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RESEARCH PAPER

Effect of Nutrient Combinations on Growth, Yield Attributes and Yield of Mustard (*Brassica juncea* L.): A Comprehensive Review

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ABSTRACT

The rapeseed mustard crop growing areas are also experiencing this circumstance, which is causing fertility to fall and, as a result, poor productivity. In order to provide nutrients in adequate quantities to mustard crops, it is necessary to optimize the nutrient dose based on crop and soil requirements. Macro and micronutrients are both influenced by varying levels of nitrogen, phosphorus, and potassium, as well as sulphur, zinc, and boron. The usage of high analysis NPK fertilizers and limited nutrient cycling has resulted in increased sulphur and zinc shortage in recent years. The integrative effect of organic, inorganic, and bio-fertilizers is critical for sustained crop production. Biofertilizers and organic manures are important in maintaining soil health. Nitrogen, phosphorous and potassium as major nutrients and Sulphur, boron among the secondary nutrients play an important role in influencing the yield and quality of mustard. Moreover, balanced fertilization is an important aspect of crop production technology.

HIGHLIGHTS

- The effect of nutrient combinations on mustard growth, yield attributes, and yield would provide valuable insights for researchers, agronomists, and farmers seeking to enhance the productivity and sustainability of mustard cultivation.
- Identification of the optimal ratios of essential nutrients (nitrogen, phosphorus, potassium, sulfur, micronutrients, etc.) required for maximizing the growth, yield, and quality of mustard plants.

Keywords: mustard, nitrogen, phosphorus, potassium and sulphur

The genus *Brassica* and family Crucifereae (Syn. *Brassicacae*) include mustard. As a cool-season crop, mustard needs temperatures between 6 and 26 °C. Mustard has an effective photosynthetic response at temperatures between 15 and 20 degrees Celsius because it assimilates carbon through the C_3 pathway. The plant absorbs the most CO_2 when it is this temperature. Mustard is often grown in a rainfed environment and is only moderately tolerant of acidic soil; it needs well-drained soil with a pH close to neutral. It works well under rain-fed cropping systems, which cover about 70% of the land, and has a low water requirement (240-400 mm). It is one among India's most important *rabi* oilseed crops, second only to peanuts in terms of yield and area, and it provides around 50 percent of the populations daily fat needs in the state of Uttar Pradesh, Punjab, Rajasthan, Madhya Pradesh, Bihar, Orissa, West Bengal and Assam (Anonymous, 2021).

The oil content of seeds varies depending on the shape, from 30- 49%. The resulting oil cannot simply

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be substituted by any other edible oil because it is the primary cooking medium in northern India. Mustard oil is widely used to cook pickles and vegetables as a side dish and to flavors curries. In addition, it is used to create cosmetics and hair oils. The oilcake is used to make both manure and animal feed; green feed for cattle is found form green stems and leaves (Anonymous, 2021).

According to the USDA (2013), India is responsible for 11.27% of the world's mustard production and 19.29% of its total area. Over the preceding eight years, there has been a huge increase in productivity, going from 1840 kg/ha in 2010–11 to 2000 kg/ha in 2019–20. India produces large amounts of the crops rapeseed and mustard. With an average yield of 2200 kg/hectare, India's total rapeseed and mustard production is projected to be 11.46 mt in 2021. About 25% of the nation's total oilseed production comes from it (Meena K. and M. Yadav 2018).

Rapeseed and mustard account for the majority of the oilseed crops grown in Rajasthan, taking up 3.6 million hectares and producing 4.4 million tonnes. Both in terms of area and production, Rajasthan comes first in rapeseed and mustard. Despite being a significant oilseed crop, its productivity in the state (1316 kg ha^{-1}) is well below the achievable yield potential of 2200 to 2400 kg/ha.

As a crop that responds to nutrients, mustard uses nitrogen fertilizer to boost biomass production. However, nitrogen experiences multiple losses, therefore a sufficient supply is needed to make up for N losses caused by crop removal or leaching (Tabachow *et al*. 2001). In order to feed the world's ever-growing population, agricultural nitrogen use has expanded globally over the last 10 years. As a result, nitrogen is a critical nutrient for plants. Due to its role in boosting crop yield, phosphorus is another crucial macronutrient for plants.

According to MCGRATH and Zhao (1996), potassium is crucial for the activation of enzymes as well as resistance to the cold, illness, water stress, and other harmful situations. After N, P, and K, sulphur is regarded as the most important nutrient for plants. Sulphur is necessary for cell formation and boosts a plant's ability to withstand low temperatures and drought. According to MCGRATH and Zhao (1996), oilseed crops have a high requirement for sulphur, requiring about 16 kg to yield 1 tonn of seeds with 9% dry matter.

After zinc, boron ranks as the second-most important micronutrient in mustard (Ahmed *et al*. 2015). It is crucial for cell differentiation, elongation, and division in the meristematic area (Shireen *et al*. 2018). Additionally, it aids in the regulation of numerous physiological and metabolic processes in plants, including the production of nucleic acids, cell walls, glucose, root elongation, and the transportation of carbohydrates (Yadav *et al*. 2016). It improves flower production, pollen viability, seed and fruit development, and flowering time in crop plants (Havlin *et al*. 2013). It is crucial for the reproductive growth of plants. To increase the yield of mustard while also improving the quality of the produce, nutrients must be applied in a balanced and sufficient manner.

Growth and Yield Attributes

Kumar *et al*. (2011) found that sulphur application up to 40 kg ha^{-1} in the mustard crop increased leaf area index and dry matter production. The mustard variety Varuna was the subject of an experiment, and the results showed that P uptake greatly rose with the application of S at a rate of 40 kg S ha^{-1} then significantly dropped, whereas protein absorption significantly increased with the addition of S and K. In an experiment on sulphur nutrition in rice and mustard grown in succession applied four levels of S (0, 15, 30 and 45 kg ha^{-1}) to the rice as the main plot and three levels (0, 20, and 40 kg S ha^{-1}) to the mustard crop.

Singh *et al.* (2010) conducted an experiment at BHU Varanasi with four fertility levels, namely 75%, 100%, 125%, and 150% where RDF was 80-40-30 NPK kg ha^{-1} and it was discovered that growth and yield attributing characters such as number of primary and secondary branches, plant height, number of Siliqua per plant, and number of seeds $siliqua^{-1}$ increased with increasing fertility levels. (Dalal *et al.* 2011) investigated the effects of six various levels of N, P, and K @ on plant height, branch number, and seed output. They found that applying 50:40:25 kg NPK ha^{-1} resulted in the highest seed production, while applying 60:50:30 and 70:50:35 kg NPK ha^{-1} resulted in a lower yield. Furthermore, there were no benefits in plant performance at larger doses.

Potdar D.S. (2019) found that providing 60 kg ha^{-1} of phosphorus significantly increased mustard output contributing features such as number of Siliqua per plant, number of seeds siliqua^{-1}, and seed yield in available phosphorus on clay loam sand soil tested low in Udaipur, Rajasthan. Shailendra *et al.* (2013) conducted a field study at Naggar farm of IARI, Regional Station Katrian, (Kullu Valley) H.P. during 2005-06 and 2006-07 to find out the optimum and economical doses of phosphorous for better growth and yield of cauliflower. The leaf size index, frame size, curd size index, gross weight and net weight increased on application of phosphorous. The maximum curd yield was recorded with 50% P (R.P.)

Kumar (2019) discovered that applying N up to 100 kg ha^{-1} boosted plant height, Leaf area index, chlorophyll content, and dry matter accumulation up to 100 kg N ha^{-1} and that plant height continued up to 150 kg N ha^{-1} at PAU Ludhiana. The number of siliqua per plant, number of plants, number of seeds siliqua^{-1}, and weight of 1000 seeds all rose significantly with nitrogen treatment of 200 kg ha^{-1} when compared to the control and 50,100,150 kg of nitrogen ha^{-1}.

An experiment conducted in Gwalior M.P. revealed that 125% RDF (100N, 22P, 20.7K, 6.25 Zn kg ha^{-1}) produced significantly greater values of growth contributing features in *Brassica juncea* than lower doses (Trivedi *et al.* 2013). An experiment with six levels of Zinc (0, 2, 4, 6, 8, 10 kg ha^{-1}) was undertaken, and it was revealed that plant height was greatest in the treatment with 10 kg ha^{-1} zinc, as well as the greatest number of primary and secondary branches, 1000 seed weight, and seed index (Sahito *et al.* 2014).

An experiment conducted in Kota, Rajasthan, with NPK and S (80-40-0-60) doses containing (75%, 100%, 125%, and 150% RDF) and four varieties of Indian mustard revealed the most primary and secondary branches per plant, as well as 1,000 seeds and an increased number of siliqua per plant with 100% RDF (Meena *et al.* 2013). It was discovered in an experiment carried out in Jobner, Rajasthan, that NPK alone or in combination with sulphur doses of 60 kg ha^{-1} to *Brassica oleracea* var. botrytis L. increased plant height, number of leaves per plant, leaf area, and chlorophyll content as compared to NPK 75% RDF with 20 kg S ha^{-1} and over control (Gocher *et al.* 2015).

According to an experiment carried out in Jorhat, Assam, the application of NPK (90-60-60) kg ha^{-1} offered the most growth-attributing features and was comparable to the application of (75-50-50) kg ha^{-1} NPK (Sharma *et al.* 2017). In an experiment done in Faizabad, Uttar Pradesh, it was discovered that applying nitrogen up to 160 kg ha^{-1} resulted in maximum plant height, dry matter accumulation, leaf area index, and Stover yield, and was equivalent to applying nitrogen at 120 kg ha^{-1} (Raghuvanshi *et al.* 2018; Mahbeer Meena *et al.* 2018). Suri and Choudhary (2013), reported positive interactive effect of phosphorus and phosphatic biofertilizers on growth of mustard.

Effect on Yield

(Patidar *et al.* 2000) in Jodhpur (Rajasthan) found that in sandy clay loam soil conditions, the cultivars Pusa bold and T-59 produced 30.35 and 24.59% more seeds than the native variety, respectively. Numbers of siliqua per plant, length of siliqua, number of seed siliqua^{-1}, and test weight are the main variables affecting mustard seed yield since these parameters have a strong positive relationship with seed output.

According to the finding of Bisht *et al.* (2018), brassica genotype oil output considerably increased with increasing nitrogen doses, up to 80 kg ha^{-1}. Similar to this, it was reported from Rajasthan that applying nitrogen up to 120 kg N ha^{-1} considerably enhanced biological yield and Stover yield.

(Adeniyan *et al.* 2011) investigated the influence of different organic manures combined with NPK fertiliser on the chemical characteristics of acid soil. When compared to unfertilized soil, the application of 5 tonnes ha^{-1} of each of the evaluated organic manures and 100 kg ha^{-1} NPK 15-15-15 fertilizer enhanced the chemical characteristics of both acid and nutrient deprived soils. The application of several forms of organic manures lowered the acidity levels of both soils. In nutrient impoverished soil, the application of NPK fertilizer yielded the maximum dry matter yield of 5.58 g per plant. Kumar *et al.* (2011) found from Varanasi that nitrogen application up to 80 kg ha^{-1} resulted in a considerable improvement in seed yield, Stover yield, and oil content, which may be related to improved crop growth and superior yield features of Indian mustard.

Yadav *et al.* (2014) found a significant improvement in stead and seed yield with the application of 60 kg P_2O_5 ha^{-1} and applying 60 kg S ha^{-1} increased oil content in yellow mustard and mustard by 12% and 16%, respectively. Similarly, raising sulphur levels increased mustard yield by up to 40 kg S ha^{-1}, which remained similar to applying 60 kilogramme S ha^{-1} (Parihar *et al.* 2014). When sulphur doses were raised up to 30 kg ha^{-1} in the Jammu and Kashmir tests, seed and stave production increased dramatically, 21.4% higher than the control (Kaur *et al.* 2014). With the treatment of 50 kg P_2O_5 ha^{-1} in Anand, Gujarat, seed and stover yields were observed to be higher than with lower doses and no phosphorus application (Govahi, M. and Saffari, M. 2006). As compared to the applications of 20 kg P_2O_5 ha^{-1} and 40 kg P_2O_5 ha^{-1}.

Seed yield and Stover yield of mustard rose with treatment of 60 kg P_2O_5 and 5 kilogramme Zn ha^{-1} in Jaipur, Rajasthan. Similarly, in another trial, seed yield was shown to be highest in the 125% RDF treatment (100 N, 22 P, 20.7 K, 6.25 kg Zn ha-1) when compared to 50, 75, and 100% RDF treatments, with increases in seed yield of 19.9%, 11.8%, and 3.9%, respectively (Trivedi *et al*. 2013). In another experiment, it was discovered that applying zinc at a rate of 10 kg ha^{-1} resulted in the highest seed yield when compared to lower zinc dosages (Sahito *et al*. 2014). A study done at Gujarat-Ahmedabad by Dhruw *et al.* (2017) found that the application of 120: 60: 40: 40 (N: P: K: S) gave the highest straw and seed yield. A study done at Bulandshahr, U.P., with NPK along with sulphur and with or without FYM, found that the application of NPK along with 40 kg sulphur ha-1 gave significantly higher straw yield when compared to other treatments.

With the exception of the number of siliqua per plant, which grew significantly up to 120 kg ha^{-1} of N, application of nitrogen improved all yield-contributing features, including length of Siliqua, number of seed Siliqua^{-1}, and 1000-seed weight, up to 160 kg ha^{-1} of N. All the yield-contributing characteristics significantly outperformed the control (0 kg ha^{-1} N) after the application of 40 kg ha^{-1} of nitrogen. This could be as a result of nitrogen administration promoting root growth, which improved nutrient uptake from the soil and improved source capacity development (Raghuvanshi *et al*. 2018).

As a result of increased nitrogen, cells divide and develop more quickly, resulting in a quicker growth rate (Kumar *et al*. 2019). With increasing boron doses, mustard seeds significantly improved their boron uptake, reaching its peak at 2 kg B ha^{-1}. Higher seed production and higher seed B content with higher B levels were associated with an increase in boron uptake (Yanthan *et al*. 2021). Sulphur operating in a beneficial nutrient environment of the rhizosphere as well as plant system may account for the increased performance of mustard with higher sulphur rates. Sulphur also stimulates the development of floral primordial tissue, accelerating the differentiation of vegetative tissue into reproductive tissue, improving yield qualities, and increasing seed production. Shivran *et al*. (2018) also observed similar findings.

Sahoo *et al*. (2017) found that the increase in growth, productivity and oil content of *Brassica campestris* var. toria in the red soil of Odisha were significantly high for each successive addition of sulphur up to 45 kg ha^{-1} irrespective of its sources viz; SSP, Gypsum and Elemental sulphur. However, the application of sulphur @ 60 kg ha^{-1} as SSP had significantly resulted in the highest oil content in the seed.

CONCLUSION

It is concluded that sulphur operating in a favourable nutritional environment of the rhizosphere as well as plant system could be attributed to the increased performance of mustard with higher sulphur rates. Additionally, sulphur, NPK, and micronutrients hasten the differentiation of vegetative tissue into reproductive tissue while promoting the development of floral primordials, which improves yield qualities and increases seed output.

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