Role of Soil and Water Management in Mustard Crop Yield

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Abstract

Soil and water management play crucial roles in determining the yield of mustard crop. These resources are the major inputs, and mustard, like any other crop, has specific requirements for optimal growth and productivity. Efforts should be made to generate information on the effects of soil fertility, and amounts of irrigation water on the growth and yield of this crop.

Soil management

Soil management plays important role in the yield of mustard crops, as it directly influences various factors like soil nutrient availability, bulk density, aggregation, microbial activity, essential for plant growth and development. Mustard requires essential nutrients like nitrogen, phosphorus, potassium, sulphur and micronutrients for optimal growth. Proper soil management involves maintaining adequate soil fertility through practices such as fertilization, organic matter incorporation, and soil amendment with compost or manure. Balanced fertilization ensures that the mustard plants have access to the nutrients they need for robust growth and maximum yield. Integrated nutrient management (INM) is one of the best management practice that provides balanced nutrition and improves the soil properties for enhancing the use efficiency of various nutrients from the soil.

Integrated nutrient management significantly improved the uptake use efficiency of nitrogen and sulphur in both seed and stover of crop by incorporation of 25% nitrogen through FYM+ 75% by chemical fertilizer + 100% sulphur (Bhat et al., 2005). At Bharatpur and Jobner, 50% RDF + 50% N through FYM and vermi-compost recorded 17.8 and 8.6 % increase in seed yield. The incorporation of organic manures and crop residues increased available phosphorus over initial value. Organic carbon status improved in organic source-incorporated plots. Recommended dose of fertilizer (RDF) along with application of 10t FYM/ha improved soil physical condition by improving aggregation, increased saturated hydraulic conductivity and reducing bulk density and penetration resistance of the surface soil (Hati et al., 2006). When the availability of one nutrient influences the distribution, absorption, or function of another, this is known as an interaction among nutrients. The secret to improving crop production, produce quality, and nutrient use efficiency is to identify and take advantage of beneficial nutrient interactions. The interaction of N with sulphur, a critical nutrient for all oilseed crops is a researchable issue. The use of high analysis straight fertilizers to supply N and P, the high cropping intensity and the inherent nature of the soil have led to wide spread S deficiency and a negative soil budget. While N directly affects the photosynthesis efficiency of the plants affects photosynthesis efficiency indirectly by improving the Nitrogen Use Efficiency (NUE) of the plant.

One area in which oilseed crops have not received enough attention is the function and significance of micronutrients in raising productivity and production. The relevance of micronutrients was overlooked as a result of the ongoing marketing of straight fertilisers and the emphasis placed on macronutrients like N, P, and K. Nowadays, micronutrient deficiencies are common throughout the nation, especially in many of the regions used to raise oilseeds. In general, mustard is highly susceptible to deficiencies in some micronutrients, particularly boron and zinc. The harvest index (HI) was significantly affected by Zn application, although seed yield showed diminishing return with additional $ZnSO_4$ doses. The concentration of Zn at flowering, pod formation stage, concentration and uptake of Zn in straw and grain at maturity and uptake of Zn in grain and straw at maturity of Indian mustard increased significantly with an increase in Zn levels. Boron has a crucial role in cell wall synthesis, root elongation, glucose metabolism, nucleic acid synthesis, lignification and tissue differentiation (Karthikeyan et al 2008). Organic matter addition enhanced the overall physico-chemical properties of soil and governs the availability of essential plant nutrients (macro and micro) and their steady supply throughout the crop growth period for optimum development.

Water management

Irrigation

Water is a scarce and invaluable natural resource, demanding careful utilization to optimize productivity per unit volume. Although, water requirement of mustard is not so high, but requires at stages which are sensitive to moisture stress conditions. Sharma and Kumar, 1989; Singh et al., 1991 stated that moisture stress in all growth stages significantly reduced the leaf area index (LAI), number of branches per plant, number of pods per plant, and seed yield and harvest index of different varieties of mustard. Therefore, enhancing crop yield per unit volume of water can be achieved by strategically irrigating crops during critical growth stages. Maintenance of optimum moisture conditions in the root zone depth is crucial for proper growth as well as development of plants (Bodner et al., 2015). It can be achieved by adopting proper irrigation scheduling and good conservation practices. Post-sowing irrigation and fertiliser delivery (100% NPK and 100% NPK plus farmyard manure) together had a major impact on LAI, most likely by enhancing the leaves' photosynthetic production efficiency and strengthening the fundamental structural framework (Mohammad et. al., 1997). Additionally, the crop's productivity, uptake of nutrients, and general quality can all be enhanced by scheduling irrigation appropriately (Meena, 2011). The crop yielded more dry matter when treated with 100% NPK, organic manure, and one or two post-sowing irrigations. This might be due to the maintenance of higher levels of auxin in the plant tissues and by synthesizing more food in the leaves with better water relations in plants under I120 and I180 treatments (Majid and Simpson, 1997). Furthermore, the availability of vital plant nutrients from either organic or inorganic sources enhanced overall plant vigour, with application of combined 100% NPK or 100% NPK + organic manure. Better photosynthetic absorption and crop development may have come from this (Mohammad et al., 1997; Ozer, 2003). In addition to the pre-sowing irrigation, at least one post-sowing irrigation is necessary to maintain improved plant water relations, a larger leaf area, and the formation of dry matter. Effective water management reduces the risk of waterlogging, which can cause root diseases and negatively impact yield. Several workers have also suggested scheduling of irrigation at 0.6 IW: CPE ratio for better seed yield.

Better moisture availability with irrigation application, aids in an increase in the nutrient contents in plants, can be linked to higher nutrient uptake through increased irrigation frequency (Silber, 2005). Water management enhanced the uptake of less mobile nutrients like P and K. As water is absorbed by the roots, the soluble portion of the nutrients in the soil solution flows to them. K is only slightly available in the soil solution and is heavily absorbed by soils. K moves to the root by diffusion, which was further facilitated by the presence of sufficient moisture in the root zone. Verma et al. (2014) reported significantly higher N uptake by plants with increase in irrigation frequency. Xu et al. (2004) also found that P uptake by plants was significantly increased in irrigated conditions over no irrigation. This may be explained by saying that providing appropriate irrigation during the crop's key stages guaranteed an adequate supply of moisture, which aided in the correct utilisation of nutrients and the formation and partitioning of photosynthates to the sink. Moreover, comparable results were demonstrated by Gupta et al. (2017)

Although, the variations in the oil content with varied irrigation levels were not wide, but the oil content was increased a bit with increasing the irrigation frequency. Shekhawat et al. (2012) also reported significantly higher oil content in the Indian mustard seed with the increase in irrigation frequency. Better meristematic activity due to enhanced turgidity and cell division resulted in higher P and S uptake by the plant. This might be the reason behind the augmentation in oil content under higher irrigation frequency.

Water Quality

The quality of water can have a significant impact on the yield of mustard crops. Water with high salinity or alkalinity can negatively impact mustard crops. High levels of salts in water can negatively affect mustard plants. This will lead to water stress in plants by reducing water uptake, which in turn affects nutrient absorption. Moreover, excessive salt concentration in the soil can disrupt the osmotic balance of plant cells, leading to reduced water and nutrient uptake. This can result in stunted growth and lower yields. Over the past few decades, the threat of irrigation-induced soil and groundwater salinization has increased and is becoming a major concern because of its implication for food security and environmental conservation (Kaledhonkar and Keshari, 2006).

Conclusion

In conclusion, effective soil and water management practices play a crucial role in optimizing the availability of both macro and micro nutrients in soil. By implementing strategies such as organic amendments, appropriate fertilization,

irrigation with good quality at appropriate times, health of soil and plants can be significantly enhanced. These practices not only improve nutrient availability but also promotes sustainable productivity and environmental stewardship. Thus, adopting comprehensive soil and water management techniques are essential for maintaining soil fertility and ensuring long term sustainability.

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