

Path Analysis of Pearl Millet Yield and Yield Components under Moisture Stress

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Abstract Grain yield of pearl millet (*Pennisetum glaucum*) is influenced by several yield components. Path coefficient analysis was conducted to study the relationship between grain yield and its components. Thirty hybrids of pearl millet were grown under natural terminal moisture stress at Jodhpur. Grain yield mainly depended upon threshing percentage, biological yield and number of panicles m^{-2} . Early maturing genotypes yielded higher. Longer duration of pre-flowering period affected inversely seed weight and threshing percentage. Seed weight showed negligible direct effect on grain yield but influenced it through threshing percentage. Similarly plant height influenced grain yield via biological yield.

Keywords Pearl millet, *Pennisetum glaucum*, Yield components, Threshing ratio, Path analysis, Moisture stress

A considerable number of studies on grain yield determinants in pearl millet [*Pennisetum glaucum* (L.) R. Br.] include statistical correlation between various agronomic traits and grain yield (Virk 1988). Although these are helpful in determining the principal components influencing final grain yield, correlation coefficients may be confounded with the indirect effect due to common association inherent in trait interrelationship. Path coefficient analysis has proven useful in providing additional information that describes a priori cause and effect relationship, such as yield and yield components (Dhillon *et al.* 1977, Khairwal *et al.* 1990).

Pearl millet is mainly cultivated in arid and semi arid environment with limited water supply, while most of the path coefficient studies have been carried out in the material grown under irrigated conditions. The traits identified as beneficial under well-watered conditions may not prove so under water deficit conditions. Our objective was to study yield and yield component relationship through the use of path coefficient analysis in pearl millet grown under natural terminal moisture stress conditions.

Materials and Methods

The experiment was conducted during *khariif* (June-September) 1991 at the Central Arid Zone

Research Institute, Jodhpur. Thirty single cross F_1 hybrids were grown in randomized block design with three replications. Each plot consisted of 4 rows of 4 m length spaced at 60 cm. The material was oversown with tractor drawn planter and plants were thinned to 15 cm spacing two weeks after sowing. The experiment was fertilized with 40 kg N ha^{-1} . Weeds were removed mechanically.

The total amount of precipitation received during the pre-flowering period was 164 mm and during post-flowering period 17 mm and thus the crop experienced severe moisture stress during grain filling stage.

Duration of pre-flowering period equaled to number of days from sowing to emergence of stigma in 50% of the main shoots in a plot. At the time of maturity plant height (cm) and panicle length (cm) of main shoots were recorded on the five well-bordered plants in each plot. At the time of harvesting, number of panicles m^{-2} and grain yield (g) were recorded from all the 4 rows. Dry stover weight was added to panicle weight to get total biological yield ($kg plot^{-1}$). The threshing % was determined as the ratio of grain weight to panicle weight of the plants harvested from two central rows of 1 m length ($1.2m^2$). The seed weight (g) of

Table 1 Correlation coefficients among grain yield and other traits in pearl millet

| | Threshing percentage | Panicles m ⁻² | Pre-flowering period | Seed weight | Plant height | Biological yield | Panicle length |
|--------------------------|----------------------|--------------------------|----------------------|-------------|--------------|------------------|----------------|
| Grain yield | 0.62** | 0.52** | -0.49* | 0.46* | 0.23 | 0.43* | -0.27 |
| Threshing % | — | 0.18 | -0.31* | 0.48** | -0.02 | -0.05 | -0.22 |
| Panicles m ⁻² | | — | -0.46* | 0.32* | 0.13 | 0.31* | -0.35* |
| Pre-flowering period | | | — | -0.59** | -0.12 | 0.12 | 0.39* |
| Seed weight | | | | — | 0.01 | -0.11 | -0.32* |
| Plant height | | | | | — | 0.36* | 0.29 |
| Biological yield | | | | | | — | 0.15 |

*, ** Significant at P = 0.05 and 0.01, respectively.

500 grains taken randomly from the bulk plot harvested was recorded from duplicate samples.

Correlation coefficients between all possible pairs of eight traits were computed and, then, were subjected to path coefficient analysis to get direct and indirect effects as shown by Dewey and Lu (1959).

Results and Discussion

The grain yield was found to be highly correlated with threshing % (Table 1). This is expected because seed yield of cereals under water deficit conditions depends on the ability of genotypes to remobilize the assimilates to reproductive growth (Austin *et al.* 1980, Blum *et al.* 1983) and threshing ratio represents such ability (Bidinger *et al.* 1987). Grain yield was also highly correlated to number of panicles m⁻² ($r = 0.52^{**}$, $P \leq 0.01$). Earlier, number of panicles per unit area has been reported as an important trait in determining grain yield in pearl millet (Mahalakshmi & Bidinger 1986, Soman *et al.* 1987). Grain yield was adversely affected by longer duration of pre-flowering period. This was expected as the short duration genotypes complete the life cycle before the moisture stress becomes severe towards the end of growing season. Seed weight and biological yield increased the seed yield. This result agrees with the findings of Mahalakshmi, *et al.* (1985) and Khairwal *et al.* (1990).

Longer duration of pre-flowering period affected inversely threshing % and seed weight but

increased panicle length (Table 1). Longer duration of pre-flowering period in cereals induces high water consumption in the pre-anthesis period, thus affecting adversely grain yield and seed weight (Fischer 1981). Higher threshing ratio increased the seed weight because of high mobilization of photosynthates to the developing grain. More panicles m⁻² reduced panicle length and seed weight was adversely affected by longer panicles. Biological yield was influenced by plant height and number of panicles m⁻². Such compensation in yield components stems from intraplant competition for the stored photosynthates. In fact, yield component compensation, primarily due to competition for the resources available, remains one of the impediments to progress (Grafius 1972) because yield components occur in succession and may interact in compensatory patterns during plant development.

The direct effects obtained in path analysis showed that grain yield primarily depended upon threshing %, biological yield and upto some extent upon number of panicles m⁻² (Table 2). The mean seed weight showed negligible influence on grain yield. Actually, when grain filling takes place under water deficit conditions, as happened in the present study, yield can considerably be buffered by a higher contribution from assimilate mobilization before and immediately after anthesis, leading to very small variation in seed weight (Austin *et al.* 1980). However, seed weight showed considerable influence on yield via threshing % indicating the importance of this trait under moisture stress con-

Table 2 Path analysis showing the direct (diagonal) and indirect effects of seven metric traits on grain yield of pearl millet

| | Threshing percentage | Panicles m ⁻² | Pre-flowering period | Seed weight | Plant height | Biological yield | Panicle length |
|--------------------------|----------------------|--------------------------|----------------------|-------------|--------------|------------------|----------------|
| Threshing % | 0.50 | 0.02 | 0.08 | 0.02 | 0.00 | -0.02 | 0.02 |
| Panicles m ⁻² | 0.09 | 0.12 | 0.13 | 0.01 | 0.01 | 0.14 | 0.03 |
| Pre-flowering period | -0.16 | -0.05 | -0.27 | -0.02 | -0.01 | 0.05 | -0.03 |
| Seed weight | 0.24 | 0.04 | 0.16 | 0.04 | 0.00 | -0.05 | 0.03 |
| Plant height | 0.00 | 0.01 | 0.03 | 0.00 | 0.05 | 0.16 | -0.02 |
| Biological yield | -0.02 | 0.04 | -0.03 | 0.00 | 0.02 | 0.45 | -0.01 |
| Panicle length | -0.11 | -0.04 | -0.10 | -0.01 | 0.02 | 0.07 | -0.08 |

Residual = 0.25

ditions. Similarly, plant height also influenced yield through biological yield. These results agree with the results of previous path analysis studies in pearl millet (Dhillon *et al.* 1977, Singh *et al.* 1980, Khairwal *et al.* 1990).

The present study revealed that threshing % is a major component in deciding the grain yield in pearl millet in terminal moisture stress conditions. Bidinger *et al.* (1987) also advocated grain yield per panicle, representing the ability to both fill and set grains under terminal stress, as an important criterion to identify drought tolerant genotypes. The biological yield was another trait which considerably influenced grain yield. Hence, this trait also needs consideration to improve yield under limiting water conditions.

References

- Austin RB, Morgan CL, Ford MA & Blackwell RD 1980 Contribution to grain yield from pre-anthesis assimilation in tall and dwarf barley phenotypes in two contrasting seasons. *Annals of Botany* **45** 309-319
- Bidinger FR, Mahalakshmi V & Rao GDP 1987 Assessment of drought resistance in pearl millet (*Pennisetum americanum* (L.) Leeke) II. Estimation of genotype response to stress. *Australian Journal of Agricultural Research* **38** 49-59
- Blum A, Poiarkova H, Gozlan G & Mayer J 1983 Chemical desiccation of wheat plants as a simulator of post-anthesis stress. I. Effects on translocation and kernel growth. *Field Crops Research* **6** 51-58
- Dewey DR & Lu KH 1959 A correlation and path coefficient analysis of components of crested wheatgrass seed production. *Agronomy Journal* **51** 515-518
- Dhillon BS, Gupta VP & Seth AS 1977 Path coefficient analysis of grain yield in pearl millet. *Genetica Agraria* **31** 411-415
- Fischer RA 1981 Optimizing the use of water and nitrogen through breeding of crops. *Plant and Soil* **58** 249-278
- Grafius JE 1972 Competition for environmental resources by component characters. *Crop Science* **12** 364-367
- Khairwal IS, Singh S & Parkash Om 1990 Path analysis in pearl millet. *Haryana Agricultural University Journal of Research* **20** 76-77
- Mahalakshmi V & Bidinger FR 1986 Water deficit during panicle development in pearl millet: yield compensation by tillers. *Journal of Agricultural Sciences* **106** 113-119
- Mahalakshmi V, Subramanian V, Bidinger FR & Jambunathan R 1985 Effect of water deficit on yield and protein content in pearl millet grains. *Journal of Science for Food and Agriculture* **36** 1237-1242
- Singh YP, Kumar S & Chauhan BPS 1980 Path coefficient analysis of grain yield in pearl millet (*Pennisetum americanum* (L.) Leeke). *Madras Agricultural Journal* **67** 214-219
- Soman P, Jayachandran R & Bidinger FR 1987 Uneven variation in plant-to-plant spacing in pearl millet. *Agronomy Journal* **79** 891-895
- Virk DS 1988 Biometrical analysis in pearl millet-A review. *Crop Improvement* **15** 1-29

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