + Jeevamrut +Panchgavya +Vermiwash	86.53	1.4	4.76
T ₁₀ -Mulching + FYM	84.80	1.7	8.56
C.D.	3.84	0.333	1.312
SE(m)±	1.28	0.111	0.438
C.V.	2.80	7.142	7.092
LW: Leaf wilting; LC: Leaf scorching			

(11.03 °Brix) was observed in the control (T₁). The increase in TSS under T₉ may be attributed to improved nutrient availability, enhanced photosynthetic efficiency and greater translocation of carbohydrates from leaves to bulbs. The combined application of FYM, neem cake, Jeevamrut, Panchgavya and Vermiwash improved soil biological activity and nutrient-use efficiency, leading to higher accumulation of soluble sugars in onion bulbs. A similar result was obtained by Sruthi *et al.*, (2019), Anand *et al.*, (2025) and Byomakesh *et al.*, (2025) in onion.

Ascorbic Acid:

A significant variation in ascorbic acid content was observed among the treatments. The maximum ascorbic acid content (13.53 mg 100 g⁻¹) was recorded in T₉, followed by T₆ (12.70 mg 100 g⁻¹), T₄ (12.13 mg 100 g⁻¹) and T₅ (12.03 mg 100 g⁻¹), while the minimum value (10.20 mg 100 g⁻¹) was recorded in the control. The higher ascorbic acid content under T₉ may be attributed to balanced nutrient supply, improved microbial activity and enhanced synthesis of vitamin C promoted by natural farming inputs. Organic manures and liquid bioformulations enhance physiological and biochemical activities, resulting in greater accumulation of antioxidants and improved nutritional quality of onion bulbs. Furthermore, improved soil health and sustained nutrient availability under integrated natural farming practices

favour efficient metabolic processes responsible for ascorbic acid synthesis. A similar result was obtained by Sruthi *et al.*, (2019), Anand *et al.*, (2025) and Byomakesh *et al.*, (2025) in onion.

Climate Stress Parameters

Relative Water Content (RWC)

The data presented in Table 5 revealed that different natural farming treatments significantly influenced the relative water content (RWC) of onion leaves. The highest RWC (86.53%) was recorded under T₉ (50% FYM + 50% Neem Cake + Jeevamrut + Panchgavya + Vermiwash), followed by T₁₀ (84.80%), T₆ (83.40%) and T₈ (81.90%), whereas the lowest value (69.20%) was observed in the control (T₁). The higher RWC under T₉ may be attributed to improved soil moisture retention, enhanced root growth and better water uptake resulting from the combined application of FYM, neem cake and liquid organic formulations. Similar observations were reported by Sharad *et al.*, (2015) in onion.

Leaf Wilting:

Leaf wilting differed significantly among the treatments. The minimum leaf wilting score (1.40) was recorded under T₉, followed by T₁₀ (1.70) and T₆ (2.00), whereas the maximum wilting (4.33) was observed in the control. The reduction in leaf wilting under T₉ may be attributed to improved soil moisture conservation, higher relative water content and enhanced physiological efficiency resulting from the integrated application of FYM, neem cake, Jeevamrut, Panchgavya and Vermiwash. These inputs improved root development and water absorption while maintaining cell turgidity under moisture stress conditions. Consequently, plants were able to withstand temporary water deficits more effectively than the untreated control.

Leaf Scorching:

The severity of leaf scorching was significantly affected by the treatments. The lowest leaf scorching score (4.77) was recorded under T₉, followed by T₄ (6.70) and T₁₀ (8.57), whereas the highest scorching (18.40) was observed in the control. The reduced leaf scorching under T₉ could be attributed to better plant water status, improved nutrient availability and enhanced antioxidant activity associated with the application of natural farming inputs. Adequate moisture availability and balanced nutrition help maintain chlorophyll stability and cellular integrity under heat and moisture stress, thereby reducing tissue injury. Furthermore, improved microbial activity and sustained nutrient release under integrated natural farming practices enhance plant resilience against environmental stresses.

Conclusion

The present investigation demonstrated that natural farming practices significantly influenced the growth, yield, quality, climate resilience and economics of onion (*Allium cepa* L.) cv. Nasik Red (N-53) under the agro-climatic conditions of the Bastar Plateau. Among the different treatments, T₉ (50% FYM + 50% Neem Cake + Jeevamrut + Panchgavya + Vermiwash) consistently recorded superior performance with respect to growth attributes, bulb diameter, fresh and dry bulb weight, bulb yield, total soluble solids, ascorbic acid content, relative water content and economic returns. The treatment also reduced moisture stress symptoms, as evidenced by lower leaf wilting and leaf scorching, indicating enhanced climate resilience.

The integrated application of FYM, neem cake and liquid organic formulations improved soil biological activity, nutrient availability and water-use efficiency, which collectively contributed to better crop growth and higher productivity. Furthermore, T₉ recorded the highest gross return, net return and benefit: cost ratio, proving its economic viability for onion cultivation.

Therefore, the integrated use of FYM, neem cake, Jeevamrut, Panchgavya and Vermiwash can be recommended as a sustainable, economically profitable and climate-resilient nutrient management strategy for onion cultivation under the Bastar Plateau region of Chhattisgarh. However, further multi-location and multi-season studies are recommended to validate the consistency of these findings under diverse agro-climatic conditions.

References

- Anonymous (2025). Database. National Horticulture Board, Ministry of Agriculture and Farmers Welfare, Government of India.
- Akter, T. and Rashid M.H.A. (2022). Effects of organic mulches on growth and yield of winter onion (*Allium cepa* L.) cultivars. *Fundamental and Applied Agriculture*, **7(4)**, 298–307.
- David, A.V.A., Arulmoli R. and Parasuraman S. (2016). Overviews of biological importance of quercetin: A bioactive flavonoid. *Pharmacognosy reviews*, **10(20)**, 84–89.
- Dwivedi, S.K., Kumar S., Prakash V., Mondal S. and Mishra J.S. (2015). Influence of rising atmospheric CO₂ concentrations and temperature on morpho-physiological traits and yield of rice genotypes in sub humid climate of eastern India. *American Journal of Plant Sciences*, **6(14)**, 2239–2249.
- Gore, N. and Sreenivasa M.N. (2011). Influence of liquid organic manures on growth, nutrient content and yield of tomato (*Lycopersicon esculentum* Mill.) in the sterilized soil. *Karnataka Journal of Agricultural Sciences*, **24(2)**, 153–157.
- Gebremichael, Y., Woldetsadik K., Chavhan A. and Gedamu F. (2017). Effect of integrated nutrient management on growth and bulb yield of onion (*Allium cepa* L.) under irrigation at Selekleka, Northern Ethiopia. *International Journal of Life Sciences*, **5(2)**, 151–160.
- Gopakkali, P. and Sharanappa (2014). Effect of organic farming practices on growth, yield, quality and economics of onion (*Allium cepa*) in dry zone of Karnataka. *Indian Journal of Agronomy*, **59(2)**, 336–340.
- Gupta, A.J., Sairam V., Kotapati P., Kaldate S. and Mahajan V. (2025). Environmental modulation and genetic variation of quality traits in onion (*Allium cepa* L.): A review. *Indian Journal of Arid Horticulture*, **7(2)**.
- Jadhav, A.B., Patil V.S., Gosavi A.B. and Kamble B.M. (2025). Impact of foliar application of vermiwash on growth, nutrient uptake and yield of onion (*Allium cepa* L.). *Journal of Eco-friendly Agriculture*, **20(2)**.
- Mahajan, V., Gupta A.J., Lawande K.E. and Singh M. (2018). Onion improvement in India. *Journal of Allium Research*, **1**, 07–20.
- Mahajan, V. and Gupta A.J. (2023). Onion: Breeding and Genomics. *Vegetable Science*, **50(Special Issue)**, 244–260.
- Mahala, P., Chaudhary M.R. and Garhwal O.P. (2018). Yield and quality of rabi onion (*Allium cepa* L.) influenced by integrated nutrient management. *International Journal of Current Microbiology and Applied Sciences*, **7(5)**, 3313–3321.
- Magar, D.R., Sharma A. and Chhetri L.B. (2024). Effect of different mulching materials on Onion (*Allium cepa*) production a Lamahi, Dang, Nepal. *International Journal of Horticulture*, **14(4)**, 207–217.
- Mondal, S., Ghosh G.K. and Mandal J. (2020). Effect of graded levels of sulphur as magnesium sulphate on yield and quality of onion (*Allium cepa* L.) in Red and Lateritic Soils of West Bengal, India. *International Journal of Current Microbiology and Applied Sciences*, **9(4)**, 1–9.
- Meena, R., Singh V., Kaushik R.A., Sharma S.K., Jain H.K., Bunker R.N. and Rathore J.P. (2024). Effect of organic nutrient management practices on yield and quality of onion (*Allium cepa* L.). *Ecology, Environment and Conservation*, **30(4)**, 1695–1698.
- Yadav, O., Singh S., Patel V., Singh V. and Mishra S. (2024). Impact of chemical fertilizers, organic manure and bio-inoculants on sustainable production of onion (*Allium cepa* L.). *Biological Forum – An International Journal*, **16(1)**, 31–36.
- Patel, U. (2020). Studies on effect of integrated nutrient management and bio enhancer on productivity of onion (*Allium cepa* L.). *The Pharma Innovation Journal*, **9(6)**, 172–181.
- Prakash, S., Singh B., Kumar M., Kumar A. and Singh S. (2024).

- Effect of I.N.M. and Natural bio-stimulants for improving the growth, yield and bulb quality of Onion (*Allium cepa*). *Plant Archives*, **24**(2).
- Sruthi, B. and Somasundaram E. (2019). Influence of organic manures on yield, quality and economics of aggregatum onion (*Allium cepa* L. var. *aggregatum*). *Journal of Pharmacognosy and Phytochemistry*, **8**(3), 1768–1770.
- Sundharaiya, K., Renganayaki P.R., Sujatha K. and Sathish G. (2017). Effect of organic manures and bio-stimulants on growth and seed yield of multiplier onion (*Allium cepa* var. *aggregatum*) cv. Co (On 5). *Agriculture Update*, **12**(8), 2239-2245.
- Swain, B., Kumar S., Prajapati N.K., Watke A.G. and Mohanty S.P. (2025). Integrated nutrient approaches for maximizing growth, yield and quality in onion (*Allium cepa* L.) cv. Bhima Kiran. *International Journal of Advanced Biochemistry Research*, **9**(12), 965–969.
- Verma, N., Jaiswal R.K., Ali S.A. and Dhakad R.K. (2021). Impact of biofertilizers on growth and yield attributes of onion (*Allium cepa* L.) var. AFLR. *International Journal of Current Microbiology and Applied Sciences*, **10**(2), 931–938.
- Yadav, O., Singh S., Patel V., Singh V. and Mishra S. (2024). Impact of Chemical fertilizers, Organic Manure and Bioinoculants on Sustainable Production of Onion (*Allium cepa* L.), *Biological Forum, International Journal*, **16**(1), 31-36.