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Review an investigation of the effects of macro and micro nutrients on the production of high quality seed

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ABSTRACT: Seed is the basic input in agriculture. Higher agricultural productivity is primarily depend on quality seed. Quality seed is always maintained genetic purity, physical purity, seed health status and physiological quality. In this view, we have challenged for producing maximum quantity of quality seed with proper application of macro and micro nutrients. Requirements of macro and microelements are crucial for optimal development, growth, and ultimately the production of excellent seed in every crop. Crops must meet the same macro- and micro-nutrient requirements if they are to be produced as seed crops. In this regard, a review research was conducted to examine the effects of macro and micro elements on seed quality. According to the results of numerous studies, the macronutrients like nitrogen, phosphorus, potassium, sulphur, calcium, magnesium and micronutrients like boron, chloride, iron, manganese, molybdenum, zinc have a significant impact on seed quality, which in turn affects seed yield.

Keywords: Macronutrients: micronutrients; seed germination, seed vigour.

I. INTRODUCTION

Seeds available in the market are often very poor in quality in respect of germination, varietal purity, seed viability etc. The scarcity of quality seeds of crops in India during growing season is important issues till now due to lower production of quality seeds in a limited area. The possible way to produce the maximum quantity of quality seed, thorough manipulating of existing method of cultivation such as planting geometry, fertilization, irrigation and other cultural management practices are essential. The quality of seeds plays a critical role in the economic production of all agricultural crops. In this connection, numerous articles detailing the impact of changes in seed quality on seedling emergence and crop growth in a variety of species have been published (Powell *et al.*, 1984; Tekrony and Egli 1991). Patra (2023) suggested for obtaining quality seed, different strategies like proper sanitation, soil condition, tillage operation, isolation requirement, fertilization, rouging, and others cultural management practices are to be strictly followed during seed multiplication programme. He also suggested to follow the seed multiplication procedures for maintaining quality parameters of different traditional varieties of paddy (Patra, 2023).

Poor crop stand can promote weed populations causing competition for water, light and limiting nutrients (Kropff and van Laar 1993). It has been shown that the absence of some essential elements, such as Mg and Zn in most of the chemical fertilizers may be partly responsible for the low yield of maize in the semi-arid zones of northern Ghana (Abunyewa and Mercer-Quarshie 2004). Micronutrient deficiency is severing problem in soil and plants worldwide (Imtiaz *et al.*, 2010) while appropriate quality of micronutrients is necessary for better growth, better flowering, higher fruit set, higher yield, quality and post-harvest life of horticultural products (Raja, 2009; Ram and Bose 2000; Shekhar *et al.*, 2010; Sourour, 2000), while its deficiency leads in lowering the productivity (Karuna *et al.*, 2019 and Zagade *et al.*, 2017). A staple fertilization program with macronutrients and micronutrients in plant nutrition is very essential in the high production of crop yield with good quality seed, so there is a need balance use of fertilizers and agronomic procedures are needed to increase yield of this crop. The function of macronutrients and micronutrients is vital in crop nutrition for improved yield and seed quality (Saeed *et al.*, 2012). The soil contains the majority of the nutrients that plants need to build their tissues, produce their nucleic acids, enzymes, and maintain their osmotic equilibrium. For healthy and productive crops, plants must maintain a balance of 15 components, 12 of which are provided by the soil and are controlled by farmers (e.g., macro nutrients like nitrogen, phosphorus, potassium, sulfur, magnesium, calcium and micro nutrients like iron, boron, manganese, zinc, molybdenum, copper). Mineral nutrient stores in the seed must be sufficient to maintain seedling growth until root uptake starts to feed soil nutrients. Numerous studies have shown the significance of this, particularly for crops grown on soils with low nitrogen supply (Asher, 1987). One of the various methods used in seed farming to address seed nutrition at its most crucial point, i.e. seed filling, is supplemental foliar treatment (Shibles *et al*., 1975). It is generally known that major, minor, and macronutrients can be applied to seed crops through foliar spray (De, 1967; Kramer, 1969), and that micronutrients in particular can improve the qualities of seeds more than soil application or dusting (Sabir, 1989). Crop cultivation depends on a healthy soil environment. How well seeds establish, grow, and produce quality seeds is greatly influenced by the soil fertility, pH of the soil, microbial community, structural and textural quality of the soil, and other elements of the soil. There is a lack of information on this subject, and only a few number of studies, namely the impact of macro- and micronutrients on seed performance, have been thoroughly studied by academics. These are listed below:

Effect of Nitrogen: Application of nitrogen (N) encourages soil to absorb nutrients (Halder *et al.*, 1998). When N application is increased, the oil quality deteriorates as a result of an increase in erucic acid and a drop in the concentrations of linoleic and oleic acids (Gupta *et al*., 2002). Okra (Abelmoschus esculentus) seeds from parent plants grown in fields with high nitrogen levels exhibited considerably better pre- and post-storage germination rates than seeds from plants that did not receive additional nitrogen fertilizer (Das 1990). According to Austin (1972), A significant development of germination inhibitors in the fruits of high-nitrogen plants may be the cause of the reduced geminability of high-nitrogen fruit observed in previous investigations (Sneddon, 1963; Scott, 1969).

Effect of Phosphorus: Phosphorus is essential for the synthesis of ADP and ATP, phospholipids, and nucleic acids as well as the activity of enzymes (Thompson and Torch 1978). Therefore, it is essential for the development of roots, flowers, fruits, and seeds (Smil, 2000). Talooth *et al*. (1989) studied how different sources of Phosphorus affected soybean growth, and found that when applied at a rate of up to 150 kg per hectare, all Phosphorus fertilizers increased soybean seed yield. Raboy and Dickinson (1987) observed that increasing the total Phosphorus nutrition from the third week after flowering linearly increased its transfer to growing seeds till physiological maturity. When a soybean reaches physiological maturity, the seed quality is at its maximum (Egli and Tekrony 1995) and if seed is not harvested at this stage, the seed quality declines due to daily fluctuation in the seed moisture and field environment.

Effect of potassium: Studies on wheat have shown that a deficiency in potassium supply to the planting material reduces the development period of the developing grain, which is accompanied with an earlier presence of the ABA maximum and an enhancement in its exact amount. (Haeder & Beringer 1981a). Potassium helps to increase the absorption of nitrogen (Singh and Verma 2001). It has been implicated with the maintenance of good seed quality as significantly lower levels of diseased seed produced when levels of potassium in the soil increased (Crittenden and Svec 1974).

Effect of calcium: Burton *et al*. (2000) investigated the effects of Ca on soybean seed quality and production and discovered that lower Ca levels affected seed filling, seed production, seed germination, and the occurrence of aberrant seedlings. Similar negative consequences of low Ca levels in plants leading to poor seed quality issues such decreased germination and vigor have been documented (Keiser and Mullen 1993). Loss of membrane integrity is the main consequence of calcium shortage in plant cells (Hetch-Buchholz, 1979) and a faulty and stunted root system is a sign of Ca-deficient plants (Nelson and Niedziela 1998); Therefore, it is crucial to externally provide nutrients for crops with shallow roots, like onions, that are unable to collect nutrients from the deep soil profile. Sharma *et al*. (2010) found that mineral nutrients should be supplied during an active growth stage in order to achieve rapid plant development, a healthy plant stand, a bigger seed harvest, and increased seed quality.

Effect of Magnesium: It stimulates the most enzymes in comparison to other mineral nutrients (Epstein and Bloom 2005). Due to its role as the activator of vital photosynthetic enzymes and the core atom in the chlorophyll molecule, magnesium is a vital component of photosynthesis (Wedding and Black 1988; Portis, 1992; Marschner, 2012). Seed reserves are a major factor in germination and seedling emergence such as starch (Douglass *et al*. 1993; Wang *et al*., 2011), and consequently, for durum wheat, a clear relationship between seed size and seedling vigour was observed (Royo *et al.*, 2006). A quick production and use of ATP is also necessary during germination (Perl 1986; Weitbrecht *et al*., 2011). The content of ATP and the ability of seeds to germinate were found to be highly correlated in a prior study (Siegenthaler and Douet-Orhant 1944). Mg being necessary for ATP's synthesis and operation (Boyer, 1997; Marschner, 2012; Igamberdiev and Kleczkowski 2015), A lack of magnesium in the seed may potentially hinder germination by altering the availability and physiological function of ATP. Mg levels must be enough for sugar transfer in germination of seeds and growth of seedlings. In order to maintain germination, sucrose is transported from the scutellum into the actively growing sink tissues of roots and shoots (Aoki *et al*., 2006; Scofield *et al.*, 2007) and similarly as it is in leaves, the trans-location of sugars into the sink tissues of sprouting seeds is probably dependent on an adequate supply of magnesium. Chlorosis, caused by a magnesium deficit, causes the leaves to turn yellow and deteriorate the chlorophyll content; yet, a sufficient amount of magnesium makes the plant healthy (Hermans *et al*., 2010).

Effect of Boron: Oilseed rape has been categorized as a crop that is extremely susceptible to B shortage, hence B nutrition is crucial to its growth. This seems to be caused in part by strong demand for this micronutrient (Camacho-Cristobal *et al*., 2008; Dell and Huang 1997; Herrera-Rodriguez *et al*., 2010; Stangoulis *et al*., 2000; Zhang *et al*., 2014). The growth of roots and shoots is generally slowed or inhibited by inadequate B supply to oilseed rape because it restricts cell expansion and cell division, affects the formation of vascular bundles, and lowers pollen germination and pollen tube growth.

Consequently, B deficiency results in decreased seed quality (Dell and Huang 1997), seed abortion, damaged embryos, or shrivelled seeds, lower seed germination, and reduced seed vigour in the following generation of oilseed rape seedlings (Zhao *et al*., 2012). While seed priming with B (0.02% solution of H_3BO_3) had no noticeable impact on seed germination in oats (*Avena sativa* L.), it did enhance tillering, panicle length, and grain weight, which led to an 8.42% increase in grain production when compared to untreated seeds (Saric and Saciragic 1969).

Effect of Molybdenum: Oilseed rape, one of the most significant commercial and agricultural crops, is sensitive to Mo deficiency in soil, which affects its growth, yield, and seed quality. Liu *et al.* (2010a) showed that varied amounts of phosphorus (P) had an impact on how much dry matter, chlorophyll concentration, and net photosynthesis ratio (Pn) of seedling leaves changed with the addition of Mo to oilseed rape. Additionally, P fertiliser was clearly the only factor that boosted oilseed rape yield. (Liu *et al*., 2010b). Yang *et al*. (2009) also reported that the addition of zinc (Zn) and boron (B) fertilizers led to an increase in seed production when Mo was present. However, with the application of Mo and B fertilizer, the seed quality, including the oil content and oleic and linolec acid contents, increased greatly, whereas the quantities of stearic acid, sulfuric glucosid, and erucic acid declined (Chen *et al*., 2004). Similar results were also demonstrated under application of Mo and P fertilizers (Liu *et al.* 2012).

Effect of Mn: Storing of mineral nutrient in seed play a significant role in determining vigour and standard seedling development. Acute Mn deficiency can cause dark necrotic patches to form on leaves, which can cause early leaf loss. Some cereal leaves have white and grey patches, which are symptoms of a Mn deficit (Chang, 1999; Stout and Arnon 1939). Low manganese (Mn) content in seed resulted in wheat seedlings with low vigour and low yields (Marcar and Graham 1986; Singh and Bharti 1985). Barley and lupin with low Mn level in seed showed delayed germination and seedling development. (Genc *et al*., 2000; Longenecker *et al*., 1991; Crosbie *et al.,* 1994). Compared to the untreated control, priming *Echinacea purpurea* (L.) seed with a 0.1% MnSO4 solution improved germination by 36% and field emergence by 27% (Babaeva *et al.,* 1999). In comparison to soil application, all of the research done on seed priming with Mn have shown a significant improvement in plant establishment, growth, yield, and grain enrichment (Babaeva *et al.,* 1999; Khalid and Malik 1982; Marcar and Graham 1986).

Effect of copper: Plants lacking in copper are more susceptible to disease, particularly ergot (a fungus causing reduced yield and grain quality; Solberg *et al*., 1999). The emergence of disease-related symptoms can make it difficult to distinguish them from symptoms of a copper deficiency. The most vulnerable wheat varieties to copper deficiency are winter and spring wheat (Solberg *et al*., 1999).

Effect of Sulphur: The responses of different oilseed crops to sulphur application differed significantly (Misra *et al*., 2002). Due to its higher concentrations of sulphate and S-containing secondary metabolites as compared to other species like wheat, oilseed rape (*Brassica napus* L.) is a crop with a high S demand (Oenema and Postma 2003). The pungency of onions is increased by sulphur fertilizer (Paterson, 1979). The growth and yield of oil seed crops are typically negatively affected by sulphur shortage as a result of inadequate nutrient supply (Basumatary *et al*., 2019). According to Rakesh *et al*. (2016), As a component of the amino acids methionine, cystein, and cystine, which are necessary for the synthesis of other molecules like coenzyme-A, thiamine, and glutathione as well as for the production of chlorophyll, sulphur plays a crucial role in the growth and development of crops. As a result, plants require this element for oxidation-reduction processes, the production of chlorophyll, and the synthesis of proteins (Kumar and Trivedi 2011 and Pandey and Ali 2012).

Effect of Fe and Zn: Iron is transported from the seed coat to the embryo by passing through membranes and the apoplast that separates the two tissues (Wolswinkel, 1992). There is a lack of knowledge on the variables that influence how Fe moves into and out of the seed coat (Marentes and Grusak, 1998), and to make transgenic manipulation easier and to enhance seed [Fe] (Grusak, 2002).

Applying Fe and Zn may have improved photosynthates translocation to the sink, boosted vigour, and accumulated more photosynthates (Kanda and Dixit 1995). In calcareous soil and particularly so in high-pH, drought-prone areas, Fe and Zn shortages in rice frequently arise, which can severely inhibit initial growth and vigour and ultimately reduce rice yield (Katyal and Randhawa 1983). Inter-veinal chlorosis of younger leaves is a symptom of iron deficiency in rice plants, whereas apparent symptoms of zinc deficiency in rice include wilting caused by loss of turgidity, retarded plant development, basal chlorosis, bronzing of leaves, and in some cases seedling death (Neue *et al*. 1998). The antifungal properties of zinc and other mineral nutrients, as well as zinc's potential role in the establishment of disease resistance in plants, may be responsible for the decrease in disease incidence and severity under mineral nutrient spray (Graham and Webb 1991). Imran *et al*. (2014) found that nutrient seed priming increases maize seedling development under low root zone temperature during early growth as well as a large increase in seed contents of the relevant nutrients, i.e., Fe (25%), Zn (500%) Borax (0.50%) and $ZnSO_4$ (0.25%) seed soaking enhanced papaya (*Carica papaya* L.) stand establishment and growth in the field (Deb *et al*., 2010). Kaur *et al.* (2009) further found that seeds treated in Zn (ZnSO4) for 12 hours increased *Chlorophytum borivilianum* (L.) germination. Similarly, soaking seeds in solutions of Zn-EDTA and fritted Zn increased yield and Zn uptake, but the efficiency of each source's Zn uptake varied (Kang and Okoro 1976).

II. CONCLUSIONS

Having revised the overall picture on effect of macro and micronutrients on seed performance, it is clearly stated the impact and non impact portion at different stages of crop growth and development. Therefore, farmers and growers who are involved in seed production for harvesting quality seed, should be aware initially about the effect of macro and micro nutrients for applying good management practices.

III. FUTURE SCOPE

Application of macro and micro nutrients in proper way during seed multiplication will be more beneficial for producing maximum quantity of quality seed. In this view maximum farmers can get quality seed for producing more crop yield in his own limited land areas of crop cultivation.

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Conflict of Interest. No conflict of interest

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