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Micronutrient content evaluation of newly developed vegetable soybean population

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Abstract
The present investigation based on nutritionally rich crops vegetable soybean aimed at comparing green and mature stages. Evaluation of selected vegetable type lines for micro nutritional quality traits *viz*., iron, zinc, copper, manganese, revealed that the green stage legumes had higher amount of iron, while zinc, copper and manganese found to be higher in mature stage.

Keywords: Vegetable soybean, nutritional composition, micronutrient content.

Introduction
Soybean is a "golden bean" having a great nutritional and industrial value (Hossain *et al.* 2003) [4]. Vegetable soybean had a highest protein (40%) containing food crops compared to other pulses consumed as vegetable and is second only to groundnut in terms of oil content (20%). Among food legumes, excellent balance of amino acids was found in Soybean protein (Wolf and Cowan, 1975) [8] particularly vegetable soybean called Edamame had potential on another level as it is complete daily requirement of micronutrients, sweet in taste and less in trypsin inhibitor content than grain soybean. No other vegetable legume can beat the nutrition value of Edamame.

Legumes, being the richest source of plant based proteins (Kample *et al*. 2018) [5], (Tharanathan and Mahadevamma, 2003) [7], plays a key role in the Indian diet as India is home to the highest vegetarian population in the world. (Anonymous, 2015) [1]. They are also important sources of minerals including calcium, iron, zinc and provitamin A (Keatinge, 2011) [6]

Number of disease caused due to micronutrient deficiency. The nutritional value and protein content is an important characteristic of vegetable soybean, which is higher than all other vegetable legumes. In substitution to the animal protein this vegetal protein could heal malnutrition in people. Besides, it fixes nitrogen and forms a good source of green manure when buried after harvest of green pods. Despite in India, all these advantages, vegetable soybean is not yet popularly accepted either for domestic consumption or in the farming systems. It is because of lack of awareness and the non-availability of a suitable genotype in the transitional tract of Maharashtra. Hence, an attempt has been made to identify the suitable lines based on physiological and nutritional characters.

Materials and Methods
The 80 selected lines of crosses between five grain and three vegetable type soybean genotypes were evaluated for micronutrient content during Kharif 2017-18. The set of eight parents were crossed among themselves to develop novel variation in segregating generation for traits important for soybean to be called as "vegetable-type-soybean". The advanced lines developed through these crosses were selected based on traits under consideration. The Genotypes used in present study are enlisted in (Table 1).

Table 1: The cross combination and number of lines selected from each cross.

Sr. No.	Crosses	No. of lines selected
1	Himso-1563 x NRC-55	16
2	JS-SH-93-37 x Swarna Vasundhara	18
3	MACS-1037 x Swarna Vasundhara	08
4	MACS-1188 x AGS-459	27
5	JS-93-05 x Swarna Vasundhara	11
Total lines		80

The present investigation was conducted at the field of Department of Agricultural Botany, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra state the observations on various quality characters were recorded on five competitive randomly selected plants in each genotype and in each replication as described above and were averaged to represent the treatment means of the replication. Observation based on nutritional traits like (with units in brackets), Iron-Fe (mg/100 g), Zinc-Zn (mg/100 g), Copper-Cu (mg/100 g), Manganese-Mn (mg/100 g).

Micronutrient were estimated by Di-acid digestion method. The objective of digestion is to destroy the organic compounds and bring the elements to a soluble form. For this 0.5 g of seed samples were weighed and placed in labeled conical flasks. 10 ml-12 ml of di-acid was added to each flask. Di-acid is a mixture of nitric acid and per chloric acid in the ratio of 9:4. The flasks were placed on a hot plate and set at 150°-200°C till the residue turned colorless then after flasks were allowed to cool at room temperature. Later filtration was done using Whatman filter paper no.42 in a 50 ml volumetric flask. The final volume was made up to 50 ml using double distilled water. Finally reading is noted on the atomic spectrometer at an appropriate wavelength against standard solutions.

Result and Discussion

The results of micronutrient content such soybean seeds are presented and discussed nutrient-wise in the following paragraphs.

Zinc content

Zinc (Zn) is a chief trace mineral required for the body's immune system, cell division, and wound healing. The suggested dietary allowance for zinc is 8-11 mg/day. The tolerable upper intake level is 40 mg/day (ConsumerLab.com). In the present study, 80 genotypes selected from five crosses were evaluated for Zn content in the green stage and mature stage.

Analysis of 16 lines of the cross "HIMSO 1563 X NRC 55" revealed a wide variation of 5.10 mg/100 g to 8.20 mg/100 g in green stage and 4.37 mg/100g to 7.39 mg/100 gm in the mature stage. Lowest zinc content in both green and mature stage was noted in line VS-1-67-17, whereas the highest value for zinc content in the green stage was found in VS-1-13-17 (8.20 mg/100 g) while, line VS-1-17-17 noted to be highest in zinc content in mature stage (7.39 mg/100 g). The graphical representation of the zinc content of selected lines of the first cross can be seen in Figure 1. Among all the lines under investigation, these lines were found to the highest for zinc content.

Among the 18 lines of a second cross, JS-SH-93-05 X Swarna Vasundhara), lowest zinc content in the green and mature stage was noted in line VS-2-130-17(4.30 mg/100 g and 3.57 mg/100 g respectively) while the highest value was observed in line VS-2-131-17 (7.20 mg/100 g) and VS-2-133-17 (6.52 mg/100 g) for green stage and mature stages, respectively as depicted in Figure 1.

Zinc analysis of 10 lines of the third cross (MACS-1037 X Swarna Vasundhara) showed a variation of 4.10 mg/100 g to 6.37 mg/100 g in mature stage whereas 5.10 mg/100 g to 7.50 mg/ 100 g in the green stage, lowermost zinc content in both the stages was noted in line, VS-3-104-17 (4.10 mg/100 g in the mature stage and 5.10 mg/100 g in green stage). Line VS-3-152-17 found to be possessed higher Zinc in the green and matured stage with 7.50 and 6.37 mg/100 gm (Fig. 1).

Fourth cross i.e. MACS-1188 X AGS459 with selected 27 advanced lines was evaluated for zinc content and found the range of 2 mg/ 100 g to 5.40 mg/ 100g in the mature stage and 3.00 mg/100 g to 6.40 mg/100 g in the green stage. Line VS-4-241-17 (3 mg / 100 g) and VS-4-178-17 (6.40 mg/100gm) were found to be lowest and highest in zinc content at green stage respectively. Whereas, line VS-4-226-17 (2.07 mg/100 g) and line VS-4-182-17 (5.47 mg/100 g) observed to be lowermost and uppermost, respectively for zinc content in mature stage among all the lines (Figure 1).

Among the 10 lines of the fifth cross (JS SH-93 37 X Swarna Vasundhara), line VS-5-265-17 (4.30 mg/100gm) was found to have higher zinc content in green stage and line VS-5-265-17 (4.30 mg/100 g) found to be higher in zinc content in the green stage. Comparatively highest reading for the mature stage was noted in line, VS-5-272-17 (3.27 mg/100 g). Among all the 80 lines, VS-1-13-17 and VS-1-16-17 (8.20 mg/100gm) had maximum zinc content in the green stage while line VS-1-17-17 (7.39 mg/100gm) followed by VS-1-13-17 (7.29 mg/100 gm) had maximum zinc content in the mature stage.

Iron content

Iron (Fe) is a vital mineral as it is needed for hemoglobin synthesis and it's -deficiency cause anemia which is a widespread problem in women and children (U.S. National Library of General Medicine). The recommended nutritional allowance for iron is 8-9 mg/day with a tolerable upper intake level is 45 mg/day (ConsumerLab.com) [2].

In the present study, iron content present in the green and mature stages of selected vegetable lines was analyzed through atomic absorption spectroscopy. In the advanced lines derived from cross first of soybean genotypes, iron content ranged between 2.04 mg/100 g (VS-1-30-17) to 2.65 mg/100g (VS-1-41-17) in the green stage, while 4.10 mg/100 g (VS-1-30-17) to 4.94 mg/100 g (VS-1-75-17) in a mature stage (Figure 2). Similar results were reported by Garg *et al.* (2014) [3].

Analysis of lines generated from the cross, JS-SH-93-37 × Swarna Vasundhara, Fe content in green stage varied from 1.22 to 2.89 mg /100 g whereas, 3.29 to 4.64 in mature stage (Figure 2). Uppermost reading for Fe content in the green stage was recorded by VS-2-139-17 (2.89 mg/100 g) and VS-2-132-17 for the highest iron content in the mature stage (4.64 mg/ 100 g) for this cross.

The Iron content of selected eight lines of cross MACS1188 × Swarna Vasundhara was ranged from 1.22 to 2.87 mg/ 100 g in green seed while 3.33 to 4.42 mg/ 100 g in the mature stage. VS-3-98-17 (4.42 mg/100 g) and VS-3-108-17 (2.87 mg/100 g) were found to be highest among all the eight lines of this cross in the mature stage and green stage respectively.

The fourth cross, MACS-1188 × AGS 459 comprises of 27 advanced lines recorded range of progenies as 2.39 mg/100 gm (VS-4-239-17) to 4.62 mg /100 gm (VS-4-244-17) for iron content in the mature stage and green stage line VS-4-184-17, had highest Iron content *viz.*, 2.95 mg/100g (Figure 2).

In the case of cross JS-SH 93-05 × Swarna Vasundhara, Iron varied from 1.06 to 2.51 mg /100 g in the green stage. Variation of 2.66 to 4.47 mg/100 g in the mature stage was observed. Line, VS-5-273-17 (2.51 mg/100 g), and VS-5-274-17(4.47 mg/100 g) were found to be highest for iron content in green and mature stage respectively.

Considering all the lines, genotype VS-4-184-17 (2.95 mg/100g) for green stage and line VS-1-75-17 (4.94) for the mature stage had the highest iron content.

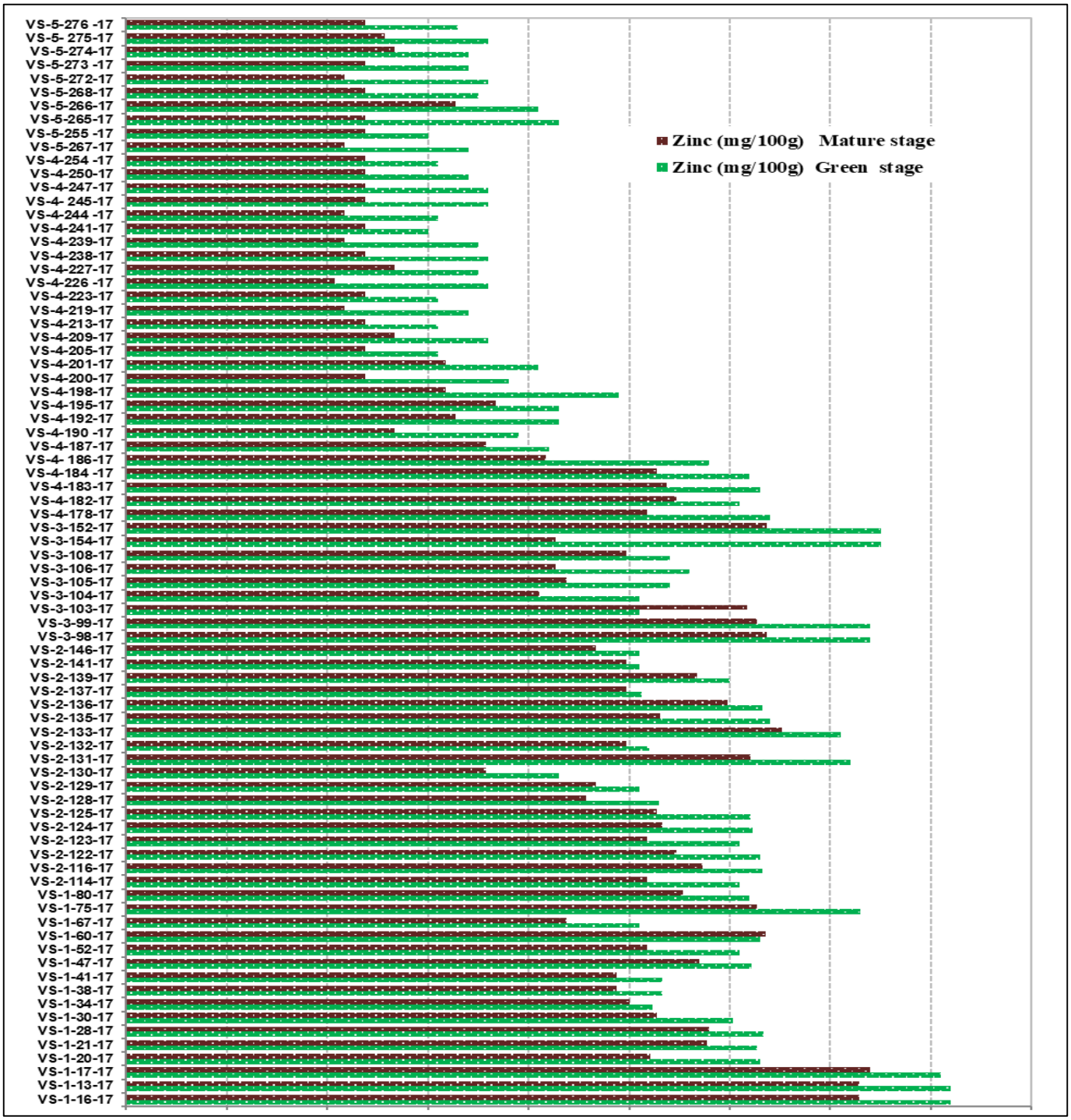

Fig 1: Graphical representation for Zinc content in lines of vegetable soybean

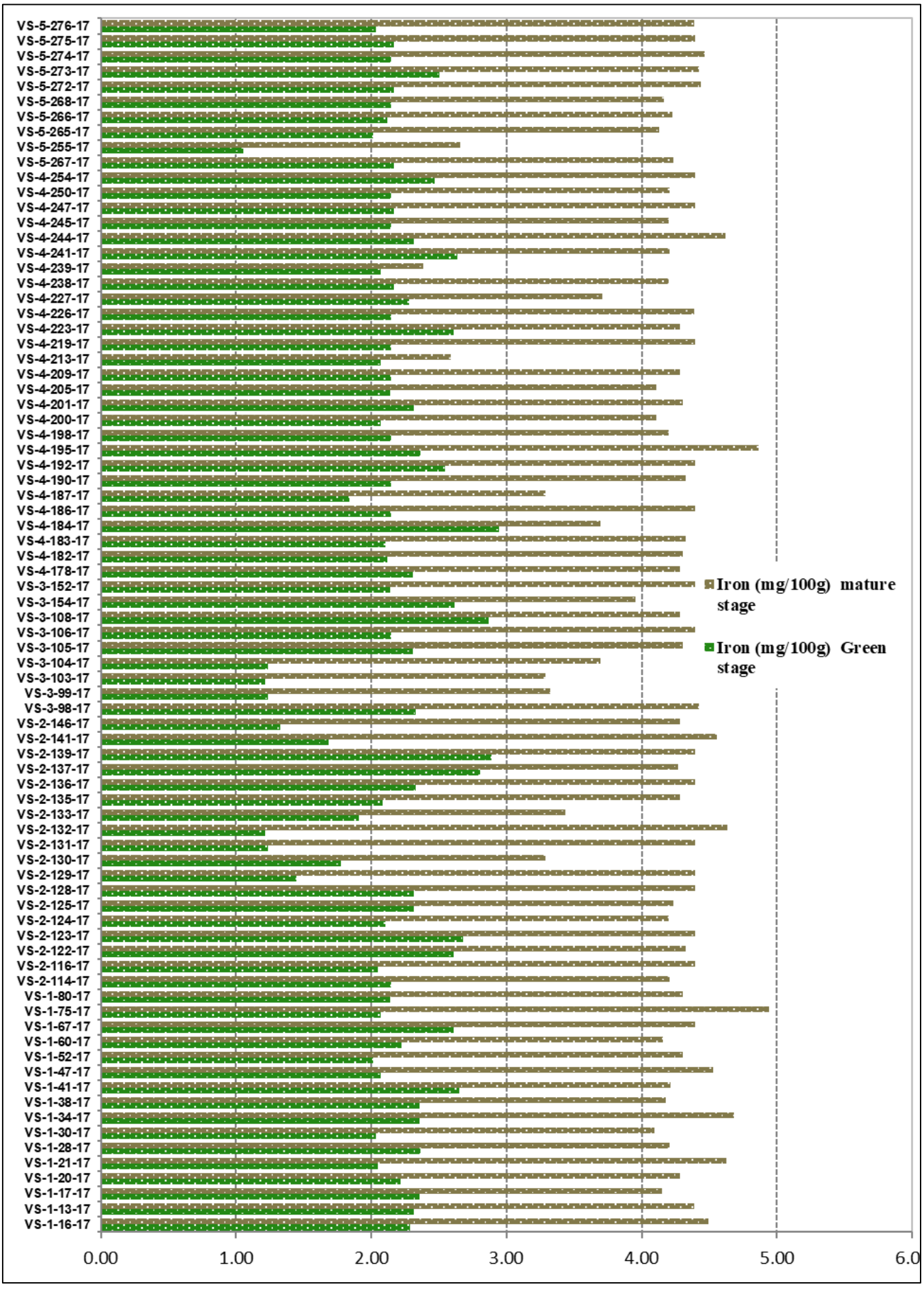

Fig 2: Graphical representation for Iron content in advanced lines of vegetable soybean

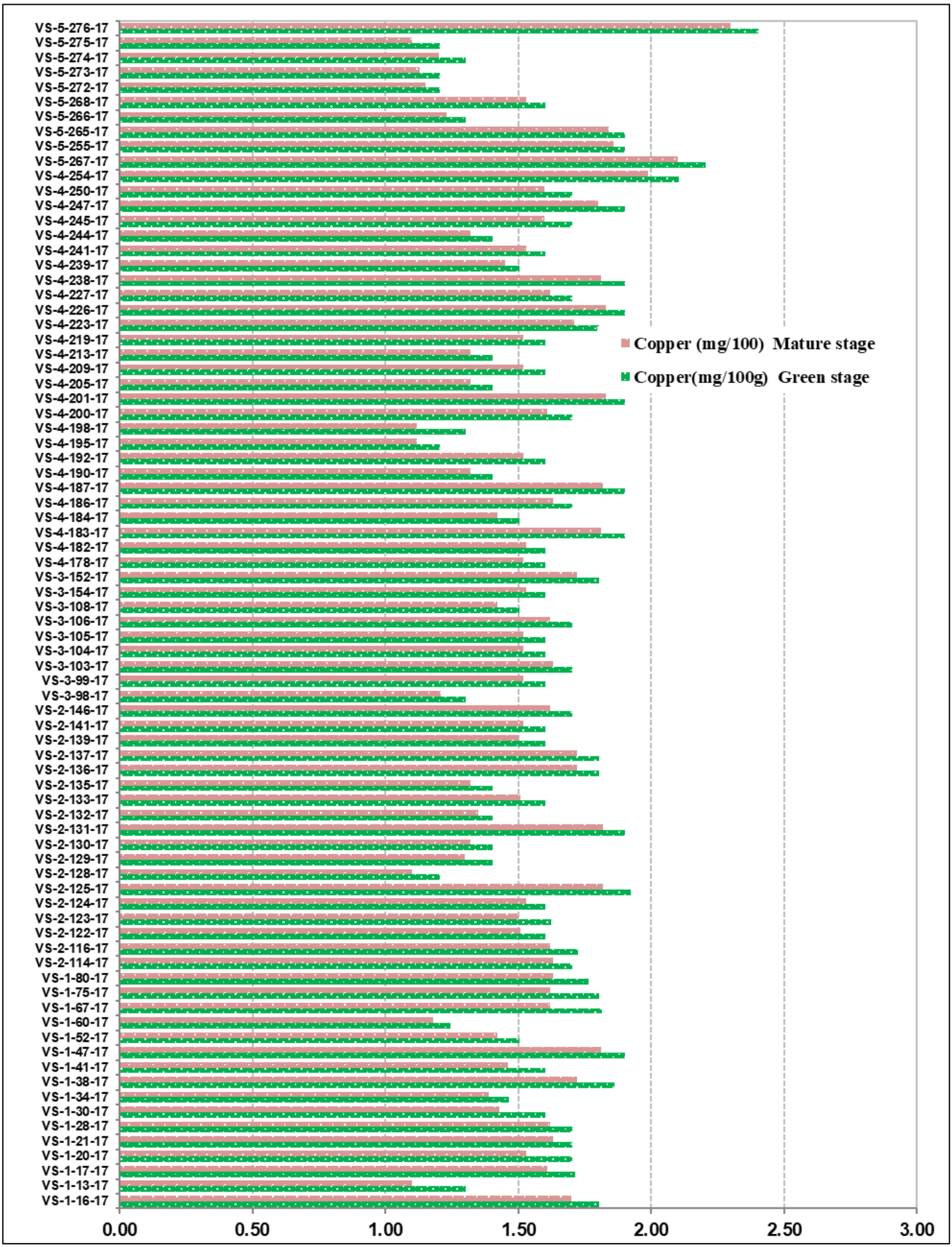

Fig 3: Graphical representation for copper content in advanced lines of vegetable soybean

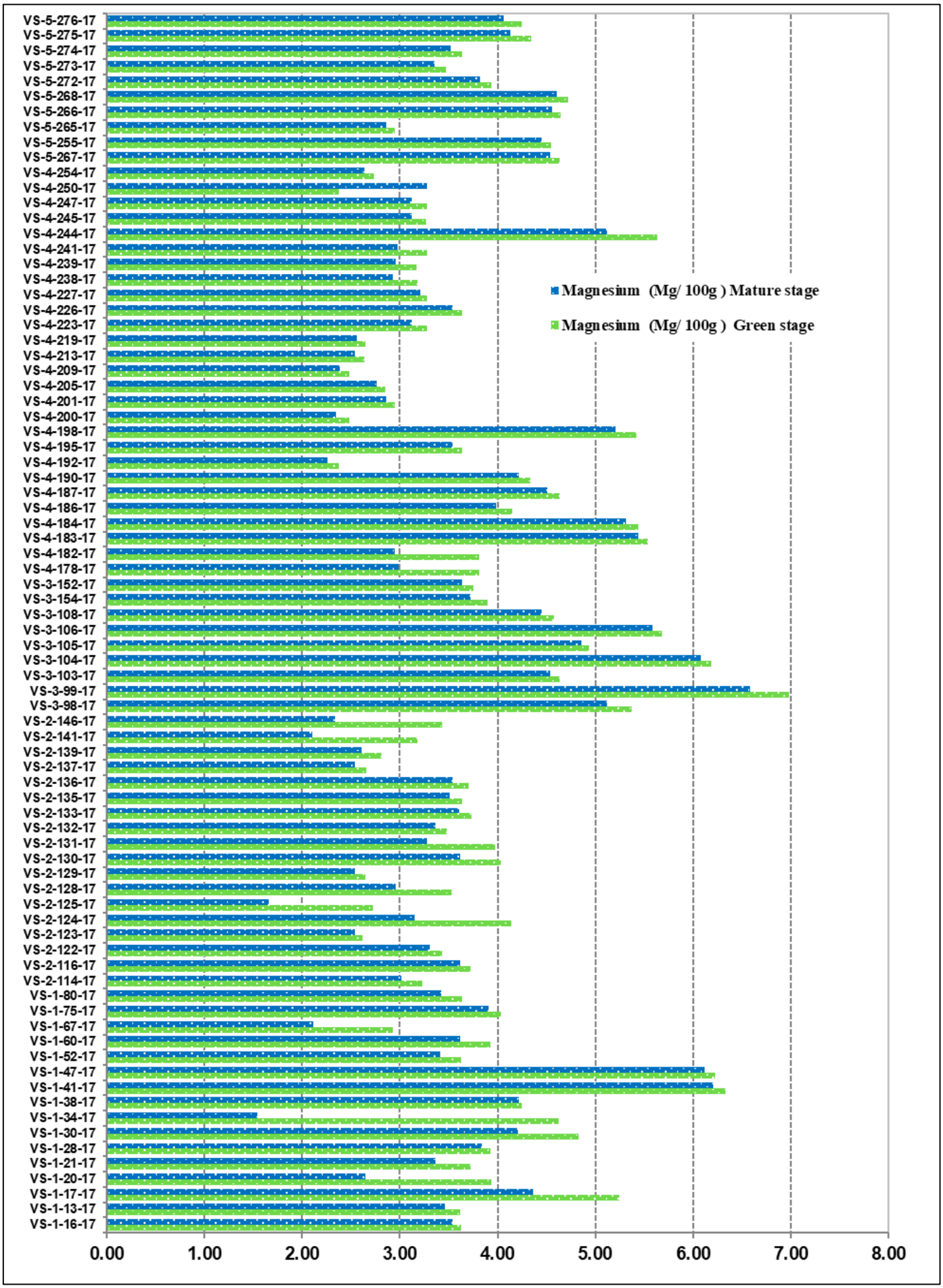

Fig 4: Graphical representation for magnesium content in advanced lines of vegetable soybean

Copper content

Copper (Cu) is a needed mineral that keeps blood vessels, nerves, and immune system healthy and aids in iron absorption. The suggested dietary allowance for copper is 1 mg/day. The acceptable higher intake level is 10 mg/day (Consumer Lab.com) [3].

The copper content of 16 lines derived from Cross-1, 1.24 to 1.90 mg/ 100 g of Cu variation was observed in green stage and 1.10 to 1.81 mg/ 100g in the mature stage. Highest Cu content in both green and mature stage was noted in line, VS-1-47-17 (1.90 and 1.81 mg/100g in green and dry stage, respectively). Lowest reading was observed in line VS-1-60-17 (1.24 mg/ 100g) and line VS-1-13-17 (1.10 mg/100 g) for in green stage and mature stage, respectively (Fig 3). Among the 18 lines generated from cross-2, JS-SH-93-37 X Swarna Vasundhara, line VS-2-131-17 (1.82 mg/100 g) showed maximum reading for Cu in matured stage. Similarly, line VS-2-125-17 (1.92 mg/100 g) noted to be maximum in green stage for Cu content (Fig 3). Lowermost reading for both the stages found in VS-2-128-17 with 1.10 and 1.20 mg/100 g in mature and green stage, respectively.

The copper content of nine advanced lines generated from cross MACS-1188 × Swarna Vasundhara ranges from 1.21 to 1.72 mg/100 gm in matured stage and 1.30 to 1.80 mg/100 g in the green stage, the highest reading for both dry and green stage was observed in VS-3-152.17 (1.72 and 1.80 mg/100 g, respectively) similarly lowermost reading was observed by VS-3-98-17 for both the stages (1.21 and 1.30 mg/100 g in mature and green stage, respectively) (Fig 3)

In case of fourth cross, MACS-1188 × AGS 459, 27 lines were evaluated. Out of which, VS-4-254-17 showed maximum value for both stages. Similarly, line VS-4-195-17 found to be lowermost for Cu content *viz*., 1.12 mg/100 g in dry stage and 1.20mg/100 g in the green stage (Fig 3). The Cu content in lines developed from the fifth cross varied from 1.20 to 2.40 mg/100 g in the green stage and 1.10 to 2.30 mg/100 g in the green stage.

Among all the genotypes under investigation the highest value was observed in line VS-5-276-17 for both the stage (2.30 and 2.40 mg/100 g in dry and green stage, respectively).

Magnesium content

Magnesium (Mg) is a mineral that is found in several foods including nuts, legumes, seeds, and leafy vegetables. Insufficiency of manganese leads to osteoporosis and other sicknesses. The mentioned dietary allowance for manganese is 1.8-2.6 mg/day. The tolerable upper intake level is 11 mg/day (ConsumerLab.com)[3].

In cross-1, Mg content at the R_6 stage (green stage) was carried from 2.93 to 5.34 mg/100 g and 1.54 to 5.21 mg/100 g at the R_8 stage (dry stage). Line VS-1-41-17 (5.34 mg/100 g and 5.21 mg/100 g) found to be uppermost in the green stage and mature stage, respectively while lowest reading noted in line VS-1-34-17 (1.54 mg/100 g) for mature stage and in line VS-1-67-17 (2.93 mg/100 gm) for the green stage as shown in Figure 4.

Evaluation of lines derived from cross-2 revealed wide variation of 1.66 to 3.62 mg/100 g at the R_8 stage and 2.62 to 4.14 mg/100gm at the R_6 stage. Lowest magnesium content at both R_6 and R_8 stage observed in line VS-2-125-17 (1.66 mg/100 g) and VS-2-123-17 (2.62 mg/100 g) correspondingly and highest reading observed in line VS-2-124-17 at R_6 stage and VS-2-130-17 at R_8 stage as presented in Figure 4.

Comparing all the lines of third cross, Mg content at R_6 stage was ranged from 3.76 to 5.99 mg/100 g whereas at the R_8 stage it ranges from 3.64 to 5.59 mg/100 g. Out of which, line VS-3-99-17 noted to highest with value 5.99 mg/100g followed by VS-3-106-17 (mg/ 5.69 mg/100g) this line also found to be highest in mg content in mature stage (5.59 mg/100g). Mg content of the line generated from the forth cross was ranged from 2.38 to 5.64 mg/100 gm at R6 and 2.26 to 5.44 mg/100 at the R_8 stage. Uppermost reading was reported by VS-4-244-17 (5.64 mg /100 gm at the green stage) and VS-4-183-17 (5.44 mg /100 gm at mature stage,).

In case of fifth cross, VS-5-268-17 (4.73 and 4.61 mg/100 g) found to be highest among all the lines of this cross as represented in Fig 4. Similar results were reported by Garg *et al*. (2014) and Kampli *et al*. (2017). Line VS-3-99-17 notated to be the uppermost mg contenting line at green stage (5.99bmg/100g at R6 and 5.58 mg/100g at R8) as well as second highest in mature stage while line VS-3-106-17 reported maximum mg content in mature stage (5.59 mg/100g).

Conclusion

Micronutrient analysis revealed that at green stage lines VS-1-13-17 and VS-1-16-17 (8.20 mg/100gm) had maximum zinc content, line VS-4-184-17 had the highest Iron while, line VS-5-276-17 found to be uppermost in copper content and line VS-3-99-17 notated to be the uppermost for magnesium content. This lines can be used as verity or quality improvement breeding programme

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