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Response of integrated nutrient management on growth, yield and economics of knol-khol: A Review

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Abstract

The present work serves as a review of nutrient management, which has affected the knol-khol crop's growth and yield characteristics as well as the pace at which it assimilates nutrients by altering the quantity of nutrients in the soil system. The present method of managing nutrients has switched its emphasis to sustainability and environmental friendliness. Crop growth and yield were both impacted by incorrect fertilizer management. The utilization of nutrient management provides soil with beneficial nutrients that help the crops to increase productivity and improves growth. It is important to boost productivity by using an effective nutrient management method. Additionally, INM along provides sustainable solutions for managing agricultural waste while safeguarding the environment. Utilization of INM holds immense promise for creating a more efficient, sustainable and productive agricultural industry. The impact of adding organic fertilizers along with chemical fertilizers on a biometric trait, which in turn has an impact on the growth, production, and economics of the knol-khol crop.

Keywords: Crop, economics, growth, nutrient management, knol-khol and yield

1. Introduction

The cabbage and cauliflower are the most widely consumed vegetables from cole crops, but knol-khol is also becoming more popular due to its anti-hyperglycemic and anticarcinogenic characteristics. A cole crop is grown during the Rabi season, Knol-Khol (*Brassica oleracea* var. *gongylodes*) is a member of the *Brassicaceae* family and is native to the Mediterranean coastal nations. Carbohydrates and minerals like calcium, magnesium, phosphorus, sodium, sulphur, and others are abundant in Knol-khol. It is also a good source of nutritional fibre, antioxidants like vitamins A, C, E, and carotene. Moreover, it has isothiocyanates like sulforaphane and other types that are thought to encourage the body to produce defence mechanisms (Banotra *et al.*, 2017) [2]. It is popular in Kashmir as well as Maharashtra, Uttar Pradesh, Assam, West Bengal, Punjab, Odisha, and numerous South Indian states. Knob, a swollen stem tissue above the cotyledons is the main edible part of knol-khol. The plant offers a wide range of therapeutic benefits that include treating conditions such as acidosis, asthma, cancer, high cholesterol, heart disease, indigestion, difficulties with the muscles and nerves, prostate and colon cancer, skin issues, weight reduction, and more (Shah *et al.*, 2019) [19]. In most cases, more use of synthetic agrochemicals such as pesticides and fertilizers has increased production output, but continued indiscriminate use of these high-energy inputs now causes a decline in production and productivity of different crops as well as the degradation of soil health and environments. Reduced vitamin and mineral content of fresh fruits and vegetables is another effect of intensive agricultural methods. Integrated nutrition management is the only solution to these issues (Ananda *et al.*, 2017) [1].

Integrated nutrient management (INM) aims to maintain and improve soil fertility for long-term crop productivity by maximizing all organic, inorganic, and biotic resources in a coordinated manner that is appropriate for each cropping system and farming situation, taking into account the ecological, social, and economic implications. As they grow quickly knol-khol can be directly seeded in the field (Sharma *et al.*, 2012) [21]. The proper management of nutrients is crucial because, without it, the nutrients will leak down and mix with the soil's water, possibly entering the soil's bottom surface. The integrated nutrient management program covers the means of resolving these problems and calls for concurrent chemical use and improved soil health. The secret to sustainable agriculture is using all three major nutrient sources, including inorganic, organic, and bio-fertilizers (Banotra *et al.*, 2017) [2].

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These three elements enhance the soil's physical, chemical, and biological properties, preserve the soil's ability to hold onto moisture, fix atmospheric nitrogen, and convert inaccessible forms of nutrients into available forms, among other benefits. Nitrogen is a crucial nutrient for plant growth, development, and reproduction among other significant nutrients (Iqbal *et al.*, 2010) [6]. Crop productivity could increase with nitrogen. Nitrogen helps cells to generate protoplasm and aids the conversion of carbohydrates into proteins. A suitable amount of mineral nitrogen, which is connected to healthy vegetative development and raises production, helps plants utilize all of the inputs from the soil. The features of crops and the health of the soil, which has deteriorated by the frequent use of chemical fertilizers, are determined by mineral nutrition (Kumar *et al.*, 2018; Ananda *et al.*, 2017) [10, 1]. In addition to employing expensive chemical fertilizers for improved quality, and yield, and to maintain the good soil, integrated nutrient management is necessary for to long-term health of the soil. One of the essential components of phospholipids, enzymes, and nucleic acids is phosphorus. It plays a significant role in the early growth and development of roots and is crucial for the flow of energy throughout the plant's body system (Muhammed *et al.*, 2023) [14]. Potassium functions as an enzyme activator for many including pyruvic kinase and cytoplasmic enzymes, and helps plants grow vigorously and fight several diseases. The bio-fertilizers are of organic origin, making them completely safe for soil and for people as well. It is in charge of the systemic impact on the metabolic processes of the plant system (Banotra *et al.*, 2017) [2]. The interactive benefits of mixing nutrients from inorganic and organic sources often provide a better status than using each component independently. A greater level of productivity has been sustained and long-term soil fertility has been preserved by the prudent application of organic and inorganic fertilizers (Kumar *et al.*, 2018) [10]. Therefore, the present paper is aimed to review the impact of integrated nutrient management on the growth, yield, and economics of knol-khol.

2. Effect of nutrient management on growth characteristics

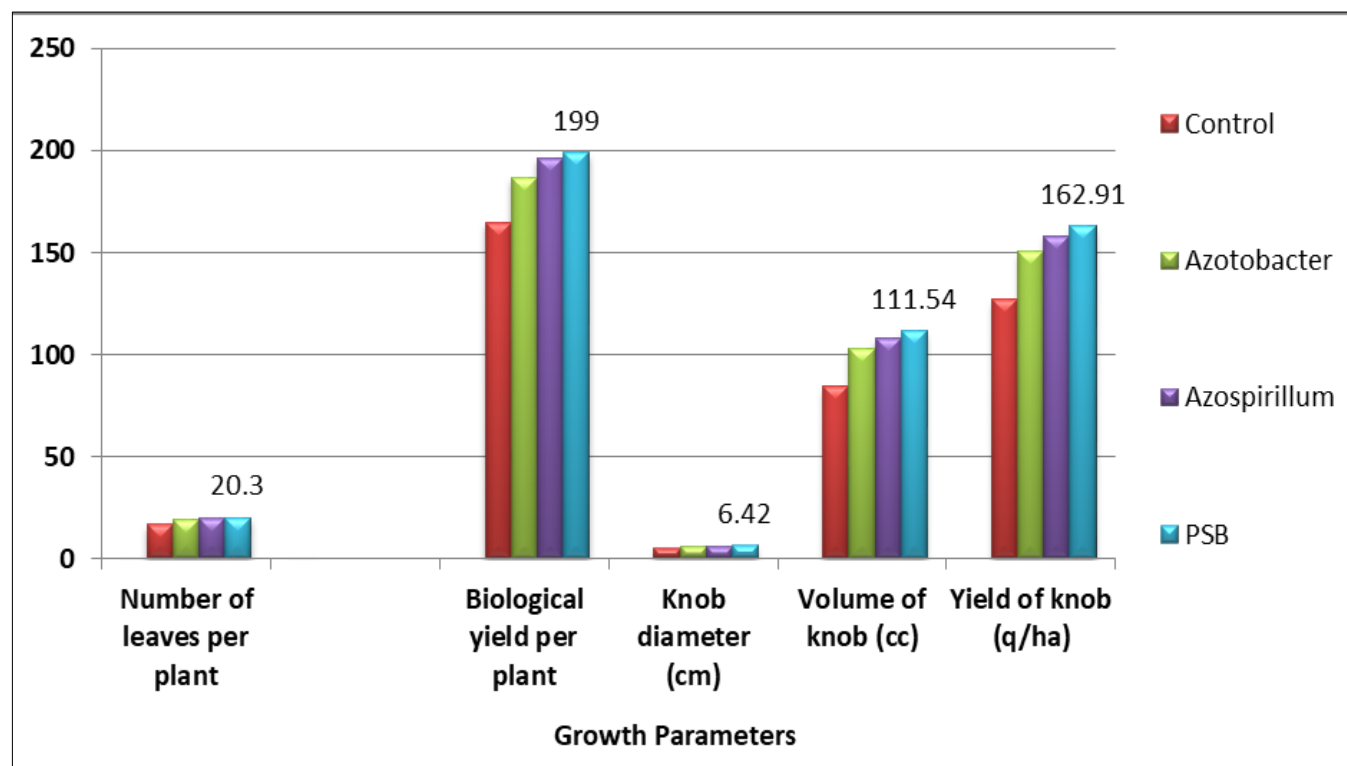
Plants required nutrients to germinate, grow, and to reproduce. Growth characteristics include height of height, leaves/plant, length of stalk, area of leaves etc. Nutrient management is required to improve the growth characteristics of plants. Komma *et al.*, (2022) [8] investigated how red cabbage growth was affected by integrated nutrition management. They use 100% RDF, 75% RDF + 25% FYM, 50% RDF + 50% FYM, 75% RDF + 25% Vermi-compost, 50% RDF + 50% Vermi-compost, 50% RDF + 50% Vermi-compost, 50% RDF + 50% Cow-dung cake, 75% RDF + 25% Poultry manure, 50% RDF + 50% Poultry manure, and Control 100% RDF as their treatments. Plant height (36.63 cm), leaf count (22.92 cm), spread (72.65 cm), and stalk length (10.82 cm) were all measured in order to determine the characteristics of maximum growth. In the treatment (T₅) 50% RDF + 50% Vermicompost, and the minimal number of days for head initiation (35.58 DAT). The output of red cabbage has been increased overall through integrated nutrition management. Due to the use of necessary fertilizers along with vermicompost, growth parameters have increased. By improving the soil's fertility and water-holding ability, this vermicompost is beneficial. The physical characteristics of the soil are improved by adding vermicompost to the

experimental plot; this improves the soil's ability to hold onto nutrients, which in turn promotes plant growth. Islam *et al.*, (2020) [7] investigated the various manures and nutrients' effects on the growth of knol-khol. The treatment consisted of T₀ control, T₁ (RDF of NPK), T₂, T₃, T₄, and T₅ (50 percent cow dung plus 50 percent NPK), 50 percent vermicompost plus 50 percent cow dung, 50 percent vermicompost plus 50 percent poultry manure, and 25 percent cow dung plus 25 percent vermicompost plus 25 percent poultry manure). After 25, 35, and 45 days following transplanting, the treatment (T₁) produced the tallest plants (DAT). While the maximum canopy spread from treatments T₃, T₇, and T₂ was 36 cm, 52 cm, & 66 cm, respectively. The utilization of manures and fertilizers increases growth characteristics. It was found that using inorganic fertilizers provided enough readily available nutrients for the appropriate development of knol-khol plants. Hussain *et al.*, (2020) [5] revealed the effect of organic fertilizers and manures on the knol-khol crop. When enriched FYM was treated in conjunction with bio-char the highest number of leaves/plant, leaf area/plant, specific leaf weight, fresh and dried leaf weight, as well as an increase of 19.5% in fresh leaf weight over enriched FYM alone, were reported. The treatment enriched with FYM+ biochar showed increases of 194 and 241% over the control, respectively.

The knol-khol crop's development was properly facilitated by the use of biochar and farmyard manure in the treatment. Kumar *et al.*, (2020) [9] studied the impact of various nutrient sources and mulching on the sustainable production of cauliflower and found that plants treated without organic manures and inorganic fertilizers resulted in a substantial way in several growth parameters. The plants exposed to 50% RDF + 15 t/ha Vermicompost + *Azotobacter* (5 kg/ha) + PSB (5 kg/ha) + Black polythene (2.5 mm) showed the greatest growth for the cauliflower crop among the treatments. The application of RDF with vermicompost and bio-fertilizers improved the nutrients in the soil and enhanced the growth of knol-khol crop. In their study of the impact of nutrients on the development of the knol-khol crop. Kumar *et al.* (2018) [10] found that the administration of 100% RDF (Recommended dose of fertilizer + *Azospirillum*) had a significant impact on knol-khol growth. The 100% RDF + *Azotobacter*, defined the plant height at highest at the time of harvest. The outcome depicted that the mixed application of organic, inorganic, and bio-fertilizer had an important effect on the growth parameter knol-khol. The development of knol-khol was greatly impacted by the balanced application of fertilizers. Mutum *et al.*, (2017) [15] examined the Knol-khol crop to examine the effects of various organic, inorganic, and bio-fertilizers. The highest height of plants, no. of leaves/plant, length of leaves, width of the leaves, length of the roots, and quantity of roots (secondary) of the knol-khol crop were observed in plants fed with 50% RDF + VC @ 5 t ha⁻¹ + biofertilizers @ 2 kg ha⁻¹ (T₃). The utilization of RDF along with vermicompost and bio-fertilizers boosted the soil's nutritional content and accelerated the growth of the knol-khol crop. Singh *et al.*, (2015) [23] evaluated the impact of integrated nutrient management (INM) on plant growth in cabbage during Rabi season. The treatment T₈ 50% RDF applied as + poultry manure (3 t/ha) + *Azotobacter* (seedling root dip for 20 min in 10% solution had the maximum plant height, head length, and the number of secondary roots in the cabbage crop. It was observed that treatment with RDF, manure and bio-fertilizers add essential nutrients to the soil and improved the growth of knol-khol.

Table 1: Bio-fertilizers and their role in growth parameters of knol-khol

| Treatments | Number of leaves per plant | | Biological yield per plant | Knob diameter (cm) | Volume of knob (cc) | Yield of knob (q/ha) |
|---------------------|----------------------------|------------|----------------------------|--------------------|---------------------|----------------------|
| | 45 DAT | At Harvest | | | | |
| Control | 16.93 | 21.35 | 164.69 | 5.02 | 84.33 | 126.84 |
| <i>Azotobacter</i> | 19.20 | 23.93 | 186.64 | 5.93 | 103.00 | 150.32 |
| <i>Azospirillum</i> | 19.78 | 25.20 | 196.34 | 6.24 | 107.88 | 158.04 |
| PSB | 20.30 | 25.82 | 199 | 6.42 | 111.54 | 162.91 |
| S.Em+ | 0.45 | 0.57 | 4.41 | 0.14 | 2.40 | 3.52 |
| CD (P = 0.05) | 1.31 | 1.63 | 12.75 | 0.40 | 6.93 | 10.15 |

Source: @ Choudary *et al.* 2017Source: @ Choudary *et al.* 2017**Fig 1:** Bio-fertilizers and their role in growth parameters of knol-khol

3. Effect of nutrient management on yield characteristics

Nutrients play an essential role in the yield improvement of plants. Plants generally depend on nutrients available in the soil. Also, fertilizers are used to supply these essential nutrients for plant yield improvement. The effects of planting geometry and nutrient concentrations on the production of knol-khol (*Brassica oleraceae var. gongyloides* L.) were assessed by Muhammed *et al.* in 2023^[14]. The treatment consisted of three nutrient levels (100, 125, and 150% RDF) and three planting geometries (30 × 15 cm, 30 × 20 cm, and 30 × 25 cm). The results showed that crops fertilized with 150% RDF had considerably higher knob yields (29.22 t ha⁻¹) than crops fertilized with 125% RDF. The benefit of fertilizer on vegetative development, which promotes photosynthetic efficiency and photosynthate translocation from source (leaves) to sink (knob), maybe the cause of the increase in yield with each subsequent increase in nitrogen level. This is because there is more food available and a larger knob as a result of fertilizer use, which increases photosynthate translocation from source (leaves) to sink (knob). Sharma *et al.*, (2022)^[20] studied the effect of integrated nutrient management on cauliflower yield, it was discovered that treatment T₈ had the highest yield, with curd length (9.03 cm), curd diameter (13.19 cm), and marketable curd weight

(962.83 g) when applied at the time of field preparation as basal dose and 50% RDF of NPK and jeevamrit at 5% fortnight application. When different chemical fertilizers and organic manures are applied together, the yield of the knol-khol crop is greatly improved. Choudhary *et al.*, (2017)^[4] examined the influence of bio-fertilizers, such as *Azospirillum*, *Azotobacter*, and PSB (Phosphorus solubilizing bacteria), as well as various NPK fertility levels on the production of Knol-khol. The study included 16 distinct treatment combinations, including four fertility levels (control, 50, 75, and 100% of NPK dosage), and four different bio-fertilizer inoculations (Control, *Azotobacter*, *Azospirillum*, and *PSB*). When compared to other bio-fertilizers, the inoculation of *PSB* results in the highest knob diameter, biological yield per plant, volume of the knob and yield of knob per hectare. *PSB*'s positive effects in combination with those of other nutrients increased reproductive structure and yield qualities may have been partitioned at a greater rate, leading to a rise in crop yield. During the same year, Meena *et al* also conducted a field on the effect experiment with 16 treatments, including four fertility levels and four different bio-fertilizer inoculations alone and in combination. A randomized block design with three replications was used to set up the experiment. In comparison to the control

application of fertilizers and bio-fertilizers alone, the treatment combination of 100% of the dose of NPK + PSB resulted in a considerably higher yield per plot and overall yield. Sangeeta *et al.*, (2014) [18] assessed the effect of integrated nutrient management on the yield of cauliflower. A total of 13 treatments were used during experimental work. The treatment comprises of RDF (Recommended dose of fertilizer), FYM (Farmyard manure), and bio-fertilizers including (*Azospirillum* and *Azotobacter*). According to the findings, the (T₄) treatment that included 50% RDF + Vermicompost @ 2 t/ha + FYM @ 5t/ha + *Azospirillum* @ 250g/ha was the most successful in increasing cauliflower production. Chaudhary *et al.*, (2015) studied how integrated nutrition management affected cabbage. A total of 10 treatments were applied, The result of the research showed that the treatment (T₄) 100% RDN + vermicompost @ 10 t ha⁻¹ + *Azotobacter* + PSB enhanced yield and yield-related characteristics amongst all the treatments, such as weight of head, volume of head, diameter, and yield of the cabbage head. Nitrogen is crucial for the process of photosynthesis since it is a component of both protein and chlorophyll. As a result, more food resources were accumulated, which finally enhanced yield characteristics and raised the amount of cabbage produced.

4. Effect of nutrient management on economic characteristics

Integrated nutrient management is one such way that is sustainable in both economic and environmental perspectives. Economic factors play a crucial role by bringing sustainability into the agricultural ecosystem which is the first priority and empowering the farmers needs to be meaningful and result-oriented. The B: C ratio, net return, and gross value are examples of economic qualities. Muhammad *et al.*, (2023) evaluated the utilization of nutrient levels and planting geometry on the economics of the knol-khol crop. The experiment comprised 9 treatment combinations with three nutrient levels with respect to RDF and three planting geometries (30 × 15 cm, 30 × 20 cm, and 30 × 25 cm). Among the different nutrient levels, the application of 125% RDF was found to obtain maximum net returns (Rs. 8, 24,925/ha) and a B: C ratio (3.40). The utilization of nutrients increases the economics of the knol-khol crop. To assess the economic study, Mohanta *et al.*, (2018) looked into the effect of integrated nutrition management in broccoli. The treatments were Control (T₀), 100% NPK (T₁), 20 t FYM (T₂), 50% NPK + FYM 10 t (T₃), Neem cake @ 5q per ha (T₄), 50% NPK fertilizer + Neem cake @ 2.5q per ha (T₅), Vermicompost @ 5t/ha (T₆), 50% NPK fertilizer + Vermicompost @ 2.5t per ha (T₇), Poultry manure @ 5t per ha (T₈), 50% N P K fertilizer+ Poultry manure 2.5t per ha (T₉). The treatment (T₇) had maximum gross returns (Rs.700680.00 per ha), net returns (Rs. 525510.00 per ha), and a B: C ratio (4.0). Singh *et al.* (2009) [22] examined a field experiment done in the winter (Rabi) seasons of 2005–2006 and 2006–2007 to ascertain the effect of different integrated nutrition management on the profitability of the cauliflower crop. There are a total of 14 treatments: T₁ (100% RDF (120:80:40 kg per ha), T₂ (100% RDF + FYM + *Azotobacter* + *Azospirillum*), T₃ (100% RDF + *Azotobacter* + *Azospirillum*), T₄ (100% RDF + FYM + *Azotobacter*), T₅ & T₆ (75 and 100% RDF+ FYM + *Azospirillum* & *Azotobacter*), T₇ (75% RDF + *Azotobacter* + *Azospirillum*), T₈ and T₉ (75% RDF+ FYM +

Azotobacter and *Azospirillum*), T₁₀ (50% RDF+ FYM + *Azotobacter* + *Azospirillum*), T₁₁ (50% RDF + FYM + *Azotobacter*), T₁₂ (50% RDF + FYM + *Azospirillum*), T₁₃ (50% RDF + *Azotobacter* + *Azospirillum*), T₁₄ (Control). The maximum B: C ratio was increased to (5.6) by the treatment (T₇), (75% RDF + *Azotobacter* + *Azospirillum*).

5. Conclusion

From the investigation, it had been procured that different integrated nutrient management techniques result in the better growth characteristics such as yield and yield-contributing traits, such as increased knob diameter and yield/ha, the height of the plant, plant spreading, diameter of the stem, and fewer days to knob initiation etc. Integrated nutrient management is essential for plant growth and increased output. Better plant nutrition delivery, increased agricultural output, and improved soil health are all benefits of using environmentally friendly biofertilizers and organic manure. So, integrated nutrient management improves the overall growth of plants with higher yields and beneficial economics. So, it will be advantageous for the farmers to use integrated nutrient management in knol-khol crops rather than the conventional ways.

6. Authors' contributions

The idea of the manuscript and the main manuscript were written by Charnjit Singh while Dr. Themmeichon Chamroy's guide and Lakhwinder Singh helped in the final editing.

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8. Conflict of Interest

The authors declared that they have no conflict of interest.

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