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Impact of different levels of iron fertilizer on growth and yield physiology of Kodo millet under rainfed conditions – An overview

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ABSTRACT

Kodo millet *(Paspalum scrobiculatum)* is a minor cereal that is grown to a large extent in the southern states of India. The crop is remarkably drought resistant and is grown primarily rainfed, though in small areas under irrigation. This is the coarsest among the food grains. The grain is easily preserved and proved as a good famine reserve and a poor man's food. Kodo millet crop is more susceptible to iron deficiency in the early stage of growth, and the plant becomes stunted in early seedling stages. If deficiency is prolonged, plants will die. Iron deficiency in kodo millet causes chlorosis, decreased vegetative growth, and marked yield losses. Therefore, Fe fertilizers, either applied to the soil or delivered to the foliage, are used to control Fe deficiency in the field. To improve the current Fe chlorosis condition, practical correction methods to be taken into account are state-of-the-art all related scientific knowledge, integrating physiological, biochemical, and agronomical data. In all cases, Fe fertilization leads to episodes of high Fe concentration in the rhizosphere, roots, or in the plant shoot tissues.

1. INTRODUCTION

Iron insufficiency is abiotic stress that influences a wide assortment of plants all through the globe. This physiological disruption is frequently found in plants developed on calcareous or basic soils. While iron is ample in the world's hull, its accessibility to plants is limited, inferable from the iron (Fe^{3+}) oxides' extremely helpless dissolvability in high-impact conditions [1]. Lack of iron profoundly affects the physiology of plants. The deficiency of new and dry load of the plant has been connected to leaf interveinal chlorosis and rot, which start close to the shoot peak. Since iron is needed for the creation of chlorophyll, a deficiency or deactivation of iron in plants brings about diminished chlorophyll, which brings about diminished photosynthesis [1]. Iron is needed for the appropriate working of numerous metabolic and enzymatic exercises, including electron transport, nitrogen obsession, deoxyribonucleic corrosive creation, and chemical union, and along these lines assumes a critical part in plant digestion [1]. Fe application plays an important role in growth of plant, different cellular functions. and in the process of photosynthesis [2]. Under high deficiency of iron in the plants, application of Fe in the form of chelates is a very good option because Fe can retain in the plant system for a longer period for its better growth. Application of Fe in the form of chelates shows better results as compared to inorganic fertilizers because of higher solubility in water and good translocation in the plants [3].

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2. EFFECT OF DIFFERENT LEVELS OF IRON ON MORPHOLOGICAL AND GROWTH ATTRIBUTES OF KODO MILLET

The growth and yield parameters substantially increased when soil application of zinc sulfate were supplemented with foliar application of ferrous sulfate [4]. The growth and yield components were improved with soil application of recommended package of practices with soil application of zinc and ferrous sulfate at 10 kg/ha [5]. The plants which received FYM enriched with zinc and iron along with recommended nitrogen, phosphorus, and potassium (NPK) recorded higher growth parameters [6].

2.1. Plant Height

Plant height is an essential morphological trait that impacts the development and improvement of agrarian plants. Combination of pearl millet hybrid Kaveri super boss with 0.75% $FeSO_4$ spray has recorded higher plant height [7]. Application of NPK along with $ZnSO_4$ (0.5%) + $FeSO_4$ (1%) + citric acid (0.1%) spray twice at vegetative and flowering stages was recorded higher plant height in finger millet [8]. The impact of micronutrients, particularly iron, on sunflower advancement and found that foliar treatment of 0.5% ferric chloride considerably improved the plant stature of various sunflower cultivars developed in dark earth soil [9]. The foliar treatment of Fe as ferrous ammonium citrate at a concentration of 0.1% at 30, 60, and 75 days after transplantation brought about a considerable expansion in chili plant stature [10].

The foliar spraying of Fe 1% expanded the stature of wheat plants at different advancement stages [11]. A huge expansion in soybean shoot range from 23.12 cm in control plants to 30.50 cm in plants treated with a mix of iron fertilizer (Fe_2SO_4 20 mg/kg and sulfur at 80 mg/kg soil) [12]. Similarly, significant expansion in gasp tallness due to the foliar application of Fe was observed in pot cultured wheat crop [13]. In addition, foliar application in sunflower cultivars with iron (2%) at 15 days prior and after sprouting significantly upgraded plant stature [14]. The foliar treatment of Fe at rates going from 200 to 600 ppm at different advancement stages expanded plant stature in wheat cultivars. In any case, the soil treatment and foliar use of Fe considerably worked on the improvement of wheat cultivars when contrasted with the other micronutrient mixes in soil [15,16].

There was a significant expansion in plant stature after foliar utilization of chelated iron at the tillering stage instead of the heading phase of the harvest, proposing the helpful effect of iron in the beginning phases of the yield [17]. In rice cultivars, foliar treatment of 0.4% micronutrients, including iron chelates during the stem lengthening stage, fundamentally expanded plant tallness, while showering at the tillering stage had a less huge effect [18]. There is a significant expansion in plant stature (12%) in wheat after foliar treatment of Fe-DTPA (Fe 6%) all through the early tillering and booting stages [19]. Aside from these advantages, foliar treatment of 333 g Fe/ha + 167g B/ha brought about a 14.0% increment in plant tallness in wheat cultivars contrasted with control [20].

The examination of the impact of foliar utilization of nano-manures on grain development under a strengthening water system, foliar use of iron nano chelate may quantitatively upgrade plant stature by up to 8% when contrasted with other nano composts [20]. The pot culture explores different avenues regarding peanuts showed that applying iron oxide nanoparticles with a standard size of 20 nm at centralization of 10 mg/kg soil can significantly expand plant stature when contrasted with ethylenediaminetetraacetic acid (EDTA)-Fe [21]. Essentially, Fe_2O_3 nanoparticles generously affected the shoot tallness of plants all through their development in *Catharanthus roseus* (9, 18, 27, 36, 45, 54, 63, and 70 days). In multi-day plants, the best shoot tallness of 9.51 cm was found in 30 M Fe_2O_3 contrasted with the untreated control (5.17 cm) [22].

2.2. Root Length

The valuable effect of iron and sulfur treatment on soybean root length, accomplishing a most extreme length of 12.97 cm when iron at 20 mg/kg soil, was combined with sulfur at 80 mg/kg soil, contrasted with 9.70 cm in charge [19]. Utilizing EDTA-Fe, the root length of the peanut (*Arachis hypogaea*) was significantly upgraded at all Fe_2O_3 fixations (50–1000 mg/kg soil) [21]. As opposed to this outcome, spraying EDTA with iron nano-chelate concerning plants at the beginning phase of yield improvement in *Euphorbia pulcherrima* wild expanded root length more viably than Fe_2O_3 [23].

Contrasting the impacts of nano-iron manure and iron chelate on development qualities, for example, root length of *C. roseus* and new root weight of 70-day-old plants expanded essentially with expanding Fe_2O_3 nano molecule fixations (5 to 30 M) when contrasted with Fe chelate, and that Fe_2O_3 nano molecule grouping of 30 M was more compelling in expanding root length by triple when contrasted with Fe chelate [22].

2.3. Number of Tillers

Applying micronutrients (Zn at 25 kg/ha and Fe at 25 kg/ha) simultaneously while establishing generously expanded turner advancement in Durum wheat and upgrading other morphological attributes [24]. At the point, when micronutrients (Fe + Cu + Zn) were sapped in water and directed as a foliar spray (3 kg chelate/ha) at the most extreme tillering and half blossoming periods of Durum wheat, critical expansion in turner creation (16.6% above control) [25]. Applying 10 mg/kg Fe as dust manure expanded turner creation to 3.99% when contrasted with the control, while splashing with arrangements of 0.2% iron chelate EDTA during the tillering, stem prolongation, and spike improvement stages expanded turner creation by roughly 2.28% when contrasted with the control in grain (*Hordeum vulgare* L.) filled in crop [26]. Applying 20 kg $FeSO_4$/ha as a soil dust change the 50% at the days of planting and 50% at the hour of earthing altogether expanded the quantity of turners (4.4/plant) in turmeric [27]. The foliar treatment of nano-Fe during the tillering and stem stretching stages brought about the best number of turners per plant when contrasted with foliar use of nano-Fe at the stem prolongation stage alone [28].

2.4. Leaf Number

Foliar utilization of ferrous sulfate at a grouping of 0.2% at 30 and 80 days in the wake of planting expanded the number of leaves in strawberry (23.24) when contrasted with ferrous sulfate at a convergence of 0.4% (20.77) and ferrous sulfate at centralization of 0.6% (20.77) [29]. Critical difference was observed in the leaf number when the plants were applied with iron and sulphur [12]. The greatest leaf length of 10.3 in scrounge sorghum is an outcome of a foliar splash treatment of Zn (0.5%) + Fe (0.5%) + Mn (0.5%) during the harvest's initial advancement stage [30].

Varamin and Virifla observed a critical expansion in leaf number because of soil use of nano iron chelates at 4 kg/ha, a 23% increase over control on the growth and yield attributes of two spinach varieties (*Spinacia oleracea* L.) [31,32].

A correlation of the impact of various iron composts on the development attributes of wheat deception uncovered that foliar use of Fe-EDDHA brought about an expansion in leaf creation of 8.10 leaves per plant when compared with foliar use of $FeSO_{4}$ (5.3 leaves per plant) [33]. In turmeric (*Curcuma longa*), soil treatment of 20 kg $FeSO_4$/ha at the half during planting and half after earthing considerably expanded the quantity of leaves/plant (10.6).

The effect of nano chelate compost on numerous quantitative qualities of *E. pulcherrima* wild crop showed that showering EDTA-based iron nano chelate at 1.8 g/L on plants toward the beginning of the trial and again 30 days after the fact raised the leaf number to 49.23 contrasted with the control (30.3) [27].

2.5. Leaf Area

Soil application of 50 kg $FeSO_4$/ha along with NPK (44:22:30 kg/ha) combined with 0.5% foliar spray of $FeSO_4$ was the most effective treatment in improving the leaf area 116.4 cm^2 [34]. A critical expansion in the single leaf region (1170 mm) when the water system was hindered after first reap and iron was applied as a foliar spray at 1.5 L/ha. Without iron treatment, a decrease in the leaf area (380.5 mm) was likewise seen when the water system was halted after the first collection [32]. Foliar spray of iron sulfate (4%) given 15 days prior and then afterward sprouting delivered a most extreme leaf area of 1874.56 cm^2/plant in sunflower cultivars, contrasted with the control, which created a leaf space of 1724.17 cm^2/plant [14]. In wheat, the leaf area considerably to 2240.94 cm^2/plant after foliar spray of iron sulfate (4%) 15 days prior and then afterward blossoming, contrasted with the unsprayed control, which had a leaf area of 2028.22 cm^2/plant [15]. Foliar nutrition of wheat with Fe at 1000/mg at the beginning of tillering and early booting stage expanded the leaf area by 37% when contrasted with an unsprayed control likewise showed that foliar treatment of Fe (333g/ha) related to boron (167g/ha) toward the beginning of tillering and early booting stage in wheat brought about the biggest banner leaf region (28.66 cm^2), while control brought about the most minimal banner leaf region (20.61 cm^2) [19]. In addition, the foliar utilization of $FeSO_4$ + $ZnSO_4$ (0.5%) during the fabulous development stage (50 DAS) brought about the most elevated leaf region (82.84 cm^2) in maize crop.

2.6. Leaf Area Index (LAI)

The LAI of bhendi at 80 DAS ascent to 1.36 as a result of foliar application of FeSO4 (0.5%) at 40 and 60 DAS [35]. Applying 3.64 kg/ha of Fe EDTA (5.5% Fe and 2% EDTA) as two foliar splashes at the 1–2 trifoliate stage and the 4–5 trifoliolate stage considerably expanded LAI esteems in soybean [36]. The foliar treatment of Fe (12%) related to Zn (16%) and Mn (14%) at 20 and 45 days after relocating came about in the best LAI of 5.62 under saline soil conditions [37]. In wheat, a most extreme LAI of 3.39 at 98 days after planting utilizing iron at 16 kg/ha in a blend with zinc (15 kg/ha) and manganese (16 kg/ha) [38]. The significant LAI of 5.81 was recorded in grain corn after the foliar application of Fe (3 mg/L) and Zn (4 mg/L) all through the critical stages [39]. Likewise, foliar treatment of Zn (10%) + Fe (12%) + Mn (5%) during the yield's beginning phase expanded the LAI to 8.06, contrasted with control (6.7) [30].

Spinach types were treated with two distinct groupings of nano iron chelates; utilizing 4 kg of nano fertilizers brought about a 47% expansion in the LAI when compared with no compost [31]. The best LAI of 5.1 was recorded in wheat cultivar Raijav after foliar treatment of iron (2%) during the tillering stage [17]. A correlation of the impact of nano iron chelate compost and standard chelate EDDHSA on the quantitative and subjective qualities of saffron (*Crocus sativus* L.) uncovered that nano-based iron manure was more successful than standard manure and that use of nano manure at 5 kg/ha was better in expanding the LAI than the most significant level of 3.45 [40].

2.7. Specific Leaf Weight

The foliar application of $FeSO_4$ (0.5%) at 40 and 60 DAS expanded the particular leaf weight of bhendi from 4.47 mg/cm^2 (60 DAS) to 5.78 mg/cm^2 (80 DAS) [35]. Foliar treatment of 0.5% $FeSO_4$ + 0.1% citrus extract at the pre-blooming stage expanded the particular leaf weight of summer green gram to 8.67 mg/cm at development, contrasted with a base explicit leaf weight of 5.91 mg/cm in control [41]. The foliar treatment of $FeSO_4$ (0.5%) at 90 days subsequent to relocating expanded the particular leaf weight (5.37 mg/cm) in chili compared with the control (4.233 mg/cm) [42], and the foliar treatment of $FeSO_4$ (0.5%) at 60 days subsequent to planting expanded the particular leaf weight (4.71 mg/cm) in French bean contrasted with control [43].

2.8. Days to 50% flowering

A significant decrease in number of days to half of sprouting in French bean due to foliar treatment of 0.5 % FeSO4 at 20, 40, and 60 DAS [43]. Furthermore, the foliar treatment of 2% $FeSO_4$ at 60 days subsequent to planting brought about a quicker blossoming spike development (107.06 days) in Gladiolus crop in calcareous soils [44].

3. EFFECT OF DIFFERENT LEVELS OF IRON ON BIOMASS TRAITS OF KODO MILLET

Biomass esteems expanded with Fe treatment at all development stages; a critical impact of Fe preparation was seen with the greatest biomass (756 g/m) got by soil utilization of Fe at 2000 g/ha at full seed development stages, contrasted with the control (686 g/m) in soybean [44]. Natural yield was considerably expanded in plants showered with Fe 4 mL/L at 60 and 80 days in the wake of planting. However, foliar treatment of Fe carried about an expansion of 80% in organic creation in safflower [45]. Applying Fe (0.5%) improved safflower biomass creation to a limit of 17,166 kg/ha. A correlation of the impact of nano iron chelate manure and regular chelate EDDHSA on the quantitative and subjective qualities of saffron (*C. sativus L.*) uncovered that nano-based iron compost is more powerful than ordinary compost, with a 5 kg utilization of nano fertilizer essentially expanding biomass (dry yield of leaf) yield [46]. The pot culture trials with different treatments in peanuts showed that 1000 mg/kg Fe_2O_3 treatment brought about a generous expansion in root dry biomass when contrasted with the control [21].

3.1. Dry Weight of Shoot and Root

The use of Zn (0.5%) + Fe (0.5%) + Mn (0.5%) treatment mix brought about the most noteworthy dry leaf (6.1 t/ha) and dry stem yield (6.0 t/ha), while the control scrounge sorghum yielded the least dry leaf (3.9 t/ha) and dry stem yield (4.3 t/ha) [30]. The showering 1 kg/h of iron nano chelate on plants during the underlying phase of harvest in *E. pulcherrima* wild crop brought about the most noteworthy mean shoot new weight (5.84 g), root new weight (0.56 g), leaf new weight (2.70 g), shoots dry weight (0.71 g), root dry weight (0.13 g), and leaf dry weight (0.70 g) (0.3 g) [23].

The showering 1 kg/h of iron nano chelate on plants during the underlying phase of harvest development in *E. pulcherrima* wild crop brought about the most noteworthy mean shoot new weight (5.84 g), root new weight (0.56 g), leaf new weight (2.70 g), shoots dry weight (0.71 g), root dry weight (0.13 g), and leaf dry weight (0.70 g) (0.3 g) [23].

3.2. Total Dry Matter Production

The after effects of a pot test led to deciding the impact of two distinct Fe sources (Fe-EDTA and Fe-EDDHA) showered on the leaves and applied to the dirt at convergences of 0, 10, 20, and 30 ppm and applied to the leaves twice on lentil plant (*Lens esculenta* L.) demonstrated that there was a critical impact of the mix of the two sorts, focuses, and strategy for Fe application on complete dry matter and the groupings of nitrogen, phosphorous, and calcium [47].

4. EFFECT OF DIFFERENT LEVELS OF IRON ON YIELD COMPONENTS AND YIELD IN KODO MILLET

Foliar micronutrient treatment substantially affected 1000 seed weight. Maximum number of productive tillers, number of grains per panicle, and length of ear head were obtained with the application of 33 kg K/ha

+ foliar application of $FeSO_4$ at 1% and $ZnSO_4$ at 0.5% compared to all other treatments [48]. The soil application of Fe-organic complexes increased the yield and yield components of the wheat [49]. Combined treatment of 10 kg/ha of $ZnSO_4$ and 12 kg/ha of $FeSO_4$ through soil improves the yield attributes while foliar spray of 0.1% $ZnSO_4$ and 0.3% $FeSO_4$ enhances quality parameters in maize [50]. The foliar spray application of 1.0% $FeSO_4$ at flowering stage, that is, 37.24 and 139.59 q/ha was recorded significantly highest green grain and green fodder yield of parching sorghum [51].

Micronutrients given through soil + foliar application obtained significantly higher grain, stover, and biological yield in sorghum [52]. Application of vermicompost at 0.2 t/ha enriched with 5.00 kg Fe and 2.50 kg Zn in conjunction with recommended dose of fertilizer (RDF) significantly improved growth and yield attributes, namely, plant height, number of effective tillers per meter, length of ear head, number of grains per ear head, 1000-grain weight, grain, and straw yield of wheat [53].

Combined application of 5 kg Zn +10 kg Fe +10 t FY/ha increased the pearl millet grain yield [54]. RDF + soil application of $ZnSO_4$ at 15 kg/ha and $FeSO_4$ at 10 kg/ha + Foliar application of 0.5% $ZnSO_4$ and $FeSO_4$ each 30 DAS recorded significantly higher number of tillers per plant in foxtail millet [55]. The highest yields were obtained with the application of 10 L's/ha of Feramin 6% of Fe (Fe 60) in Maize [56].

Fe foliar application at a pace of 4 mL/L created the best 1000 seed weight in safflower when contrasted with control [45]. Soil treatment and the foliar shower of Fe brought about a generous expansion in 1000-grain weight in wheat cultivars when contrasted with other micronutrient mixes [57]. Iron application at a pace of 12 kg/ha related to the necessary NPK brought about the most elevated mean 1000-grain weight (34.77 g). At different improvement phases of wheat, foliar treatment of micronutrients (Fe = 1%, Mn = 2%, Zn = 2%, Cu = 1%, and B = 1%) upgraded the quantity of grains per spike, 1000-grain weight, organic yield, straw, and grain yield [11]. Similarly, the 1000-grain weight, grain creation and grain number per spike were improved in wheat [58]. Field studies performed to decide the effect of micronutrient foliar splash on wheat yield and grain quality uncovered that treatment of these supplements improved straw yield, Fe, Zn, and Mn focuses in banner leaves and grains, just as protein content in wheat grain [13]. The foliar utilization of Fe from 200 to 600 ppm at different advancement stages further developed the spike length, 1000-grain weight, grain weight per spike, grain yield, grain protein content, and protein yield of wheat plants when contrasted with untreated controls [15]. Fe treatment in wheat during the tillering and stem prolongation stages increased the number of tillers to the tune of 2.35%. Applying nano-Fe fertilizer as a foliar spray, it is foliarly highly influenced the quantity of turners, seeds per spike, grain yield, natural yield, and 1000-grain weight of wheat [28]. Field research performed to decide the effect of foliar use of iron nano chelated manures on wheat cultivars uncovered that iron nano chelate affected spike number, grain per spike, 1000-grain weight, natural yield, and reap record when contrasted with the control [59]. Foliar treatment of 0.3% micronutrients, including iron chelates, significantly affected the 1000 grain weight of rice cultivars [18]. Enhancing wheat with micronutrients (Fe, Zn, and Mn) fundamentally expanded spike length, spikelets per spike, grains per spike, 1000-grain weight, turners per square meter, grain yield, organic yield, and reap list [60].

4.1. Grain Weight/Panicle

Preparation with Fe, Mn, Zn, and Cu generously further developed grain creation, with a 20.8% increment attributable to Fe treatment at 20 kg/ha [61]. Foliar utilization of Fe at rates from 200 to 600 ppm expanded the grain weight per spike and grain creation of wheat at different improvement stages [15]. In addition, generous upgrades in grain creation inferable from the organization of these minerals were discovered. These upgrades included expanded Fe, Zn, and Mn focus in banner leaves and grains, just as protein content in wheat grain [58]. Foliar spray of Fe at rates from 200 to 600 ppm expanded grain weight per spike and grain creation in wheat plants at different advancement stages [15]. Applying nano-Fe compost foliar considerably affected wheat grain creation and organic yield [28]. In addition, foliar utilization of iron nano chelated manures to three wheat cultivars expanded the quantity of grains per spike fundamentally when contrasted with control [62]. Enhancing wheat with micronutrients (Fe, Zn, and Mn) expanded grains per spike, 1000-grain weight, grain yield, and biological yield [60].

4.2. Grain Yield

The grain yield is dictated by three factors: The quantity of panicles, the quantity of grains/panicle, and the grain weight. Micronutrients and their appropriate doses generously affect grain creation by settling insufficiency and improving yield plant development and improvement. Application of RDF+ foliar application of $FeSO_4$ at 0.5% twice at 30 and 60 DAS recorded the highest grain yield in finger millet (*Eleusine coracana*) [63]. Along with RDF, foliar application of 0.1% chelated Fe and 0.1% chelated Zn produced the higher grain yield in Pearl millet [64]. Studies done by Divya *et al*. (2021) in finger millet revealed that the application of 0.6% $ZnSO_4$ + 0.5% $FeSO_4$ through foliar application recorded highest grain yield and stover yield [65].

Rashid *et al.* [66] found that applying 10 kg Zn/ha +1 kg B/ha + 5 kg Cu/ha + 10 kg Mn/ha + 10 kg Fe/ha further developed wheat grain creation by 26.1%. Alam *et al.* (1988) [62] found that applying 2.5 kg Fe/ha in a blend with 5 kg Zn/ha further developed wheat grain creation by 10.9%, while utilizing 10 kg Fe/ha + 2.5 kg B/ha + 5 kg Zn/ha expanded grain yield by 11.3%. In wheat, Wisal *et al.* [67] showed that applying Fe alone at a pace of 5 kg Fe/ha expanded grain creation by 14% when contrasted with different micronutrients. The consequences of enormous scope of research acted in 815 flooded wheat's to decide the effect of micronutrients uncovered a 4–11% expansion in wheat grain creation when iron or a combination of Fe + Zn + Cu + B was applied related to NPK manures [68]. El-Magid *et al*. [69] found that combining Fe, Cu, Zn, and Mn further developed wheat grain and straw yields. A field investigation on wheat crops utilizing different doses of Fe (0, 5, 10, 15, and 20 kg/ha) showed that grain creation increased as the pace of Fe expanded [70]. A review looking at the impact of foliar use of macronutrients and micronutrients on wheat yield and yield parts found that three foliar showers of supplement arrangement at the tillering, jointing, and boot stages, joined with half of the suggested N and P portions, essentially expanded wheat yield and yield parts [71]. Field studies performed to decide the effect of Fe and Zn on winter wheat quantitative and quality markers showed that foliar treatment of Fe and Zn upgraded grain yield and protein content [72]. Chaudry *et al*. [73] found that when micronutrients (Zn, Fe, and B) were managed alone or related to a gauge measurement of NPK, wheat creation transcended control. Abbas *et al*. [57] noticed a critical expansion in grain yield and part yields with an expanded Fe portion of up to 12 kg/ha. Habib [74] announced that foliar use of Zn and Fe during the tillering and heading stages expanded wheat grain yield and part yields when contrasted with control. The examination on the effect of Fe and Zn on wheat freak line yield and yield parts uncovered that treatment of Fe and Zn impacted grain yield [75]. Seadh *et al*. [76] found that foliar treatment of 500 ppm Fe expanded grain yield, yield part, and protein content in wheat contrasted with untreated wheat.

4.3. Straw Yield

Higher grain and straw yields of finger millet were recorded with 150% RDF + $ZnSO_4$ 0.5% foliar spray + $FeSO_4$ 0.2% foliar spray compared to 100% RDF [77].

The grain yield is controlled by three factors: The quantity of panicles, the quantity of grains per panicle, and the grain weight. Micronutrients and their legitimate measurements affect grain creation by settling insufficiency and upgrading crop plant development and improvement. Applying 10 kg Zn/ha + 1 kg B/ha +5 kg Cu/ha + 10 kg Mn/ha + 10 kg Fe/ha further developed wheat grain creation by 26.1% [46]. Applying 2.5 kg Fe/ha in mix with 5 kg Zn/ha further developed wheat grain creation by 10.9%, while utilizing 10 kg Fe/ha +2.5 kg B/ha +5 kg Zn/ha expanded grain yield by 11.3% [62]. In wheat, Fe alone at a pace of 5 kg Fe/ha expanded grain creation by 14% when contrasted with different micronutrients [67]. The consequences of a huge scope of research acted in 815 flooded wheat's to decide the effect of micronutrients uncovered a 4–11% increment in wheat grain creation when iron or a combination of Fe + Zn + Cu + B was applied related to NPK manures [68]. The consolidating Fe, Cu, Zn, and Mn further developed wheat grain and straw yields [69]. Like this outcome, a field investigation of wheat crops utilizing different measurements of Fe (0, 5, 10, 15, and 20 k/ha) showed that grain creation increased as the pace of Fe expanded [70]. A review inspecting the impact of foliar utilization of macronutrients and micronutrients on wheat yield and yield parts found that three foliar showers of supplement arrangement at the tillering, jointing, and boot stages, joined with half of the suggested N and P dosages, altogether expanded wheat yield and yield parts [71]. Field studies performed to decide the effect of Fe and Zn on winter wheat quantitative and quality markers showed that foliar treatment of Fe and Zn improved grain yield and protein content [72]. Micronutrients (Zn, Fe, and B) were regulated alone or related to a gauge measurement of NPK, wheat creation transcended control [73]. A significant increase in grain yield (12 kg/ha) with an application of Fe were recorded [57]. When compared with control, the foliar utilization of Zn and Fe during the tillering and heading stages expanded wheat grain yield and part yields [74]. The exploration on the effect of Fe and Zn on wheat freak line yield and yield parts uncovered that treatment of Fe and Zn impacted grain yield [75]. Foliar treatment of 500 ppm Fe expanded grain yield, yield part, and protein content in wheat contrasted with untreated wheat [76].

4.4. Harvest Index

Vikash *et al*., 2015, observed that the highest harvest index was recorded with three foliar sprays of 2.0% iron sulfate in aerobic rice [77]. The foliar splash nutrients generously affected the collect file (rate) in the 2011/2012 and 2012/2013 seasons. In contrast with different nutrients, Cu (8 kg/ha) + Fe (8 kg/ha) + Mn (12 kg/ha) + Zn (10 kg/ha) had the most elevated gather file (33.21 and 33.36%) in the two seasons [78]. Foliar use of micronutrients brought about a higher gather record when contrasted with control treatment, and foliar use of Fe (4 mL/L) + B (2 mL/L) given at 60 and 80 days in the wake of planting in safflower brought about the most elevated collect list (26.7%) when contrasted with control, which had a reap list of 16.2% [45].

5. CONCLUSION

Sustainable crop substitutes are required to alleviate world hunger and increase farmer income. Minor millet production has a long history, and its spread to diverse parts of the world, which are known for their difficult farming circumstances, has resulted in significant genetic variability in these crops. Kodo millet is extremely robust and drought resistant, with the capacity to provide a good yield which makes it ideal for boosting farmers' income. Improvement in crop production and productivity is the target that the agricultural sector has to attain. In India, prolonged dry conditions lead to poor yield due to insufficient moisture in the soil. Therefore, soil application along with foliar spray will overcome the problem by substantiating the soil nutrient. Keeping this in view, this review was carried out mainly to understand the iron chlorosis by iron fertilization through the soil and foliar application, thereby improving the productive potential of Varagu, besides enhancing the mitigation of iron chlorosis.

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7. AUTHORS' CONTRIBUTIONS

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agreed to be accountable for all aspects of the work. All the authors are eligible to be an author as per the International Committee of Medical Journal Editors (ICMJE) requirements/guidelines.

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9. CONFLICTS OF INTEREST

The authors report no financial or any other conflicts of interest in this work.

10. ETHICAL APPROVALS

This study does not involve experiments on animals or human subjects.

11. DATA AVAILABILITY

The data used to support the findings of this study are included within this article.

12. PUBLISHER'S NOTE

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