Title of dissertation			
Study of Genetic Diversity, Leaf Pigmentation and Abiotic Stress Tolerance in Vegetable Amaranth			
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In variability and diversity of 47 vegetable amaranth genotypes for antioxidant vitamins and minerals composition, protein, fiber, yield and yield contributing morphological traits, we observed that direct selection through Fe, Mn, fiber content, plant height and stem base diameter, leaves plant^{-1} would significantly improve the foliage yield of vegetable amaranth. In contrast, concomitant selection based on high nutrient and antioxidant content and high foliage yield would be effective selection method for improvement of vegetable amaranth.

Forty-three vegetable amaranth genotypes were evaluated to know variations in minerals, quality and agronomic traits TAC, antioxidant leaf pigments, vitamins and foliage yield. Vegetable amaranth is a rich source of K, Ca, Mg, proteins, dietary fiber, chlorophylls, betalain, carotene, ascorbic acid and antioxidant. Six genotypes could be selected for high minerals, protein and dietary fiber contents. The genotypes VA14, VA16, VA18, VA15, and VA20 could be selected for high yields and abundance antioxidant leaf pigments and vitamins. Leaf area, shoot weight, shoot/root weight, stem base diameter, antioxidant leaf pigments, antioxidant capacity and foliage yield had a strong positive association. Selection for minerals, protein, dietary fiber content and antioxidant vitamins might be possible without compromising yield loss. In contrast, most of the interrelationships among antioxidant leaf pigments traits. These genotypes were evaluated to determine the status of total antioxidant content, polyphenol, flavonoid, antioxidant vitamins and minerals, dietary fiber, nutritional and agronomic traits and the magnitude of genetic diversity based on the contribution of those traits for meaningful grouping and proper utilization in future breeding program. Biological yield and antioxidant content were strongly associated with their related agronomic traits. Flavonoid content had a higher contribution to antioxidant capacity compared to vitamin and mineral antioxidants. Contribution of antioxidant profile and agronomic traits were the highest in diversity of vegetable amaranth. High yielding genotypes from cluster VI could be used directly as high antioxidant profile varieties and low yielding genotypes as a source of donor parents in hybridization program.

Four selected *A. tricolor* genotypes were grown under four soil water content and three selected *A. tricolor* genotypes were grown under three salinity stress to evaluate their response in nutrients, minerals, antioxidant leaf pigments, vitamins, polyphenol, flavonoid and total antioxidant activity (TAC). Vegetable amaranth was significantly affected by variety, drought or salinity stress and variety × drought or salinity stress interactions for all the traits studied. Increase in water stress, resulted in significant changes in proximate compositions, minerals, leaf pigments, vitamin, polyphenol, and flavonoid of vegetable amaranth. Similarly, proximate, minerals, leaf color parameters and pigments, ascorbic acid, polyphenol, flavonoid, antioxidant capacity in leaves were remarkably increased at 50 mM and 100 mM NaCl concentrations. Accessions VA14 and VA16 performed better for all the traits studied under drought stress. Leaf pigments, vitamins, polyphenols and flavonoids both in drought and salinity stress had a strong antioxidant activity. Vegetable amaranth can tolerate soil water and salinity stress without compromising the high quality of the final product. Therefore, it could be a promising alternative crop in semi-arid, dry and salinity prone areas.

A. tricolor VA13 was evaluated under salinity and VA3 was assessed at drought stress that significantly affected all the compounds studied. Proximate, minerals, total carotenoids, TFC, vitamin C, TPC, beta-carotene, TAC, sixteen phenolic acids and flavonoids were remarkably increased with the severity of drought or salinity stress. At moderate and severe drought or salinity stress, the increments of all these components were more preponderant. *Trans*-cinnamic acid was newly identified phenolic acid in *A. tricolor*. Salicylic acid, vanilic acid, gallic acid, chlorogenic acid, *trans*-cinnamic acid, rutin, isoquercetin, *m*-coumaric acid and *p*-hydroxybenzoic acid were the most abundant phenolic compounds in these genotypes under both stresses.

Drought stress led to decrease in total biomass, specific leaf area, relative water content, photosynthetic pigments, soluble protein and increase in MDA, H_2O_2, EL, proline, total carotenoid, ascorbic acid, polyphenols, flavonoids and antioxidant activity. However, responses of these parameters were differential in respect to cultivars and the degree of drought stresses. No significant difference was observed in control and LDS for most of the traits. The cultivars VA14 and VA16 were identified as more tolerant to drought and could be used for further evaluations in future breeding programs and new cultivar release programs. Compatible solutes, non-enzymatic antioxidant and ASC–GSH cycle played vital role in detoxifying of ROS in *A. tricolor* cultivar.

The tolerant genotype VA13 exhibited lower reduction in growth, photosynthetic pigments, RWC, negligible increment in EL, lower increment in proline, GPOX activity and had higher CAT, SOD, remarkable and dramatic increment in AsA-GSH content, AsA-GSH redox and AsA-GSH cycle enzymes activity compared to sensitive genotype VA15. The negligible increment of AsA-GSH content, AsA-GSH redox and AsA-GSH cycle enzymes activities and dramatic increment in MDA, H_2O_2 and EL were observed in VA15. SOD contributed superoxide radical dismutation and CAT contributed H_2O_2 detoxification in both sensitive and tolerant varieties, however, these had a great contribution in the tolerant variety. Conversely, proline and GPOX accumulation was higher in the sensitive variety compared to the tolerant variety. Increase in AsA-GSH cycle enzymes activities, CAT, AsA-

GSH content, SOD, and AsA-GSH redox clearly evident that CAT, AsA-GSH cycle and SOD played a vital role in detoxification of ROS in the tolerant variety of *A. tricolor*.

Photos

Observation of vegetable cultivation factory in Japan

Presentation of PhD dissertation at Gifu University