SUMMARY

Research reported in this manuscript was conducted to estimate (I) the extent of genetic variability for seed and seedling vigor traits among pea genotypes (II) to determine relationship among the various vigor traits (III) to study the heterosis, combining ability, nature and magnitude of gene effects for various field traits and laboratory characters. The ultimate aim was to identify the genotypes, which can be utilized in breeding programmes oriented towards higher yield coupled with high quality vigorous seeds. The studies also involved the identification of a suitable test for seed vigor determination in pea. The studies were carried out at two locations viz. Mountain Research Centre for Field Crops (MRCFC) Khudwani Anantnag, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Jammu and Kashmir i.e. location I and Kisan (PG) College, Simbhaoli, Hapur (KPGC) i.e. location II. However, the laboratory studies were conducted at Department of Seed Science and Technology, Ch Charan Singh University, Meerut.

Forty diverse pea genotypes with their origin from different ecological regions of the world were obtained from Division of Germplasm Collection and Exploration, National Bureau of Plant Genetic Resources Pusa, New Delhi. These genotypes were planted in the field at two sites i.e., Mountain Research Centre for Field Crops (MRCFC) Khudwani Anantnag, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, and Kisan (PG) College, Simbhaoli, Hapur (KPGC) to obtain fresh seed for two different vigor tests.

Data on seeds of all genotypes after two months from their harvesting, was recorded for various vigor characteristics viz. hundred seed weight, speed of germination, seedling root length, seedling shoot length, total seedling length, fresh seedling weight, dry seedling weight, vigor index I and vigor index II, electrical conductivity and viability test. High significant genotypic differences were found in both the seed sources for all the traits under study, and a wide range of variability was found for all traits.

In the seeds produces from both the seed sources, the estimates of PCV were higher than the estimates of GCV for all the characters, which indicate the presence of environmental influence. The genotypic coefficient of variation ranged from 7.59 for seed viability to 61.08 for vigor index I, whereas PCV ranged from 7.67 to 62.59 for the same characters respectively, for seeds from location I. However, for the seeds

raised at location II, the GCV ranged from 8.19 for seed viability to 58.39 for vigor index I, whereas PCV ranged from 8.21 to 58.99 for the same characters respectively. The estimates of GCV and PCV were high/moderate in order of their magnitude for the characters; vigor index I, seedling shoot length, total seedling length, seedling root length, fresh seedling weight and electrical conductivity for the seeds raised at both the sites. Low estimate of GCV and PCV were recorded for the characters seed viability, germination percentage, hundred seed weight and speed of germination for the seeds raised at location I as well as location II. The estimates of heritability were high for all the characters ranging from 0.76 to 0.98 for speed of germination, 100 seed weight, fresh seedling weight and electrical conductivity for the seeds raised at location I. The heritability values of the seeds raised at location II ranged from 0.79 to 0.99 for speed of germination, 100 seed weight, germination percentage, vigor index II and viability percentage.

Speed of germination had significant and positive phenotypic correlation with vigor index I, total seedling length and fresh seedling weight in seeds from location I as well as location II. Highly significant and positive phenotypic correlation was also observed between total seedling length and fresh seedling weight and vigor index I from both seed sources. The seed viability also exhibited highly significant and significant positive phenotypic correlation with 100 seed weight and seedling root length along with vigor index I respectively in seeds from location I. However, in the seeds produced at location II this relationship could not touch the significant limits. Vigor index I exhibited highly significant and significant positive phenotypic correlation with total seedling length, fresh seedling weight, speed of germination, germination percentage and 100 seed weight, dry seedling weight respectively from seeds produces at both locations. The electrical conductivity possessed highly significant negative phenotypic correlation with speed of germination, total seedling length, fresh seedling weight and vigor index I and vigor index II in seeds produced from location I. In the seeds produced at location II, although electrical conductivity showed similar negative phenotypic correlation with, speed of germination, total seedling length, fresh seedling weight and vigor index I, it showed non significant phenotypic relationship with vigor index II. Three genotypes IC-208375, EC-398602 and NBP-82 were found superior in respect of majority of vigor characteristics.

The characters that showed positive direct effects on vigor index II in order of their magnitude from the seeds produced at location I were total seedling length

(36.06), germination percentage (1.92), speed of germination (0.79), 100 seed weight (0.18), and seedling root length (0.16). Similarly the direct effects on vigor index II for the seeds produced at location II were total seedling length (5.62), dry seedling weight (0.61), viability percentage (0.47), fresh seedling weight (0.41) and germination percentage (0.21).Total seedling length contributed high positive indirect effects via seedling shoot length (35.94 & 5.55), seedling root length (35.71 & 5.27), and fresh seedling weight (30.21 & 4.60) from the seeds produced at location I and location II respectively.

For the genetic studies, twenty-three genotypes (three with high vigor and twenty with low vigor) were selected as testers and lines and were crossed in a Line x Tester fashion. Crosses were made during Rabi 2010 at Kisan (PG) College (KPGC), Simbhaoli Hapur. About 250-300 seeds were produced from each cross. Half of the F1 seeds from each cross were used for laboratory studies and remaining half of F1 seeds along with their respective parents were grown in the field at KPGC, Simbhaoli during Rabi 2011. Data on plant height, pods per plant, pod length, number of seeds per pod and seed yield per plant were recorded on five randomly selected plants in each plot of each of the three replications. The data were analyzed by following the techniques of analysis of variance (Panse and Sukhatme (1942) to genotypic and phenotypic coefficient of variation, heritability and genetic advance using software INDOSTAT 7.5 version and SPAR developed by Indian Agricultural Statistical Research Institute, New Delhi. Secondly heterosis and combining ability analysis was performed by using Kempthorne (1957) method.

Heterosis (per cent) over mid parental value (heterosis) and the better parent (heterobeltiosis) was computed for all the yield components in field studies and for vigor index in case of laboratory studies. It was observed that there was appreciable heterosis for line, tester and line x tester in almost all field characters studied. The case was same for laboratory characters as well except for fresh seedling weight, 100 seed weight, speed of germination and seedling root length. The significant positive and negative heterosis was observed for mid parent as well as better parent for different field and laboratory traits. The degree of heterosis varied considerably for every vigor character. For laboratory characters, the maximum values of heterosis over mid parent and better parent respectively was recorded for 100 seed weight (27.72 & 20.66), germination percentage (33.33 & 30.20), speed of germination (38.76 & 57.47), seedling root length (66.07 & 96.53), seedling shoot length (72.77 &

258.83), total seedling length (70.75 & 161.46), fresh seedling weight (12.36 & 45.61), dry seedling weight (28.06 & 72.08), vigor index I (22.18 & 156.87), vigor index II (42.81 & non significant value), electrical conductivity (-36.20 & -91.96) and viability percentage(13.60 & 24.31). For field characters, the maximum values of heterosis over mid parent and better parent respectively was recorded for plant height (146.82 & 256.96), pods per plant (208.47 & 368.69), pod length (63.58 & 96.67), seeds per pod (114.78 & 137.11) and seed yield per plant (96.47 & 157.95).

Combining ability analysis indicated that the good general combiners for most of the field characters included EC-538008, IC-267127, IC-267162, DMR-11, IC-208385, EC-342007, IC-424896, IC-208368 and NBP-82. The parents EC-398599, IC-424896, IC-267127, IC-208368, DMR-7, IC-208366, IC-267162, and IC-208364 were good general combiners for seed yield per plant. The good general combiners for most of the laboratory characters included EC-538008, IC-417878, DMR-7, IC-267162, EC-398599, IC-208385, IC-208385, DMR-11, IC-208368, IC-417586, EC-538005 and IC-208364. The good general combiners for vigor index included EC-538008, IC-267162, IC-208368, IC-417878, DMR-11 and EC-538005.

It was clear from the combining ability analysis that the dominance effect was found to be predominant for all field characters except for pod length and seed yield per plant. However, additive variances were higher for pod length and seed yield per plant. In contrast to this, for laboratory characters the additive effect was found to be predominant for all characters except speed of germination, seedling root length, and vigor index II. Moreover, it is clear, that vigor index I and dry seedling weight had relatively higher magnitude of additive variances as compared to other characters, whereas dominances variances were higher for speed of germination, seedling root length and vigor index II. The parents EC-398599, IC-424896, IC-267127, IC-208368, DMR-7, IC-208366, IC-267162, and IC-208364 were found better general combiners for seed yield per plant, while as IC-267162, IC-208368, IC-417878, DMR-11 and EC-538005 were found to be good general combiners for vigor index.

Based on the genetic component analysis, both additive and dominant components appeared important in the inheritance of most of the traits. However, in comparative terms, dominance (non-additive) component was relatively of higher magnitude in respect of all field characters except pod length and seed yield per plant, whereas the additive component proved more important incase of most of vigor traits except for speed of germination, seedling root length, and vigor index II. Both additive and dominance components were found playing an equal role in the inheritance of seedling root length and fresh seedling weight. The degree of dominance was higher for plant height, pods per plant and seeds per pod for field characters and vigor index II, speed of germination and seedling root length for laboratory characters.

The conclusions drawn from the current investigation are presented as under:

I. Presence of sufficient exploitable genetic variability for seed and seedling vigor in pea germplasm.

II. Presence of sufficient exploitable genetic variability for seed yield and its components in pea genotypes.

III. Importance of additive type of gene action for seed yield per plant.

IV. Importance of non-additive type of gene action for speed of germination, seedling root length, and vigor indices.

V. EC-398599, IC-424896, IC-267127, IC-208368, DMR-7, IC-208366, IC-267162, and IC-208364 were found better general combiners for seed yield per plant, while as IC-267162, IC-208368, IC-417878, DMR-11 and EC-538005 were found to be good general combiners for vigor indices.

VI. Use of above named genotypes for crossing in breeding programmes aimed for enhancing yield coupled with higher seed vigor/quality.