SUMMARY

The present investigation "Studies on provenances and plus trees performance, floral biology and geographical variation in Bundelkhand region in neem (Azadirachta indica A. Juss)" was undertaken to collect information on morphological variation vis-a-vis geographical diversity in neem, knowledge of flowering time, anthesis period, mode of pollination and provenance and plus trees performance.

A pilot survey of population of neem in Bundelkhand region was undertaken to identify sites where this species dominates. All the 40 sites were sampled for studies. At each site, five natural growing trees approximately of the same age were selected randomly on the basis of visual observations on height, girth and canopy of trees. Observations were recorded on six morphological traits namely, plant height, DBH, clean bole height, number of primary branches, taper of tree and canopy diameter. Field and laboratory experiments were conducted at the Central Research Farm of the National Research Centre for Agro-forestry, Jhansi during 1995-96.

For floral biology, ten trees of young plantation (about 10-12 years old) were randomly selected and the observation on the characters like flowering habit, date of initiation and duration of blooming, panicle development, length of panicle and number of branches and flowers per panicle, anthesis, dehiscence of anthers, size and viability of pollen grains, fruit/seed setting ability and period from formation to maturity were recorded.

For the studies of provenances and plus tree performance, twenty five provenances and twenty plus trees of neem, having approximately the same age were selected from already marked trees within each site, were studied for geographical variation. The provenances and plus trees were marked for the collection of seed samples. Collected seeds were sown in nursery and seedlings were planted in next season. Observations were recorded in seed parameters namely, seed size and seed weight; in nursery, seedling height, basal diameter, leaf length, leaf width and in field, plant height, collar diameter, number of primary
branches, leaf area index (LAI), leaf area ratio, length of primary branches, canopy area, total number of branches, total pruned biomass per tree, number of leaves per branch, weight of fresh leaves, weight of fresh wood, weight of dry leaves, weight of dry wood and diameter at breast height (DBH).

The data on the aforesaid attributes were subjected to various statistical and biometrical analyses namely, range, mean, coefficient of variance, standard error, genotypic and phenotypic coefficients of variance, heritability, genetic advance, correlation coefficients and path coefficient analysis. The results obtained are summarized below:

6.1 Geographical Variation

A wide variations exhibited among marked trees of different districts of Bundelkhand region. Maximum range of variability in plant height was observed in Jatara tehsil of Tikamgarh district; for DBH in Chhattarpur tehsil of Chhattarpur district; for clean bole height (CBD) in Kalpi Tehsil of Jalaun district; for canopy area in Konch tehsil of Jalaun district; for number of primary branches in Rath tehsil of Hamirpur district and for taper of tree in Jhansi tehsil of Jhansi district.

Maudha tehsil of Hamirpur district showed highest mean value for tree height, and clean bole height (CBH) in Datia tehsil of Datia district. For close canopy and lower number of primary branches were observed in Orai tehsil of Jalaun district. Highest value for taper of tree in Jalaun tehsil of Jalaun district was observed.

6.2 Floral Biology

Flowering in neem started in the 2nd week of March with new flush of leaves. It continued upto second week of May with peak in the first fortnight of April. However, relatively longer flowering period i.e., from 2nd week of February to May was observed in old trees. Relatively shorter flowering duration was also observed in young trees. The panicle development was completed within 20-26 days (Mean 23.20 ± 1.13). The panicle length ranged between 14.20 - 24.20 cm (mean 18.97 ± 1.27 cm). The number of buds per panicle ranged between 40.40 - 107.70 (mean 70.47 ± 6.82) and number of axillary branches per panicle ranged from 5.4 - 9.6 (mean 7.45 ± 0.38).
The period from bud initiation to opening of flower ranged from 23.0-29.0 days (25.55 ± 0.70). The period required for opening of flower to fruit initiation ranged from 18.0 to 20.0 days (19.30 ± 0.20) and period required for fruit initiation to maturity of fruit ranged from 49.00 to 52.00 (50.40 ± 0.32) days.

The anthesis starts from 6.00 P.M. and continued upto 10.00 P.M. The maximum anthesis occurred between 9.00 and 10.00 P.M. Anthesis starts earlier when temperature was low, while higher temperature delayed and shortened the duration of anthesis.

The dehiscence of anthers started at 11.00 A.M. and continued upto 3.30 P.M. Dehiscence was also affected by the temperature. The duration of dehiscence was short between 12.30 P.M. and 3.30 P.M. increased flowers when temperature was low. Maximum percent of dehiscence of anthers was between 2.00 P.M. and 2.30 P.M. with values ranging 27.78 and 41.62 percent.

The pollen viability varied from tree to tree in between 83.33 and 100.00 percent (mean 96.27 ± 1.88). The pollen size varied between 38.00 to 47.50 m (mean 44.65 ± 0.86).

No pollen germination was occurred in different concentration of sucrose solutions and sucrose with boric acid.

The fruit set was lowest at the lower portion of tree and highest at top and intermediate at the middle portion of the tree. This is due to neem is a strong light demandig tree.

The fruit setting in selfed flowers was 3.06% while in open pollinated flowers it was 4.15% only. There was a wide variation in percent fruit set from tree to tree. There was minor difference in fruit setting between selfed and open pollinated flowers. This indicated the self incompatibility mechanism is not present in neem. Growth attributes and leaf characters showed that in self and open pollinated progenies of 21 months old plants there was no difference between progenies of self and open pollinated seeds for growth and leaf characters. Hence, inbreeding depression was absent in self pollinated progenies.
6.3 Provenances and Plus Trees Performance

6.3.1 Seed physical parameters

Maximum range of variability was observed for seed length in Kalpi provenance, for seed diameter in 'Moth' provenance and 100-seed weight in 'Ghatampur' provenance. 'Kota' provenances showed highest mean value for all three characters, followed by Jabalpur and Moth provenances for seed length and seed width.

In plus tree trial, maximum range of variability was observed for seed length was recorded in PT-27 and for seed diameter in PT-28. The maximum 100-seed weight was found in PT-21. The highest mean values for all three characters were showed by 'PT-21' and 'PT-22'. 'PT-20' showed highest value for length and width of seed.

6.3.2 Nursery Studies

Maximum mean value of seedling height and basal diameter was observed in Katani provenance and it was maximum for leaf length and leaf width in Bhopal provenance.

The highest mean value for seedling height and leaf length and width was in 'PT-8' and for basal diameter in 'PT-7'.

6.3.3 Field Studies

A wide range of variability was observed for nine characters of 25 provenances of neem. The maximum range of mean performance was observed for plant height in 21 months old plants, followed by plant height in 14 month old plants, length of primary branches, canopy diameter, leaf area index, number of primary branches, collar diameter in 14 month old trials and collar diameter (21 months).

Plant height (14 and 21 month) and leaf area ratio showed significant variability. The highest mean values were observed for collar diameter and plant height (14 month) in Riva, Bhopal and Katani provenances, for collar diameter and
plant height (21 month) in Katani, Bhopal and Jabalpur and maximum mean value for leaf area index and leaf area ratio in Tikamgarh and Guna provenances.

The maximum range of mean performance of pulp trees was observed for plant height (21 month) followed by plant height (14 month), length of primary branches, number of primary branches, leaf area index, canopy area, collar diameter (14 month), collar diameter (21 month) and leaf area ratio.

Plant height (21 month) and leaf area ratio showed significant variability. The highest mean value for collar diameter and plant height (14 month) was observed in pulp tree ‘PT-19’ and PT-14, and in 21 month old plants maximum mean value in PT-19 and PT-24. The maximum mean values observed for leaf area index and leaf area ratio in PT-20 and PT-27. The desirable characters i.e. close canopy diameter and low number of primary branches was observed in PT-8 and PT-6.

Maximum range of variability was observed for plant height in Sagar provenance, for collar diameter in Kota provenances, for DBH in Vidisha provenance, for number of branches per tree in Charkha provenance, for number of leaves per branch in Murena provenance, for total pruned biomass in Jhansi provenance, for weight of fresh leaves in Kota provenance, for weight of fresh wood in Damoh provenance, for weight of leaves in Damoh provenances and weight of dry wood in Bhopal and Vidisha provenances.

The highest mean value was observed for plant height in Raigarh provenance, for collar diameter in Kota provenance, for DBH in Bhopal provenance, for number of branches per tree in Guna provenance for number of leaves per branch in Kota provenance, for total pruned biomass, weight of fresh leaves per branch, weight of fresh wood, weight of dry leaves and weight of dry wood in Dabra provenance.

All the characters studied showed high heritability. The expected genetic advance (in percent of mean) was observed high for fresh weight of wood, total pruned biomass per tree, dry weight of wood, fresh weight of leaves, dry weight of leaves and DBH and medium for the number of branches per tree, collar diameter, number of leaves per branch and plant height.

Highest phenotypic coefficient of variance was observed for fresh weight of wood, dry weight of wood, total pruned biomass, fresh weight of leaves, dry weight of leaves, number of branches per tree, DBH and collar diameter. The minimum coefficient of phenotypic variance was observed for plant height. The
maximum amount of coefficient of genotypic variance was observed for weight of fresh wood and minimum for plant height.

Plant height was associated positively and significantly with collar diameter and DBH. The dry weight of wood had significant positive association with collar diameter, total pruned biomass per tree, weight of fresh leaves, weight of fresh wood, weight of dry leaves and had weak association with DBH. Weight of dry leaves and weight of dry wood had negative correlation with number of leaves per branch.

For path coefficient analysis, all the characters except collar diameter, DBH and number of leaves per branch, had positive direct effect on weight of dry wood. Weight of fresh wood showed maximum direct effect and positive association with weight of dry wood. Total pruned biomass per tree had next highest direct effect on dry weight of wood. It has indirect effect with positive highly significant correlation with weight of dry wood.

Significant of differences were observed in 33 months old plants. The variances among the plus trees were highly significant for all the characters except weight of dry leaves.

A wide range of variability was observed for all ten characters of 20 plus trees. The maximum range of variability was observed for plant height in plus tree PT-10, for collar diameter in PT-12, for DBH in PT-21, for number of branches per tree in PT-6, for number of leaves per branch in PT-13, for total pruned biomass in PT-12, for weight of fresh leaves in PT-14, for weight of fresh wood in PT-22, for weight of dry leaves in PT-2 and weight of dry wood in PT-15.

The highest mean value was observed for plant height in PT-4, for collar diameter in PT-24, for DBH in PT-19, for number of branches per tree in PT-5, for number of leaves per branch in PT-7, for total pruned biomass, weight of fresh wood and weight of dry wood in PT-15 and for weight of fresh leaves and weight of dry leaves in PT-14.

All the characters studied showed high heritability. The expected genetic advance expressed as percent over mean was high for all characters, except weight of dry leaves (low genetic advance).

The highest phenotypic coefficient of variance was observed for weight of dry leaves, weight of dry wood, total pruned biomass, weight of fresh leaves,
DBH, number of leaves per branch and collar diameter. The minimum coefficient of phenotypic variance was observed for plant height. The maximum amount of coefficient of genotypic variance was observed for weight of dry wood and minimum for weight of dry leaves.

The weight of dry wood had negative association with number of branches per tree and weight of dry leaves. Weight of dry wood had positive association with other remaining traits.

In path coefficient analysis all the characters except collar diameter, DBH, number branches of per tree, weight of fresh leaves and weight of fresh wood had positive direct effect on weight of dry wood.

Total pruned biomass showed maximum direct effect on weight of dry wood. Total pruned biomass also showed positive association with weight of dry wood. Plant height had next highest direct effect on weight of dry wood with positive association.

Through these studies it has been observed that both provenances and the plus trees trials showed tremendous variability. It is hoped that further survey and collection of neem genotypes provenances from the traditional neem trees growing areas may further augment the genetic variability and this release the chance for selection of better neem genotypes for direct planting or use as base materials for further improvement. It is, therefore, suggested that intensive survey of neem growing areas should be made, particularly at the time of fruit maturity so that germplasm could be enriched.