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Effect of integrated nutrient management on growth, yield and quality of onion [*Allium cepa* (L.)] Varieties

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Abstract

The present investigation entitled “Effect of integrated nutrient management on growth, yield, quality and nutrient uptake of onion [*Allium cepa* (L.)] Varieties.” was carried out during two consecutive seasons of 2021-22 and 2022-23 the experiment was conducted at fields of university, Bhopal (M.P.). This experiment has been conducted in 12 treatments and two varieties and their 24 combinations, with three replications. The experiment has formed under Factorial Randomized Design. In the experiment the 12 treatments of integrated nutrient management such as F₁-PM (2 t/ha), F₂-FYM (6 t/ha), F₃-VC (5 t/ha), F₄-50% RDF, F₅-50% RDF + PM, F₆-50% RDF + FYM, F₇-50% RDF + VC, F₈-75% RDF, F₉-75% RDF + PM, F₁₀-75% RDF + FYM, F₁₁-75% RDF + VC and F₁₂-100% RDF, Two varieties are used in the experiments such as V₁ (Nasik Red) and V₂ (Agrifound Dark Red). The observations to be recorded under the experiments are Morphological parameters like Plant height (cm) at 30 and 60 DAT, Length of leaf (cm) at 30 and 60 DAT, Number of leaves per plant at 30 and 60 DAT and Neck diameter of bulb (cm) at 30 and 60 DAT (cm). Yield-attributing parameters like Fresh weight of bulb (g), Dry weight of bulb (g) and Yield per hectare (q), Quality parameters Total soluble solids (TSS). The result revealed that the maximum Plant height at 30 and 60 DAT, Length of leaf at 30 and 60 DAT, Number of leaves per plant at 30 and 60 DAT and Neck diameter of bulb, Fresh weight of bulb, Dry weight of bulb and Yield per hectare, Total soluble solids (Brix) was found maximum under the variety V₂ Agrifound Dark Red, and fertilizers application treatments F₁₂-100% RDF, while the minimum was observed under the treatments control.

Keywords: Onion, bulb, INM, nutrient uptake

Introduction

Onion is one of the most popular vegetables that form of our daily diet. In India, onion is an important commercial crop, and is widely grown in different parts of the country. At present, India stands second largest producer of onion in the world, next only to China. Indian onions are famous for their pungency, and are available round the year. Globally, onion is being cultivated in about 175 countries. According to the United Nations Food and Agricultural Organizations, there are estimated 6.7 million acres of onion as an indispensable item in every kitchen as condiment and vegetable. It is used either in raw form and dehydrated form to add flavour and taste. Since onion has medicinal value, it is used in some pharmaceutical preparations also. It has many uses as folk remedies and recent report suggests that onion play a part in preventing heart disease and other ailments. Onion bulb is rich in minerals like phosphorus, calcium and carbohydrate. It also contains proteins and vitamin C. China ranks first in area and second in onion production in the world. The use of different types of organics improves soil properties, its health and fertilizer use efficiency, mitigates short supply of micronutrients, stimulates the proliferation of diverse group of soil microorganisms and improves the ecological balance of rhizosphere (Sanwal *et al.*, 2007; Saket *et al.*, 2014) ^[27, 25].

Materials and Methods

The present investigation entitled “Effect of integrated nutrient management on growth, yield, quality and nutrient uptake of onion [*Allium cepa* (L.)] Varieties.” was carried out during two consecutive seasons of 2021-22 and 2022-23 the experiment was conducted at fields of university, Bhopal (M.P.). This experiment has been conducted in 12 treatments and two varieties and their 24 combinations, with three replications. The experiment has formed under

Factorial Randomized Design. In the experiment the 12 treatments of integrated nutrient management such as F₁-PM (2 t/ha), F₂-FYM (6 t/ha), F₃-VC (5 t/ha), F₄-50% RDF, F₅-50% RDF + PM, F₆-50% RDF + FYM, F₇-50% RDF + VC, F₈-75% RDF, F₉-75% RDF + PM, F₁₀-75% RDF + FYM, F₁₁-75% RDF + VC and F₁₂-100% RDF, Two varieties are used in the experiments such as V₁ (Nasik Red) and V₂ (Agrifound Dark Red). The observations to be recorded under the experiments are Morphological parameters like Plant height (cm) at 30 and 60 DAT, Length of leaf (cm) at 30 and 60 DAT, Number of leaves per plant at 30 and 60 DAT and Neck diameter of bulb (cm) at 30 and 60 DAT (cm). Yield-attributing parameters like Fresh weight of bulb (g), Dry weight of bulb (g) and Yield per hectare (ton), Quality parameters Total soluble solids (TSS).

Results and Discussions

Plant height (cm) at 30 and 60 DAT

Variety V₂ has recorded maximum (20.62 and 28.23 cm) plant height (cm) at 30, and 60 days after transplanting of the onion crop, in the pooled year, while the minimum (20.14 and 27.01 cm) plant height was measured in same year was found in the variety V₁. Plant height is the genetic characters of the variety and hence different varieties varied with respect to these characters which ultimately brought about variation in these characters. This finding corroborates with the results of Mohanty and Prusti (2001) [18].

In the fertilizer application for observing plant height (cm) at 30 and 60 days after transplanting of the onion crop the treatment applied in F₁₂ [100% RDF (N₁₂₀P₈₀K₈₀)] has showed maximum (24.01 and 40.77 cm) plant height in the pooled year, followed by the treatment F₁₁ (75% RDF + VC) (22.54 and 36.54 cm) and F₁₀ (75% RDF + FYM) (22.31 and 34.74 cm), while the minimum (17.19 and 24.17 cm) plant height was recorded in treatment F₁ [PM (2 t/ha)]. This could be due to significantly higher uptake of N, P and K as compared to no fertilizers application which might have played an important physiological role in the plant system for its overall growth and development. Bairagi *et al.*, 2015 [5].

The combined application of variety and recommended dose of fertilizers are showed best result at 30 and 60 days after transplanting of the onion crop as compare to other combinations in the treatment in pooled year basis. The treatment combination V₂F₁₂ [Agrifound Dark Red + 100% RDF (N₁₂₀P₈₀K₈₀)] was found maximum (24.59 and 41.17 cm) plant height, followed by the all other treatment combinations. The minimum plant height was recorded under the treatment combination V₁F₁ [Nasik Red + PM (2 t/ha)] (16.96 and 24.12 cm). The increase in height of the plant at increased application of Nitrogen fertilizers in the application of RDF could be attributed to its involvement as building blocks in the synthesis of amino acids, as they link together and form proteins and make up metabolic processes required for plant growth. Similar results have been reported by Amans *et al.*, (1996) [2], Kumar *et al.*, (1998) [17], Khan *et al.*, (2002) [15], El-Shaikh (2005) [9], Shaheen *et al.*, (2007) [29] and Abdissa *et al.*, (2011) [1].

Kalirawna *et al.*, (2022) [14] also reported the same, according to that Kalirawna, treatment provide good amount of nutrients and fertilizer for their growth. Probable increase in plant height may be due to increased soil nutrient uptake and effective translocation to various plant parts by the effect of organic manures and inorganic fertilizers.

Rate of release of nutrients are much higher in the inorganic fertilizers since they provide major elements at the early stage

of plant growth and development. Thus, plants exhibited accelerated growth rate than other organic nutrients or compost. According to Tindall (1968) [33] stated that relatively high levels of nutrients are required for optimum growth and development at early stage. In compost, nutrient element content is low and the nutrients are not readily available for plant uptakes (Brady, 1985) [6].

Length of leaf (cm) at 30 and 60 DAT

The discussion of pooled basis indicated that there was significant effect of varieties on length of leaf at 30 and 60 days after transplanting. In this Variety V₂ has observed maximum (15.95 and 27.73 cm) length of leaf at the stages of growth, while the minimum (14.77 and 25.31 cm) length of leaf was measured in the variety V₁. In the application of recommended dose of fertilizers in the form of treatment F₁₂ [100% RDF (N₁₂₀P₈₀K₈₀)] has showed maximum (22.55 and 36.44 cm) length of leaf at different growth stages of plant of onion crop, followed by the other treatment F₁₁ (75% RDF + VC) (21.60 and 34.00 cm) and F₁₀ (75% RDF + FYM) (20.90 and 33.50 cm), while the minimum length of leaf was recorded in treatment F₁ [PM (2 t/ha)] (12.56 and 22.37 cm). Thus, inorganic fertilizers hasten early growth of onion leaves, but that could recompense by the organic manures in the later stages. Organic manures activate many species of living organisms which release phytohormones and may stimulate the plant growth and absorption of nutrients (Arisha *et al.*, 2003) [3] and such organisms need nitrogen for multiplication (Ouda and Mahadeen, 2008) [21].

In the treatment combination V₂F₁₂ [Agrifound Dark Red + 100% RDF (N₁₂₀P₈₀K₈₀)] noted maximum (22.55 and 36.44) length of leaf at different growth stages of onion crops, followed by the other combinations of treatments V₁F₁₂ [Nasik Red + 100% RDF (N₁₂₀P₈₀K₈₀)] (22.05 and 36.09), V₂F₁₁ (Agrifound Dark Red + 75% RDF + VC) (21.97 and 34.39) and V₂F₁₀ (Agrifound Dark Red + 75% RDF + FYM) (21.29 and 35.55). The minimum length of leaf at all the growth stages was recorded under the treatment combination V₁F₁ [Nasik Red + PM (2 t/ha)] (11.95 and 22.23). The positive effect of Nitrogen on length of leaf may be due to its role on chlorophyll, enzymes and proteins synthesis. The results of this study agree with finding of Jilani (2004) [13] who reported that, application of 200 kg N ha⁻¹ significantly enhanced the length of onion leaves. Similarly, Kumar *et al.*, (1998) [17] and Singh *et al.*, (1999) [30] indicated that application of N at 150 kg ha⁻¹ gave the best result with the regard to onion leaf length. Similarly Abdissa *et al.*, (2011) [1] also reported that Nitrogen application showed significant effect on onion leaf length.

Number of leaves per plant at 30 and 60 DAT

The discussion of the observation on the pooled basis of the result that there was showed significant effect of varieties on number of leaves per plant at 30 and 60 days after transplanting. The Variety V₂ has been recorded maximum (4.73 and 6.47) number of leaves per plant at different growth stages like 30 and 60 days after transplanting and the minimum (4.59 and 5.62) number of leaves per plant was measured in variety V₁ at all the growth stages.

In the treatment of fertilizer that is recommended dose of fertilizers the treatment F₁₂ [100% RDF (N₁₂₀P₈₀K₈₀)] has showed maximum (5.71 and 8.21) number of leaves per plant at 30 and 60 days after transplanting, followed by the other treatments F₁₁ (75% RDF + VC) (5.41 and 7.29) and F₁₀ (75% RDF + FYM) (5.15 and 7.14), while the minimum number

(3.84 and 4.71) of leaves per plant was recorded in treatment F₁ [PM (2 t/ha)]. This result agrees with the findings of El-Oksh *et al.*, (1993) [8]. They observed that Nitrogen application had significant effect on number of leaves of onion. Singh *et al.*, (1989) [31] stated that a combination of 120 kg N/ha with green manure gave the tallest plants and the maximum number of leaves/plant. Reddy and Reddy (2005) [24] also observed that highest number of leaves per plant in onion was recorded with 30 t/ha vermicompost with 200 kg N/ha. Application of 80 kg N/ha increased the number of leaves/plant compared to 40 kg N/ha (Nehra *et al.*, 1988) [20]. Kumar *et al.*, (2001) [16] found that 130 kg N/ha resulted in the highest number of green leaves per plant of onion.

The other treatment with combination with vermicompost also found better after the application of RDF, it is clearly showed that vermicompost it might be due to the good accumulation of photosynthesis or good absorption of nutrient it might. Kalirawna *et al.*, 2022 [14] in onion crops.

The combination of variety and recommended dose of chemical fertilisers in the treatment combination V₂F₁₂ [Agrifound Dark Red + 100% RDF (N₁₂₀P₈₀K₈₀)] was found maximum (5.80 and 8.28) number of leaves per plant at the growth stages of plant, followed by the other treatment combinations like V₁F₁₂ [Nasik Red + 100% RDF (N₁₂₀P₈₀K₈₀)] (5.63 and 8.13), V₂F₁₁ (Agrifound Dark Red + 75% RDF + VC) (5.50 and 7.34) and V₂F₁₀ (Agrifound Dark Red + 75% RDF + FYM) (5.36 and 7.24), the minimum (3.82 and 4.65) number of leaves per plant at 30 DAT was recorded under the treatment combination V₁F₁ [Nasik Red + PM (2 t/ha)]. It is clearly showed that the variety V₂ showed better performance in the region with the combination of chemical fertilizers.

Neck diameter of bulb (cm) 30 and 60 DAT

The discussion of the results of neck diameter of bulb on pooled basis indicated that there was significant effect of both varieties on neck diameter of bulb at different stages of growth like 30 and 60 days after transplanting. Variety V₂ (Agrifound Dark Red) has recorded maximum (0.67 and 1.62 cm) neck diameter of bulb, which was at par with the variety V₁ (Nasik Red) (0.66 and 1.50).

In application of recommended dose of fertilizers applied in the treatment F₁₂ [100% RDF (N₁₂₀P₈₀K₈₀)] has showed maximum (0.89 and 2.16 cm) neck diameter of bulb at all the growth stage of onion crop, followed by the treatment F₁₀ (75% RDF + FYM) (0.84 and 2.06) and F₁₁ (75% RDF + VC) (0.76 and 1.99), while the minimum neck diameter of bulb was recorded in treatment F₁ [PM (2 t/ha)] (0.61 and 1.29). Similarly, increased neck diameter, bulb diameter and weight with the application of higher levels of NPK fertilizer was obtained by Jawadagi *et al.*, (2012).

Treatment combination V₂F₁₂ [Agrifound Dark Red + 100% RDF (N₁₂₀P₈₀K₈₀)] noted maximum (0.93 and 2.22) neck diameter of bulb at all the growth stages of onion crop, followed by the treatment combinations V₁F₁₂ [Nasik Red + 100% RDF (N₁₂₀P₈₀K₈₀)] (0.88 and 2.18), V₂F₁₁ (Agrifound Dark Red + 75% RDF + VC) (0.86 and 2.10), the minimum neck diameter of bulb at all the growth stages was recorded under the treatment combination V₁F₁ [Nasik Red + PM (2 t/ha)] (0.59 and 1.25).

The increase in neck diameter, bulb diameter and length may be attributed to pattern solubilization of plant nutrients by addition of organic manures leading to increase in uptake of N, P, K (Subbaiah *et al.*, 1982) [32]. When the organic manure

are added to soil, complex nitrogenous compounds slowly break down and make steady Nitrogen supply throughout the growth period of the crop. This might have attributed to more availability and subsequent uptake by the crop, thus, increasing the yield. Corroborative results were also reported by Patil *et al.*, (2005) [22]; Ethel *et al.*, (2009) [10]; Gami *et al.*, (2012) [11] and Bagali *et al.*, (2012) [4] in onion crop. According to Kumar *et al.*, (1998) [17] they observed that the application of chemical fertilizers in increasing the application of N and S fertilizer rate they increased neck diameter of onion crop. Yohannes *et al.*, (2017) [34] reported that neck thickness is one of the important parameters which is highly significantly influenced by the combined application of inorganic and organic fertilizers. However, Negasi *et al.*, (2017) [19] reported contrasting findings. Comfortable plant growth with respect to plant height, number of leaves per plant and leaf area per plant could be attributed to increased rate of photosynthesis and assimilation in plant tissues.

Yield-attributing parameters

Fresh weight of bulb (g)

The discussion on the basis of pooled that is first- and second-year observations are used, in this regards the variety Variety V₂ (Agrifound Dark Red) has found maximum (58.69 g) fresh weight of bulb, followed by the variety V₁ (Nasik Red) (58.06 g).

In the same application fertilizers treatment F₁₂ [100% RDF (N₁₂₀P₈₀K₈₀)] was showed maximum (70.06 g) fresh weight of bulb, followed by the treatment F₁₁ (75% RDF + VC) and F₁₀ (75% RDF + FYM) (67.63 g), while the minimum fresh weight of bulb was recorded in treatment F₁ [PM (2 t/ha)] (55.13 g). The variation in the fresh weight of bulb might be due to the treatment response. The data pertaining to the fresh weight of bulb indicates that the differences were significant when the CD value was greater than the treatment difference. Similar result was found Kalirawna *et al.*, 2022 [14] in onion crops.

The treatment combination V₂F₁₂ [Agrifound Dark Red + 100% RDF (N₁₂₀P₈₀K₈₀)] noted maximum (70.08 g) fresh weight of bulb, which was at par with the treatment combinations V₁F₁₂ [Agrifound Dark Red + 100% RDF (N₁₂₀P₈₀K₈₀)] (70.04 g), the minimum fresh weight (55.07 g) of bulb was recorded under the treatment combination V₁F₁ [Nasik Red + PM (2 t/ha)].

Dry weight of bulb (g)

The Variety V₂ (Agrifound Dark Red) has recorded maximum dry weight (41.61 g) of bulb, followed by the variety V₁ (Nasik Red) (41.16 g). In the application of recommended dose of fertilizer in the form of treatment F₁₂ [100% RDF (N₁₂₀P₈₀K₈₀)] has showed maximum dry weight (49.04 g) of bulb, followed by the treatment F₁₁ (75% RDF + VC) (47.34 g) and F₁₀ (75% RDF + FYM) (46.52 g), while the minimum dry weight of bulb was recorded in treatment F₁ [PM (2 t/ha)] (38.59 g).

In the same of pooled basis the treatment combination V₂F₁₂ [Agrifound Dark Red + 100% RDF (N₁₂₀P₈₀K₈₀)] was noted maximum dry weight (49.06 g) of bulb which was at par with the treatment combination V₁F₁₂ [Agrifound Dark Red + 100% RDF (N₁₂₀P₈₀K₈₀)] (49.03 g), while the minimum dry weight (38.55 g) of bulb was recorded under the treatment combination V₁F₁ [Nasik Red + PM (2 t/ha)].

Yield per hectare (q/ha): The Variety V₂ (Agrifound Dark Red) has recorded maximum bulb yield (387.05 q/ha), while

minimum yield per hectare was measured in case of variety V₁ (Nasik Red) (391.25 q/ha). In the same application RDF in the form of treatment F₁₂ [100% RDF (N₁₂₀P₈₀K₈₀)] has showed maximum yield (467.06) per hectare, followed by the treatment F₁₁ (75% RDF + VC) (450.90 q/ha) and F₁₀ (75% RDF + FYM) (443.01q/ha), while the minimum yield (367.53) per hectare was recorded in treatment F₁ [PM (2 t/ha)]. Application of inorganic fertilizers gave higher yield than application of organic manure alone. Thus, inorganic fertilizers release the nutrients quickly and fulfill the plants need at the opposite time. Therefore, plants would not face any limitation during the yield forming period and it could produce better yield Seran *et al.*, (2010) [28].

The treatment combination V₂F₁₂ [Agrifound Dark Red + 100% RDF (N₁₂₀P₈₀K₈₀)] noted maximum (467.20 q/ha), which was at par with the treatment combinations V₁F₁₂ [Agrifound Dark Red + 100% RDF (N₁₂₀P₈₀K₈₀)] (466.92 q/ha), followed by the treatment combinations V₂F₁₁ (Agrifound Dark Red + 75% RDF + VC) (452.78 q/ha) and V₂F₁₀ (Agrifound Dark Red + 75% RDF + FYM) (449.36 q/ha), while the minimum yield per hectare was recorded under the treatment combination V₁F₁ [Nasik Red + PM (2 t/ha)] (367.16 q/ha). The overall trend of yield attributes under different varieties may be attributed exactly in accordance with the increase in plant growth parameters. Agrifound Dark Red attained the maximum growth parameters, hence resulted in maximum yield-attributing characters. The increased growth parameters eventually increased the translocation of photosynthates from vegetative parts towards the reproductive organs (yield-attributes). The larger bulb diameter with higher yield in Onion due to chemical fertilizer's application is likely as because Nitrogen encourages cell elongation, above ground vegetative growth and to impart dark green color of leaves which may be linked to the increase in dry matter production and allocation to the bulb (Brady, 1985) [6]. This result is sustaining Nasreen *et al.*, (2007) [23] who reported that a significant increase in the mean diameter of bulbs due to the application of N up to 120 kg ha⁻¹. Similar results also reported by Yadav *et al.*, (2003) [26] who found that N at 150 kg ha⁻¹, enhanced the formation of bulbs with larger diameters. Kumar *et al.*, (1998) [17], Khan *et al.*, (2002) [15] and Abdissa *et al.*, (2011) [1] also reported that bulb diameter is significantly affected by the application of Nitrogen.

Purohit 2015 [7], the increased yield attributes due to N150P80K80 was owing to the significant increases in plant growth parameters *viz.* plant height, number of leaves per plant and neck diameter under these highest levels of nutrients.

Total soluble solids (TSS °Brix)

The Variety V₂ (Agrifound Dark Red) has recorded maximum TSS (12.99 °Brix), followed by the variety V₁ (Nasik Red) (12.81°Brix). In case of fertilizer application treatment F₁₂ [100% RDF (N₁₂₀P₈₀K₈₀)] has showed maximum TSS (14.23 °Brix), followed by the treatment F₁₁ (75% RDF + VC) and F₁₀ (75% RDF + FYM) (13.79 °Brix), while the minimum TSS content was recorded in treatment F₁ [PM (2 t/ha)] (12.41 °Brix).

The treatment combination V₂F₁₂ [Agrifound Dark Red + 100% RDF (N₁₂₀P₈₀K₈₀)] noted maximum TSS (14.47 °Brix), followed by the treatment combinations V₁F₁₂ [Agrifound Dark Red + 100% RDF (N₁₂₀P₈₀K₈₀)] (13.98 °Brix), V₂F₁₁ (Agrifound Dark Red + 75% RDF + VC) (13.88 °Brix), the

minimum TSS was recorded under the treatment combination V₁F₁ [Nasik Red + PM (2 t/ha)] (12.37 °Brix).

Conclusion

On the basis of two year of experiment it is concluded that the variety V₂ Agrifound Dark Red and treatments of fertilizers F₁₂-100% RDF was found best on the parameters such as Plant height at 30 and 60 DAT, Length of leaf at 30 and 60 DAT, Number of leaves per plant at 30 and 60 DAT and Neck diameter of bulb, Fresh weight of bulb, Dry weight of bulb and Yield per hectare, Total soluble solids (Brix).

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