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RESEARCH ARTICLE :

Impact of seed zinc and iron content of on germination and seedling vigour in pigeonpea

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SUMMARY : A study was carried out to evaluate the influence of seed zinc and iron content on quality traits in pigeonpea (*Cajanus cajan* (L.) Millsp). A total of 64 pigeonpea genotypes were used for mineral content (Zn and Fe) analysis and categorized into low, medium and high iron and zinc content. Five and three genotypes from each category for iron and zinc were used for seed quality analysis. Results revealed that there was a progressive increase in seed germination (from 82.92 to 96.50 % and 81.76 to 94.95 %), seedling length (25.93 to 33.48 cm and 27.38 to 32.75 cm) and seedling vigour index (2150 to 3231 and 2239 to 3110) with increase in seed-Fe and Zn content, respectively.

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KEY WORDS :
Seed, Iron, Zinc, Pigeonpea, Seed quality

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BACKGROUND AND OBJECTIVES

Pulses constitute an important ingredient in vegeterian diet and are source of protein, containing nearly twice as much protein as that of cereals and nutritionally balances the protein requirement of vegetarian population, hence called as 'poor man's meat. These are also suitable for sustainable agriculture as they enrich the soil through biological fixation (Hariprasanna and Bhatt, 2002). Pigeonpea is the most important pulse crop of India and is grown on an area of 3.88 m ha with an annual production of 3.29 mt with a productivity of 849 kg per ha. In Karnataka it is grown in an area of about 0.82 m ha with a production of 0.60 mt. Average productivity of pigeonpea in Karnataka accounts for 700 kg per ha and its potential yield marked up to 3.5 tonnes per ha. Its area, production and productivity in India in last five decades showed that there was about two per cent area increase per year but the yield levels are stagnated around 600-700 kg per ha (Anonymous, 2014).

Iron and zinc are important elements out of the 16 essential elements needed for plant growth. Iron is used for the synthesis of chlorophyll and is essential for the function of chloroplasts. Zinc (Zn) is essential in protein synthesis and gene expression in plants (Cakmak 2000; Broadley *et al*. 2007). It has been estimated that about 10 % of the proteins in biological systems need Zn for their structural and functional integrity (Andreini *et al*. 2006). This element has also been indicated to be required as a cofactor in over 300 enzymes (Coleman 1998). During germination, production of Reactive Oxygen Species (ROS) is well known (Cakmak *et al*. 1993; Bailly *et al*. 2002; Qin and Liu 2010) and Zn plays a central role in detoxification of ROS in plant cells (Cakmak 2000; Broadley *et al*. 2007).

Earlier studies indicated that growing wheat crops with high seed Zn resulted in better seedling vigor and viability, higher yield, and lessening of seed rate required for sowing, especially on potentially Zn deficient soils (Rengel and Graham 1995; Rengel 2002; Cakmak 2008). Applying Zn fertilizers in the soil also increases dry matter, grain yield and grain Zn concentration in rice (Shehu and Jamala 2010; Fageria *et al*. 2011). In case of pigeonpea there is no much information on how the elevated level of seed zinc and iron may consequently affect germination and seedling growth. Therefore, in the present investigation an attempt has been made to know the influence of seed-Fe and Zn content on seed germination and seedling vigour index in pigeonpea genotypes.

RESOURCES AND METHODS

A total of 64 pigeonpea genotypes available with Agricultural Research Station, Kalaburgi, UAS, Raichur, Karnataka were used for mineral content (Zn and Fe) analysis and categorized into low, medium and high iron and zinc content. Five and three genotypes from each category for iron (Low; RVKT-261, GRG-333, GRGB-131, NTL-900, WRGE-97; medium: AGL-2013, WRP-1, GRPH-1, TS-3R, RVK-275 and high GRG-2009, ICPL 96061, ICPL 20136, GPHR-08-11, ICP-16317) and zinc content (Low; MARUTI, TS-3R, WRP-1; medium: ICP-11320, GRG-2009, BDN-2008-12 and high: ICPL 14001, GRPH-2, AGL-1632), respectively were used to study the effect of seed micronutrient (Zn and Fe) content on seed germination and seedling vigour index.

Germination test was conducted with four replicates of 100 seeds each in the paper (between papers) medium in the walk-in germination room. maintained at 25 ± 1°C temperature and 90 ± 5% RH. At the end of sixth day of placing the seeds, the number of normal seedlings in each replication was counted and the germination was calculated and expressed in percentage (Anonymous, 2013).

$$\text{Germination \%} = \frac{\text{No. of normal seedlings}}{\text{Total no. of seeds}} \times 100$$

From the germination test, ten normal seedlings were randomly selected from each treatment on the day of final count. The seedling length was measured from tip of shoot to root tip and the mean length was calculated and expressed as seedling length in centimeters (Anon, 2013).

Seedling vigour index was computed by adopting the formula as suggested by Abdul-Baki and Anderson (1973) and expressed in whole number.

Seedling vigour index = Germination (%) × Mean seedling length (cm)

OBSERVATIONS AND ANALYSIS

Beneficial effect of high seed-Zn during seed germination and early seedling growth has been reported by several authors (Yilmaz *et al.*, 1998 in wheat and Boonchuay *et al.*, 2013 in paddy). In the present investigation an attempt has been made to know the influence of seed-Fe and Zn content on seed germination and seedling vigour index in pigeonpea genotypes. Out of 64 genotypes evaluated for Fe and Zn content in experiment- I, genotypes were categorized in to three levels namely, low, medium and high. These genotypes were found to have different impact on seed seed quality parameters. Seed germination significantly increased with increase in seed zinc content. Among the genotypes, ICPL 14001 which belonged to high zinc content group recorded significantly highest seed germination (94.67 % in 2014, 95.24 % in 2015 and 94.95 % in pooled mean) (Fig. 1), seedling length ((32.60, 32.90 and 32.75 cm in 2014, 2015 and pooled mean, respectively) (Fig. 2) and seedling vigour index (3105, 3115 and 3110 in 2014, 2015 and pooled mean, respectively) (Fig. 3) compared to other genotypes while, lowest was noticed in genotypes which falls under low iron content category.

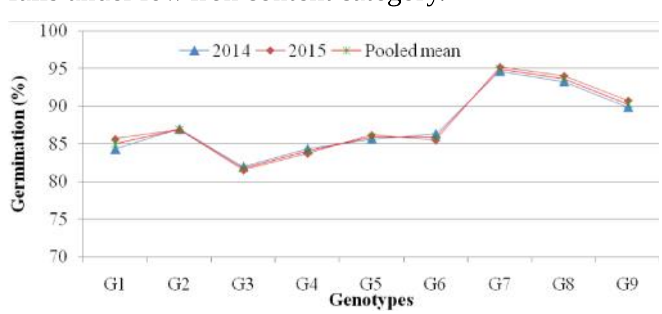

Fig. 1 : Germination (%) as influenced by seed zinc content

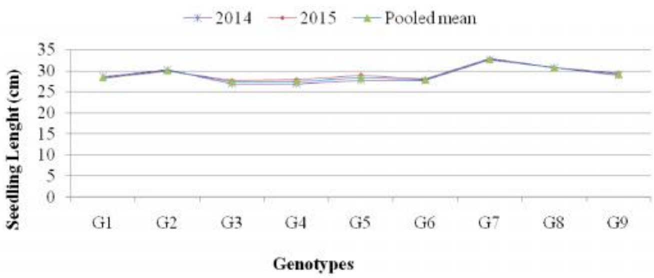

Fig. 2 : **Seedling length (cm) as influenced by seed zinc content**

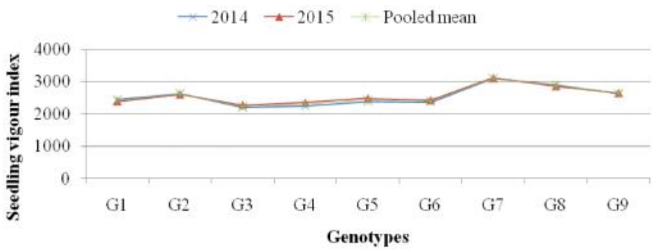

Fig. 3 : **Seedling vigour index as influenced by seed zinc content**

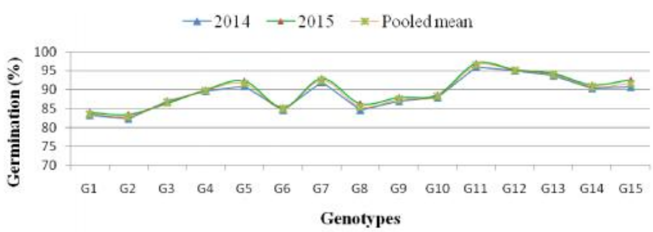

Fig. 4 : **Germination (%) as influenced by seed iron content**

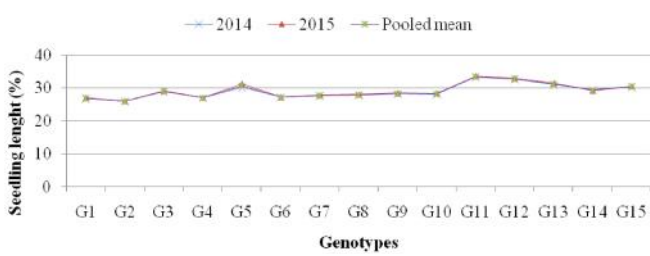

Fig. 5 : **Seedling length (cm) as influenced by seed iron content**

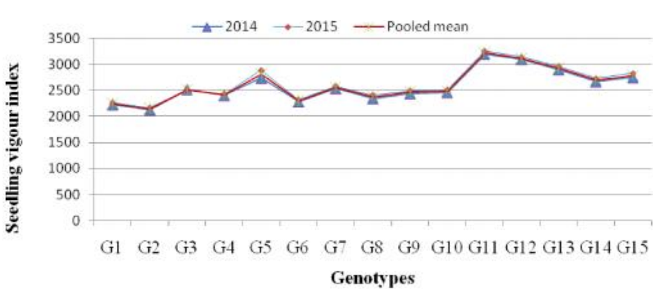

Fig. 6 : **Seedling vigour index as influenced by seed iron content**

So **s**eed iron content significantly influenced the germination percentage. Seed germination significantly increased with increase in seed iron content. Among the genotypes, GRG-2009 belonged to high iron content group recorded significantly highest germination (96.00 % in 2014, 97.00 % in 2015 and 96.50 % in pooled mean) (Fig. 4), seedling length (33.33 in 2014, 33.63 in 2015 and 33.48 cm in pooled mean) (Fig. 5) and seedling vigour index (3200 in 2014, 3262 in 2015 and 3231 in pooled mean) (Fig. 6) compared to other genotypes. Whereas, genotypes which belonged to low zinc content group showed lower seed quality parameters.

There was a progressive increase in seed germination (from 82.92 to 96.50% and 81.76 to 94.95%), seedling length (25.93 to 33.48 cm and 27.38 to 32.75 cm) and seedling vigour index (2150 to 3231 and 2239 to 3110) with increase in seed-Fe and Zn content, respectively (Fig. 7 and 8). Seeds dense with iron and zinc content significantly recorded highest germination and seedling vigour compared to low and medium groups. The present result confirms the findings of Yilmaz *et al*. (1997) in wheat and Boonchuay *et al*. (2013) in paddy, who also observed increase in seedling vigour with progressive increase in seed-Zn content. Micronutrients caused transfer of photosynthetic material to the seeds, and when compared to the control (without foliar application), produced stronger seeds and finally improved seed germination as observed in castor bean by Mohammad *et al.* (2012). Genotypes with high seed-Zn recorded highest seedling length and seedling vigour index compared to genotypes with high seed-Fe.

Increase in seed germination and seedling vigour with increase in seed-Zn could be ascribed as the micro element Zn is a component of protein synthesis and their related functions (Broadley *et al*., 2007). There are nearly 2800 proteins which need Zn for their structural and functional integrity (Andreini *et al*., 2006). These findings indicate that there may be greater necessity of Zn during root and coleoptile development for active protein synthesis and / or other related functions. During the seed germination, production of Reactive Oxygen Species (ROS) is unavoidable and seeds /seedlings have defense mechanisms against ROS production (Qin and Liu, 2010). One of the defense enzymes against ROS is superoxide dismutase which is Zn dependent (Cakmak, 2000 and Broadley *et al*., 2007).

It is concluded that, higher zinc and iron in pigeonpea seed effectively improves the germination and seedling vigour and genotypes with higher zinc and iron content can be used for sowing to get uniform and better seedling growth under micronutrient deficient soils, Further, these genotypes can be used in crop improvement programme to transfer the gene/s responsible for enhancing Zn / Fe in seed to the promising varieties to augment nutritional security.

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