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Effect of integrated nutrient management on growth and yield of onion (*Allium cepa* L.)

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Abstract
A field experiment was carried out to study the "Effect of integrated nutrient management on growth and yield of onion (*Allium cepa* L.) under Malwa Plateau of Madhya Pradesh" during Rabi seasons of 2020 and Rabi seasons of 2021 under irrigated conditions at Village–Ratadiya, Block – Ghattiya, Dist. – Ujjain Madhya Pradesh. The experiment consist has 12 treatments with control such as T_1-Control, T_2-100% inorganic RDF (N:P:K:S:Zn 120:60:80:40:05), T_3-Soil Test Based Fertilizer Recommendation (STV), T_4-75% RDF inorganic + 25% N through Vermicompost, T_5-75% RDF inorganic + 25% N through Poultry manure, T_6-75% RDF inorganic + 25% N through Neem cake, T_7-50% RDF inorganic + 50 N through Vermicompost, T_8-50% RDF inorganic + 50% N through Poultry manure, T_9-50% RDF inorganic + 50% N through Neem cake, T_{10}-100% N through vermicompost (VC) (7.0 t/ha), T_{11}-100% N through poultry manure (PM) (5.0 t/ha), T_{12}-100% N through Neem cake (NC) (3 t/ha) with three replications, three replications. The experiments has randomized block design with pooled data analysis. The observation to be recorded for plant growth parameters such as Plant height cm) at 45 DAT and at harvest and Length of leaf 45 DAT. Yield parameters like Length of bulb, Neck thickness and Diameter of bulb and Yield of bulb. The result revealed that the maximum Plant height (49.20 and 55.77 cm) at 45 DAT and at harvest and Length of leaf 45 DAT (49.85 cm). Yield parameters like, Length of bulb (8.53 cm), Neck thickness (2.44 cm) and Diameter of bulb (6.32 cm) and Yield of bulb 382.85q/ha, while the minimum was found under the treatments T_1 Control.

Keywords: onion, growth, bulb, organic and STV

Introduction
One of the most prominent commercial vegetables is the onion (*Allium cepa*). The most extensively grown member of the genus Allium is the onion (*Allium cepa* L., from the *Latin cepa* "onion"). Chinese onions, shallots, garlic, leeks, and scallions are near relatives of it.
Integrated nutrient management (INM) has been presented as a viable technique for tackling such difficulties, given the rising food needs of a growing human population and the need for an ecologically benign plan for sustainable agricultural growth. INM offers a diverse potential for improving plant performance and resource efficiency while also allowing for environmental and resource quality preservation. When compared to traditional approaches, INM boosts crop yields by 8–150 percent, increases water-use efficiency, and increases farmers' economic returns, all while enhancing grain quality and soil health and sustainability. Advanced INM methods significantly minimise reactive nitrogen losses and (Greenhouse Gas) emissions, according to model simulation and fate assessment.
Advanced INM procedures resulted in fewer chemical fertiliser inputs and, as a result, decreased environmental and human costs (such as intensity of land use, N consumption, reactive N losses, and green-house gas emissions) without sacrificing crop yields. INM practice might be an innovative and ecologically beneficial technique for global sustainable agriculture, according to strong and persuasive data (Wei Wu and Baoluo Ma, 2015) [20]. For a healthy yield, onions need a lot of fertiliser and manure. Fertilizer needs, on the other hand, are determined by the soil type and crop type. Continuous use of inorganic fertilisers has a negative impact on soil health, resulting in decreased yields of poor quality. Organic materials are great for cultivation since they nourish the soil and help to maintain a healthy environment. Plants that have good soil have healthy plants. An organic soil filled with microorganisms and fungus gives nutrients to plants slowly, just as it does in nature. By adding organic nutrients to the soil and promoting the development of naturally existing beneficial organisms.

Materials and Methods

A field experiment was carried out to study the "Effect of integrated nutrient management on growth and yield of onion (*Allium cepa* L.) under Malwa Plateau of Madhya Pradesh" during Rabi seasons of 2020 and Rabi seasons of 2021 under irrigated conditions at Village –Ratadiya, Block – Ghattiya, Distt – Ujjain Madhya Pradesh. The experiment consist has 12 treatments with control such as T_1-Control, T_2-100% inorganic RDF (N:P:K:S:Zn 120:60:80:40:05), T_3-Soil Test Based Fertilizer Recommendation (STV), T_4-75% RDF inorganic + 25% N through Vermicompost, T_5-75% RDF inorganic + 25% N through Poultry manure, T_6-75% RDF inorganic + 25% N through Neem cake, T_7-50% RDF inorganic + 50 N through Vermicompost, T_8-50% RDF inorganic + 50% N through Poultry manure, T_9-50% RDF inorganic + 50% N through Neem cake, T_{10}-100% N through vermicompost (VC) (7.0 t/ha), T_{11}-100% N through poultry manure (PM) (5.0 t/ha), T_{12}-100% N through Neem cake (NC) (3 t/ha) with three replications, three replications. The experiments has randomized block design with pooled data analysis. The observation to be recorded for plant growth parameters such as Plant height (cm) at 45, at harvest and Number of leaves per plant, 45 and 90 DAT. Yield parameters like Average bulb weight (g), Length of bulb (cm), Neck thickness (cm) and Diameter of bulb (cm).

The effect of vermicompost and other fertilizers on cultivation of tomato plants.

Results and Discussion

Plant Height (cm) at 45 DAT and at Harvest Stage

In the application of fertilizers the treatment T_3 [Soil Test Based Fertilizer Recommendation (STV)] has showed maximum plant height at 45 DAT and at harvest stage. Followed by the treatment T_2 (100% inorganic RDF (N:P:K:S:Zn 120:60:80:40:05) and T_4 (75% RDF inorganic + 25% N through Vermicompost). While the minimum plant height at plant height at 45 DAT and at harvest stage, was recorded in treatment T_1 (Control). This conclusion is consistent with that of Pandy and Ekpo (1991) [18], who found that the greatest nitrogen ha-1 produced the tallest plants. This outcome also agrees with Singh and Mohanty (1998) [19] findings that the tallest plants were produced when N and K were applied at 160 and 80 kg ha^{-1}.

The higher nitrogen fertilizer concentration in NPS fertilizers, which promotes excessive crop development and crop height, may be the cause of the variation in onion crop yields following enhanced NPS fertilization. Additionally, the genetic composition of onion plants determines the height of the plants Kitila *et al.,* (2022) [10].

A possible reason for crop failure could be higher nitrogen use, which plays a major role in the development of amino acids, proteins, chlorophyll, and cells that support the growth of onions. This finding is consistent with studies by Nasreen *et al.,* (2007) [11], Gustafson (2010) [5], and Birhanu *et al.,* (2014) [2] that found that applying nitrogen fertilizer accelerated the vegetative growth of onions by raising the rate of photosynthesis. According to Hewitt and Smith (1974) [6], the causes of the rise in plant length with the application of N may be attributed to enhanced vegetative development with increasing N. This may be because an increase in N supply leads to the consumption of carbohydrates to generate protoplasm and more cells to boost growth.

Length of leaf (cm) 45 DAT

In the application of fertilizers the treatment T_3 [Soil Test Based Fertilizer Recommendation (STV)] has showed maximum length of leaves per plant at 45 DAT. Followed by the treatment T_2 (100% inorganic RDF (N:P:K:S:Zn 120:60:80:40:05) and T_4 (75% RDF inorganic + 25% N through Vermicompost). While the minimum length of leaves per plant at 45 DAT and 90 DAT was recorded in treatment T_1 (Control). This could be explained by the way that N simulates vegetative development, which involves the synthesis and utilization of carbohydrates through photosynthesis and metabolism. (Jayakumar *et al.,* 2007) [7].

Length of bulb (cm)

In the application of fertilizers the treatment T_3 [Soil Test Based Fertilizer Recommendation (STV)] has showed maximum length of bulb. Followed by the treatment T_2 (100% inorganic RDF (N:P:K:S:Zn 120:60:80:40:05) and T_4 (75% RDF inorganic + 25% N through Vermicompost). While the minimum length of bulb (cm) was recorded in treatment T_1 (Control). Consistent results were documented, indicating that the maximum onion bulb length was achieved with an application of 138 kg N ha^{-1}. (Gessesew 2015) [3]. Onion bulb length may have grown because to an increase in leaf quantity and length, which boosts assimilate production and allocation to the bulbs. (Jayathilake *et al.,* 2002) [8].

Diameter of bulb (cm)

In the application of fertilizers the treatment T_3 [Soil Test Based Fertilizer Recommendation (STV)] has showed maximum diameter of bulb. Followed by the treatment T_2 (100% inorganic RDF (N:P:K:S:Zn 120:60:80:40:05) and T_4 (75% RDF inorganic + 25% N through Vermicompost). While the minimum diameter of bulb (cm) was recorded in treatment T_1 (Control). The finding is contrary to the result reported by Khan *et al.,* (2002) [9] who reported that N an increase in application of N increased bulb size. This outcome was also consistent with research by Negasi *et al.,* (2017) [12], which showed that chemical fertilizers enhanced onion bulb diameter. It might be explained by the possibility that raising major elements, in particular N, through fertilizers sped up the synthesis of amino acids and chlorophyll. This increased photosynthesis from leaves to bulbs led to an increase in bulb diameter and weight (Shedeed *et al.,* 2014; Tana and Wolde 2015) [13, 14].

Bulb yield (q/ha)

The treatment T_3 [Soil Test Based Fertilizer Recommendation (STV)] has showed maximum bulb yield. Followed by the treatment T_2 (100% inorganic RDF (N:P:K:S:Zn 120:60:80:40:05) and T_4 (75% RDF inorganic + 25% N through Vermicompost). While the minimum bulb yield (q/ha) was recorded in treatment T_1 (Control). The usage of NPKS fertilizers may have increased bulb weight and size, which in turn may have increased photosynthesis. This might lead to improved growth and expansion of the vegetative growth overall, and eventually much higher amounts of carbohydrates in the bulbs at maturity. The results of Tibebu *et al.,* (2014) [15], who saw excellent onion bulb yields in response to a nitrogen the application, are not consistent with this outcome. Additionally, Woldeyohannes *et al.* (2007) [16] showed a consistent rise in onion bulb output as a result of

raising the NPS's nitrogen levels from 0 to 100 kg N ha-1. This outcome was consistent with the research conducted by Bagali *et al*. (2012) [1], which showed that greater quantities of inorganic fertilizers led to increased onion bulb yields. The use of N may have contributed to the rise in vegetative growth and enhanced assimilation production, which in turn led to an increase in bulb diameter and average bulb weight and an increase in marketable bulb yield (Girma 2011; Khan *et al*., 2002; Nasreen *et al*., 2007) [4, 9, 11].

Neck thickness (cm)

In the application of fertilizers the treatment T_3 [Soil Test Based Fertilizer Recommendation (STV)] has showed maximum neck thickness. Followed by the treatment T_2 (100% inorganic RDF (N:P:K:S:Zn 120:60:80:40:05) and T_4 (75% RDF inorganic + 25% N through Vermicompost). While the minimum neck thickness (cm) was recorded in treatment T_1 (Control). In accordance, Yohannes *et al.*, (2017) found that one of the crucial factors that is greatly impacted by fertilizer application is neck thickness. Negasi *et al.*, (2017) [12], however, presented conflicting results. More rate of photosynthesis and absorption in plant tissues may be the cause of plants growing comfortably in terms of height, number of leaves, and area of leaves per plant.

Table 1: Effect of integrated nutrient management on growth characters of onion

Treat.	Plant height (cm) at 90			Plant height (cm) at Harvest Stage			Length of leaf (cm) 45 DAT		
	I Year	II Year	Pooled	I Year	II Year	Pooled	I Year	II Year	Pooled
T_1	38.35	40.26	39.31	48.49	50.91	49.70	32.99	34.64	33.82
T_2	44.88	47.12	46.00	53.23	55.89	54.56	45.77	48.06	46.91
T_3	48.00	50.40	49.20	54.41	57.13	55.77	48.63	51.06	49.85
T_4	44.63	46.86	45.74	53.03	55.68	54.36	43.02	45.17	44.10
T_5	39.41	41.38	40.39	50.48	53.00	51.74	39.14	41.10	40.12
T_6	40.08	42.08	41.08	51.14	53.70	52.42	39.46	41.43	40.45
T_7	43.85	46.04	44.94	52.19	54.80	53.49	41.15	43.21	42.18
T_8	38.83	40.77	39.80	50.12	52.63	51.37	37.79	39.68	38.74
T_9	43.09	45.24	44.16	51.85	54.44	53.15	39.61	41.59	40.60
T_{10}	42.19	44.30	43.24	51.33	53.90	52.61	39.49	41.47	40.48
T_{11}	38.63	40.56	39.59	49.15	51.61	50.38	35.38	37.15	36.27
T_{12}	38.69	40.62	39.65	49.22	51.68	50.45	36.93	38.78	37.85
S.Em±	0.092	0.096	0.066	0.052	0.055	0.038	0.124	0.131	0.090
CD at 5%	0.293	0.308	0.189	0.168	0.176	0.108	0.398	0.417	0.257

Table 2: Effect of integrated nutrient management on yield characters of onion

Treat.	Diameter of bulb (cm)			Neck thickness (cm)			Length of bulb (cm)		
	I Year	II Year	Pooled	I Year	II Year	Pooled	I Year	II Year	Pooled
T_1	3.13	3.29	3.21	1.29	1.35	1.32	7.56	7.94	7.75
T_2	6.12	6.42	6.27	1.80	1.89	1.85	8.12	8.52	8.32
T_3	6.16	6.47	6.32	2.38	2.50	2.44	8.32	8.74	8.53
T_4	6.09	6.39	6.24	1.69	1.78	1.74	8.05	8.46	8.25
T_5	5.91	6.21	6.06	1.50	1.57	1.53	7.76	8.14	7.95
T_6	5.95	6.25	6.10	1.64	1.73	1.69	7.81	8.20	8.00
T_7	6.06	6.36	6.21	1.63	1.72	1.68	8.00	8.40	8.20
T_8	5.89	6.19	6.04	1.34	1.41	1.37	7.69	8.07	7.88
T_9	6.01	6.31	6.16	1.66	1.75	1.71	7.98	8.38	8.18
T_{10}	5.96	6.26	6.11	1.60	1.69	1.64	7.88	8.27	8.08
T_{11}	5.81	6.10	5.95	1.43	1.50	1.46	4.57	4.80	4.69
T_{12}	5.88	6.17	6.02	1.48	1.55	1.51	7.44	7.81	7.63
S.Em±	0.018	0.019	0.013	0.013	0.013	0.009	0.036	0.037	0.026
CD at 5%	0.058	0.060	0.037	0.040	0.042	0.026	0.114	0.120	0.074

Table 3: Effect of integrated nutrient management on Yield of bulb q/ha of onion

Treat.	Yield of bulb q/ha		
	I Year	II Year	Pooled
T_1	276.18	289.99	283.08
T_2	356.04	373.85	364.95
T_3	373.51	392.19	382.85
T_4	343.98	361.18	352.58
T_5	293.84	308.54	301.19
T_6	296.31	311.13	303.72
T_7	335.24	352.01	343.63
T_8	293.11	307.77	300.44
T_9	334.64	351.38	343.01
T_{10}	329.24	345.71	337.48
T_{11}	276.98	290.83	283.90
T_{12}	277.78	291.67	284.72
S.Em±	0.975	1.024	0.707
CD at 5%	3.115	3.271	2.014

Conclusion

For the two years of experiments, it is concluded that the application of fertilizers in the treatment T3 [Soil Test Based Fertilizer Recommendation (STV)] has showed maximum Plant height cm) at 45 DAT and at harvest, Length of leaf 45 DAT, Length of bulb, Neck thickness, Diameter of bulb and Yield of bulb, followed by the treatment T2 (100% inorganic RDF (N:P:K:S:Zn 120:60:80:40:05) and T4 (75% RDF inorganic + 25% N through Vermicompost), While the minimum was recorded in treatment T1 (Control).

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