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Tiranam Venkat Sai Manindra
PG Scholar, Department of Genetics and Plant Breeding, Lovely Professional University

Puneet Walia
Assistant Professor, Department of Genetics and Plant Breeding, Lovely Professional University

Tammaneni Sai Venkata Varaprasad
PG Scholar, Department of Genetics and Plant Breeding, Lovely Professional University

Corresponding Author:
Tiranam Venkat Sai Manindra
PG Scholar, Department of Genetics and Plant Breeding, Lovely Professional University

Impact of bio-fortification on different crops its cultivars, yield parameters

Tiranam Venkat Sai Manindra, Puneet Walia and Tammaneni Sai Venkata Varaprasad

Abstract
More than half of the world is facing the problem of malnutrition this must be considered as a serious issue which is a current challenge to the human kind. The planet breeding methods have been evaluated per achieving the good agronomic yield but not considering the nutritional quality and also the other effects related to this problem are resolved pharmaceutical supplements or by the industrial fortification. Nowadays Hidden hunger became very frequent especially in the children and in women this is mainly due to the low intake of nutrients. The process of bio-fortification mainly includes biologically available concentration of nutrients in the edible parts of plants by the process of genetic selection or by agronomy and this process can lead to solve the problem of malnutrition or hidden hunger.

Keywords: Malnutrition, cultivars, yield parameters, nutrients, growth attributes

Introduction
Bio fortification is a process by which result in improving the percentage of nutrients in the plants naturally with the help plant breeding methods to provide effective, long term and also sustainable delivery of nutrients. The word is derived from two different languages the word "*bios"* derived from Greek language meaning "*life*" and the word "*fortificare*" derived from Latin language meaning "*making strong".* This process help in reducing the malnutrition and also maintaining the nutritional status. This helpful to the people living in rural areas as they have low access to supplements and also fortified products. And the process of bio fortification is mainly followed in the varieties may in the having the good agronomical yield and the varieties which are constantly preferred by the population. Improving of such varieties leads to the direct consumption of the consumers mainly in the rural areas it is very helpful when compared to the supplementary nutritional products. These foods cannot deliver good nutrition when compared to the fortified foods or supplements but they are helpful in daily increasing the nutrients content level if they are consumed daily. Idea was found by bio-fortification, by lead researcher was Dr. Howarth Bouis – now a co-laureate of the World Food Prize, the research was accelerated when the international multidisciplinary Harvest Plus (Bio-fortification Challenge) program was launched in 2004 by the Consultative Group on International Agricultural Research (CGIAR) and the International Food Policy Research Institute (IFPRI).

Enhancement of bio-fortification
Isotopic incorporation of iron levels in RBC showed that in the children age groups of (4-6 years and 7-10 years) there is an increase in median level daily requirement of iron to 36 percentage in 4 to 6 years and 51 percentage in 7 to 10 years of age by Hackl *et al*., (2019) [13].
There is gradual increase in concentration of zinc and also the Iron concentration in the grains of rice due to the application of methods like genetic engineering and the genes involved in it Kawakami *et al*., (2018) [20].
Study reveal that more than 2 billion people are micronutrient deficient. Due to polished rice the concentration of iron and Zinc get decreasing so the breeding programs are introduced for bio fortified rice which should gradual increase in increasing the contents of micronutrients in rice especially zinc and iron by Kurniawan *et al*., (2016).
Study reveal that more than 2 billion people are micronutrient deficient, due to polished rice the breeding programs are done to increase the micronutrient content in rice and engineering reports on iron content resulted that there is improvement in micronutrient percentage under

the field conditions by Trijatmiko *et al*., (2016) [39].

Biofortification through molecular approaches

An experiment conducted during year 2018, 2019 a cross between japonica cultivars of the Korean variety Goami 2 and Hwaseonchal resulted in identification of genes which effect the GZC and GIC used in the milled products and also observation of dysgenic interactions, genes which are required for the zinc or iron homeostasis by Jeong *et al*., (2020) [19]. Experiment conducted on random and trait linked markers are identified by using the 22 micro satellite markers which exhibited 100% polymorphism and heterozygosity. In Arunachal Pradesh the cultivar Nali Dhan recorded the high genetic diversity and the cultivar Moirangphou Khonganbi recorded the low genetic diversity by Vanlalsanga *et al*., (2019). Study conducted on black rice to investigate the proteins using SDS PAGE and ExperionTM260 15 protein bands identified. SDS PAGE protein range was 8-137kDa; ExperionTM260 from 1.2kDa to 260kDa by Sari *et al*., (2018) [31].

Impact of biofortification on nutrients content and yield attributes

Experiment on zinc application in soil @25 kg/ha with foliar spray ZNSO4 @ 0.5% resulted good plant height, Branches, Dry matter at 30, 60 DAS at harvest. Zinc application @3g Kg of seed has same result to zinc sulphate @ 0.5% both has good growth attributes Parmar and Poonia (2020) [26]. Experiment on different varieties of chick pea at Rajasthan (Bikaner) resulted good Relative growth rate, Dry matter, Crop growth rate, Crop growth rate 30, 60, 90 DAS at harvesting by Choudhary *et al*. (2020) [11]. Experiment on chickpea (Habru) and observed high zinc content straw when compared to the Mastewal variety by Hidoto *et al.,* (2020) [17]. Experiment conducted at Rajasthan (Nagaur) on chickpea varieties GNG-1581 resulted additional net return of 21,082/ ha during farming practices (2019-20) by Jat *et al*., (2021) [18]. Field experiment at Iran on chick pea observed high pods, primary and secondary branches, seeds, pods, seed Index, grain yield, protein%, protein yield, Biomass but they differ with the application of nano fertilizers by Morovat *et al*., (2019) [24]. Biofortified indica rice attains iron and zinc nutrition dietary. Experiment conducted on chickpea and observed increase in plant height, primary and secondary branches; zinc, Iron content in grain (flowering, pod formation stages) with application Zinc sulphate @25 kg/ ha at sowing along with Foliar spray ZNSO4 0.5% during 2 years of experiment by Pal *et al*. (2019). Field experiment at Raipur (Chhattisgarh) on chickpea reported increase in yield of seed, harvest index in the treatment with RDF (20:50:20 kg/ ha) with ZNSO4 0.5%, 0.1% FESO4 by Banjara and Majgahe (2019) [9]. Field experiment on application of RDF with foliar application of ZNSO4, FESO4 during the pre-flowering, pod formation stages result in increase of pods, seeds, yield of seed by Deshlahare *et al*. (2019) [12] Experiment at Dharwad (Karnataka) reported application of ferrous sulphate @ 6 kg/ ha with zinc sulphate @ 4 kg/ ha resulted in high seed index, yield of straw and seed, uptake of Iron and Zinc, crude protein content in grains by Pooja and Sarawad (2019) [27].

If rice is not polished adequately it may lead to the deficiency of micro nutrients such as zinc and iron called as micronutrient malnutrition is affecting more than 3 billion people across the world, biofortification methods help in reducing the deficiencies of micronutrient by selection of best genotypes to fulfill the modern molecular plant breeding methods Reddy *et al*., (2018) [30]. Experiment on application of zinc as foliar spray @ 0.5% in mung bean resulted in increase of height of plant, vegetative branches number and also contents of chlorophyll (SPAD), reproductive branches, seeds number per pod, Test weight, biological yield at Faisalabad (Pakistan) by Haider *et al*. (2018) [14]. Increase in the growth characteristics like branches, height of plant, root nodules, and dry weight of nodules, yield of the seed and stover, biological yield of chick pea by application of iron @4 kg/ ha, zinc @ 5 kg/ ha after harvesting of the plant conducted at Junagadh (Gujarat) by Kuldeep *et al*. (2018) [22]. Application of zinc @ 7.5 kg per hectare resulted in the increase of yield of grain, uptake of zinc, concentration of zinc in seeds conducted on chickpea (Pusa-372) crop at Indian Agricultural Research Institute (New Delhi) by Prasad and Shivay (2018). Increase in height of plant, branches count, nodule, seeds and pods count, nodules fresh weight due to the application of zinc @ 5 kg/ ha at Dantiwada (Gujarat) on cluster bean crop by Kuniya *et al*. (2018) [23]. Application of RDF with the foliar application of Zinc @ 0.5%, Iron @ 0.05 percentage recorded good yield of seed, stover yield and harvest index, Zinc and iron content in seeds and straw followed by seed treatment with zinc @ 1g per kg of seeds. Application of zinc sulphate @ 25 kg per hectare showed best results conducted at SKUAST (J & K) by Nandan *et al*. (2018) [25]. Experiment conducted on Agricultural farm stated that increase in seeds count, yield of straw, biological yield at I.A.V.B by Purushottam *et al*., (2018) [28]. There is increase in seed, straw, total uptake of zinc by the application of zinc sulphate @ 0.5% by Sreiniketan *et al*., (2018). Experiment stated that increase in pods per plant, yield of seed and straw by application of zinc @30 kg/ha at Satna (M.P.) by Sharma and Sirothia (2018) [32]. There is significant increase in plant height, dry matter and leaf area index by the applying foliar spray of zinc 0.5% with iron 0.05% and RDF along with seed treatment by zinc at the rate of 1 g/kg of seed soil application of zinc sulphate at the rate of 25 kg/ha at SKUAST (J & K) by Kapilashiv (2017) [2]. Field experiment conducted at Allahabad (Uttar Pradesh) result in good plant height at 60 DAS, nodules count at 30 DAS in green gram by the application of 40 kg Sulphur/ha, 0.5% Feso4 at 20 DAS by Saini *et al*., (2017) [7]. Field experiment conducted on chickpea result in high pods, seed yield, test weight by seed coating of znso4, boron, ammonium molybdate, Feso4 at (Raichur) Karnataka by Shinde *et al*. (2017) [5]. Experiment conducted on zinc fertilization on chickpea showed significant increase in grains, straw and Zinc uptake in grain and straw by foliar spray of znso4 0.5% three times at for filling and early stages of flowering and vegetative growth by Hidoto *et al*., (2017) [16]. Experiment conducted at Rajasthan (Bikaner) and result in uptake of zinc in seed and straw of chickpea due to the application of zinc @ 6 kg/ ha by Balai *et al*., (2017) [6]. Experiment result in good uptake of iron due to the application of iron @5 ppm at Uttar Pradesh (Kanpur) by Kumari *et al*., (2017) [21]. Experiment conducted at Raichur resulted in higher nodules, yield of pod and seed in chickpea due to the seed coating by using micronutrients such as boron, zinc sulphate, iron sulphate, ammonium moly date at flowering stages by Vasudevan *et al*., (2016) [4]. Experiment conducted with application of zinc sulphate @ 25kg/ha resulted in higher ZN content and yield compared to zinc sulphate @ 30kg/ ha by Hidoto *et al*., (2016) [15]. Cross conducted between transgenic lines (High Free Lysine; HFL1 and HFL2) resulted in increase of amino acids and also total protein content which also lead to improvement in physiochemical properties but there is little bit difference in plant height and colour of grains by Yang *et al*., (2016).

Impact of biofortification on different crop cultivars

Experiment conducted on clay textured soils of Gujarat (Junagadh) on different varieties of the chickpea resulted application of Zinc sulphate @25 kg/ ha with Zinc as foliar spray 0.5% recorded highest pods count, good straw, seed yield, seed index, maximum net returns, high benefit cost ratio compared to soil application of zinc @25 kg per hectare in GJG-3 variety compared to the GG-1 variety but it has high pod by Parmar and Poonia (2020) [26]. Experiment conducted on different varieties of chick pea at Bikaner of Rajasthan and stated that there is good production of dry matter, Relative growth rate, Crop growth rate at 30, 60, 90 DAS at harvesting in GNG-1958 variety compared to GNG-2171, GNG-1581 variety, but GNG-1581 produced highest net assimilation rate, chlorophyll content. Good seed yield, uptake of nitrogen in seed and straw, high Benefit to cost ratio, high net returns was observed in GNG-1581 variety compared to GNG-2171, GNG-1958 variety, but GNG-1958 recorded high straw, Biological yield by Choudhary *et al.*, (2020) [11].

Application of RDF with foliar application of Zinc @ 0.5%, Iron @ 0.05% followed by seed treatment with zinc application @ 1g/kg recorded good yield of seed and stover, harvest index, high zinc, iron content in seed and straw and Iron also crude protein, high SPAD meter reading in GNG-1581 compared to RSG-963 of. Soil application of zinc sulphate @ 25 kg/ ha showed significant improvement in yield of seed and stover, harvest index conducted at SKUAST (J & K) by Nandan *et al*., (2018) [25].

Different investigations conducted on Iron and Zinc content in high yielding (Sarjoo-52, Madhukar, NDR-359, CSR-13, Swarna, Sub-1 and Swarna) of this varieties highest fe content was found in Sarjoo-52 and the lowest content was found in Swarna; zinc content was high in Sarjoo-52 and low in CSR-13; highest protein was found in Swarna and the lowest was in Madhukar; carbohydrate content was high in Madhukar and low in Swarna.

Impact of biofortification on economics

Experiment conducted on different varieties of chick pea at Bikaner of Rajasthan resulted in high benefit to cost ratio, net returns from variety GNG-1581 when compared to GNG-2171and GNG-1958 by Choudhary *et al.*, (2020) [11]. Two-year field experiment conducted on chickpea and the observed results were increase in gross returns in the treatment with zinc sulphate @25 kg/ha followed by foliar application of zinc sulphate @ 0.5 at flowering stage and pod formation stages (2015-16; 2017-18) by by Pal *et al*., (2019). Experiment conducted at Rajasthan (Bikaner) resulted in good net returns, B: C ratio due to the application of zinc @ 6 kg/ha by Balai *et al*., (2017) [6]. High B: C ratio and net returns for obtain due to the application of RDF with zinc and iron @ 0.5 and 0.5 percentage followed by seed treatment with zinc @ 1 g/kg of seeds with RDF, znso4 @25 kg/ha also showed best result in GNG-1581at but RSG-963 showed satisfactory, gross returns Samba (Jammu and Kashmir) by Kapilashiv *et al*., (2017) [2].

Conclusion

Biofortification need to be fully scaled-up, as the evidences suggest that it's effectiveness to the increase in different crop parameters but there need to be increase in the methods and approaches for biofortification and also to overcome the challenges so that they will be increase in the nutrient content, crop yield parameters etc., which ultimately lead increase in quality and quantity of food for the present population.

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