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Correlation in Seed Coat Colour and Pod Colour of French Bean Collected form Garhwal Himalayas

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Abstract: Uttarakhand is one of the most important sources of French bean and the landraces grown throughout Uttarakhand are valuable sources of genes for breeding Programme and evolutionary studies. The objective of our experiment was to study about the correlation between pod colour and seed coat colour. Thirty accessions of French bean were collected from different districts of Garhwal region of Uttarakhand. Two years field trials (2019 and 2020) were conducted and the seed and pod data were recorded. Frequency distribution, UPGMA cluster analysis and Mantel correlogram revealed that the accession whose pod colour was green (without any pattern), their seeds were also plane while the accessions whose pods were carrying some pattern or stripes their pods were also textured or mottled. The knowledge of correlation between seeds and pods can be used in French bean breeding Programme. The knowledge could be used to identify within accession variability in French bean germplasm to protect each type from extinction

Keywords: French bean, accessions, UPGMA, correlogram, correlation.

Introduction

The French bean (*Phaseolus vulgaris* L.) is a nutritionally dense crop that is both economically and agriculturally important around the world (Fetahu *et al*., 2014). It is a crop with a wide range of morphological characteristics that is found all over the world (Gaitan *et al*., 2002). French bean has a small genome (580 Mbp/haploid genome) that is distributed across 22 chromosomes (n=11) (Gepts *et al*., 2008). French be has a high nutritional value, with protein (22.24 to 31.59 percent), carbohydrates (27.80 to 34.78 percent), fibre (16.81 to 40.63 percent), ash (4.1 to 4.82 percent), and lipids (1.66 to 2.22 percent) (Fetahu *et al*.,2014). According to FAO, French bean global harvested area was 33.1 million ha and production was 28.9 million tons in 2019. Asia shares 50% of the global production of common bean and Myanmar, India, Brazil, China, America were the top five dry bean producing countries in the world in 2000–2019 (WHO, 2020).Maharashtra, Uttarakhand, Jammu & Kashmir, Uttar Pradesh and Himanchal Pradesh are the major states in India, where the French bean is growing in a large amount in an area of 137.54 thousand ha with production of 1370.21 thousand MT (NHB, 2015). A great diversity of French bean is present in Uttarakhand (Prabha *et al.*, 2021) and 5776 ha area is under French bean production in Uttarakhand. Uttarkashi, Chakrata and Chamoli

are main districts which are famous for the production of good quality French bean.

The seed coat, which is a major modulator of interactions between the internal structures of the seed and the external environment, not only maintains the integrity of the seed parts but also protects the embryo from mechanical injuries and pest disease attacks. The seed coat also improves seed survival in the soil, particularly in adverse environmental conditions, and aids in the prevention of species extinction in nature (Souza *et al*., 2010 and Tiryaki *et al*., 2014). At physiological maturity, the seed coat acquires its specific colour, and seed coat pigmentation has been shown to play an important role in seed dormancy and germination (Debeaujon *et al*., 2000, Powell *et al*., 1989, Ochuodho *et al*., 2008). Furthermore, pod and seed coat colour have been used to develop a simple method of improving seed quality for several crop species, including French bean (Possobom *et al*., 2015 and Hacisalihoglu *et al*., 2013, cowpea (Marwanto *et al*., 2013) rapeseed (Zhang *et al*.,2004), flax (Dana *et al*., 2008), and *Arabidopsis* (Debeaujon *et al*., 2000). Lots of variation in seed coat colour and pod colour is present in French bean. These variations can be used as morphological indicator to identify the French bean varieties during DUS testing. Therefore, this study was aim to determine seed coat colour variation and their possible correlation with pod colour parameters in French bean accessions collected from Garhwal Himalaya.

Plant material

The plant material used in this study comprised thirty accessions of French bean collected from different district of Garhwal region. Data on the germplasm were recorded during two vegetative cycles of 2019 & 2020 in the farmer's field at New Tehri, Tehri Garhwal. This field is located at 30.3739^0 N, 78.4325^0 E and elevation of 1750m above sea level. The soil of the experimental farm is fine loam rich in organic matter. Average rainfall was recorded 1332.4 mm during April to November. The crop was sown in the month of April each year by following RBD in two replications. Ten seeds per row were sown for each accession with spacing of 30x15 cm. The harvesting was done in the month of November to December.

Plant characters, Data recording & Statistical analysis

Two plant characters *viz.*, pod colour and seed coat colour were recorded. Further, frequency distribution was observed by calculating their mean, UPGMA cluster analysis based on Euclidean distance and Mantel correlogram was observed by using PAST version 4.03. The Pearson correlation coefficient (R and *p)* was calculated by using online calculator.

Plate-1. Seed accessions without texture in seed coat.

Results and discussion

Frequency distribution

The frequency distribution was recorded for both the traits and it was found that in the case of pod colour out of these twenty accessions, two accessions (GFB-06 and GFB-09) were maroon coloured (group-I), the accession GFB-12 was white coloured (group-II), GFB-15 khaki coloured (group-III), GFB-19, GFB-20 yellow coloured (group-IV), GFB-01, GFB-02, GFB-03 and GFB-11 was cream mottled (group-V), GFB-04, GFB-05 and GFB-07 was maroon mottled (GFB-06), the colour of GFB-10 and GFB-13 was recorded dark blue mottled (group-07), GFB-14 was khaki mottled (group-08), GFB-16 was light pink mottled (group-09), the colour of GFB-17 and GFB-18 was recorded as olive mottled (group-10) and GFB-08 was purple mottled (group-11).

The pod colour was found green for 17 accessions *viz.*, GFB-03, GFB-04, GFB-05, GFB-06, GFB-07, GFB-08, GFB-09, GFB-10, GFB-12, GFB-13, GFB-14, GFB-15, GFB-16, GFB-17, GFB-18, GFB-19, GFB-20 one accession was found with black striped (GFB-01), one with purple striped (GFB-11) and one with maroon striped (GFB-02). Arunga *et al.* (2015) found a correlation between flower colour and seed colour and they reported that white seeded accessions produced white flowers, black seeded accessions produce purple flower and brown seeded accessions produced purple or pink flowers. Similar pod and seed coat colour was also reported by Gopinath *et al.* (2013), Arunga *et al.* (2015), Nkhata *et al.*(2020), Sarikamis *et al.* (2009), Vaz *et al.* (2017), Caproni *et al.* (2019).

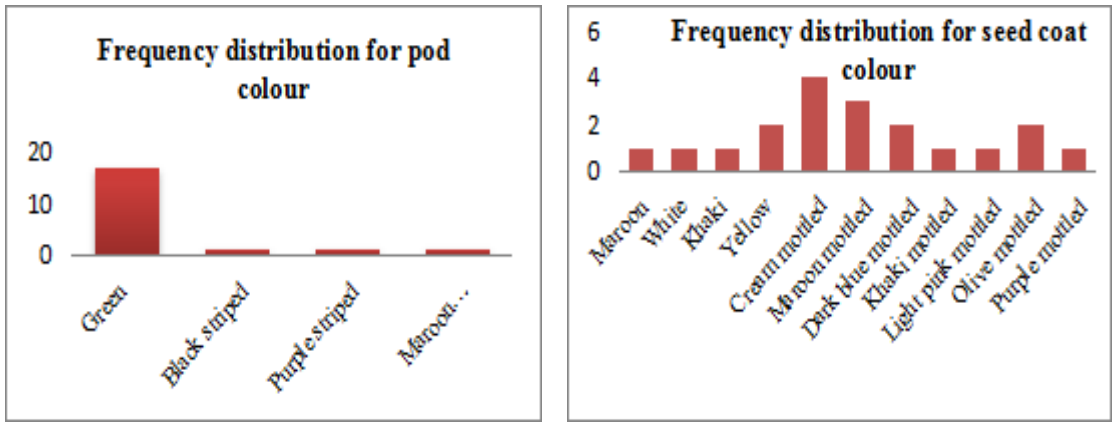

Fig.-1 (A) Frequency distribution for pod (B) Frequency distribution for seed coat colour

Pearson Correlation Coefficient and Mantel correlogram

0.4372R and **0.0157*p*** value was recorded in our study, which showed a positive correlation between pod colour and seed coat colour. The mantel correlogram showed positive correlation, no correlation and a negative correlation. In the fig.-2, the red coloured group is showing a positive correlation, orange group is showing no correlation while yellow, cyan and blue coloured groups showing highly negative correlation. Karasu *et al.* (2010) found positive correlations between number of seeds per plant and number of seeds per pod, biomass yield and seed yield per plant. Similarly Sodagar *et al.* (2020) reported that Seeds/pod represented positive variable association with seed weight plant, pod length, pod width and pod length. Some other researchers Sehirali *et al.* (1980), Himan *et al.*(1996), Pooran-Chand *et al.*(1999), Amini *et al.*(2002). Verma *et al.* (2014) also reported similar studies.

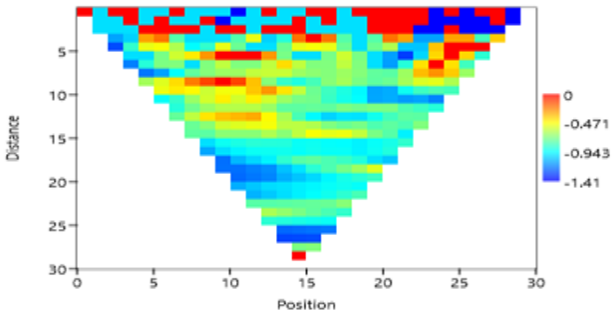

Fig-2. Correlation coefficient by Mantel correlogram.

Red coloured accessions are positively correlated while orange are showing no correlation. All other coloured groups are negatively correlated accessions. A correlation was recorded in our study between pod colour and seed coat colour and it was found that the seeds which were plane or single coloured, their pod colour were always green. No stripes were recorded in their pod. While the pod colour in which stripes of any colour was found were always mottled or speckled.

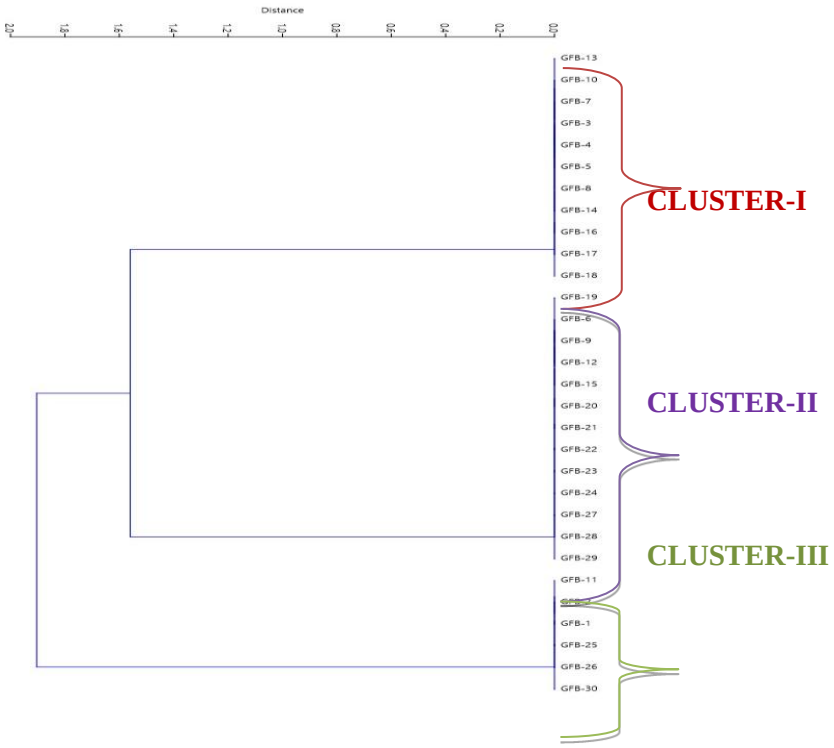

Fig-3. Mahalanobis cluster analysis of 30 french bean genotype on the basis of UPGMA euclidean distance.

*The I and III clusters are negatively correlated while the cluster II is positively correlated accessions

Mahalanobis UPGMA Cluster analysis

The Mahalanobis UPGMA Cluster analysis (Fig.3) clearly grouped all the highly correlated accessions in separate group. Two clusters were formed at the distance of 1.9, which were further divided into three sub-clusters at the distance of 1.58. These clusters contain highly positive and egative correlated accessions. Cluster-I grouped eleven accessions *viz.*,GFB-13, GFB-10, GFB-07, GFB-03, GFB-04, GFB-05, GFB-08, GFB-14, GFB-16, GFB-17, GFB-18 cluster-II grouped a total of thirteen accessions *viz.*, GFB-19, GFB-06, GFB-09, GFB-12, GFB-15, GFB-20, GFB-21, GFB-22, GFB-23, GFB-27, GFB-28, GFB-29 while the sub-cluster III contains six accessions *viz.*, GFB-11, GFB-02, GFB-01, GFB-25, GFB-26 and GFB-30. In the cluster I and III all the accessions which are negatively correltaed with seed coat colour and pod colour are distributed. Here the negative correlation means pattern (speckeld and mottled) was absent in seed coat but absent in their pods.The II sub-cluster contained all the positively correlated accesions which means that seeds which were plane or no pattern were recorded and there pods were always plane or unpatterned.

Conclusion: The structure and colour of the seed coat are important traits for legume species in determining the quality and commercial value of seeds. Seed coat colour is also a central target in several French bean species, and any trait correlated with it, particularly pod colour, is a convenient way to select/deselect desired/unwanted plant material in a breeding Programme. Defining such a correlation between coat colour and pod colour parameters of French bean may aid in the development of better forage crops in the common vetch breeding Programme. In the French bean used in the experiment, there is evidence of a link between pod colour and seed coat colour. Grain coat genetics knowledge can be very useful in French bean breeding because it is important in farmer and customer preference. The knowledge should be applied to identify within accession variability in French bean germplasm in order to protect each type from extinction.

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