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Partitioning trait associations with container foliage yield in water spinach (*Ipomoea aquatica* Forssk.) through path coefficient analysis

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Abstract
Improving foliage yield in water spinach (*Ipomoea aquatica* Forssk.) requires identifying traits that contribute directly to yield as well as traits whose associations operate through other components. This paper interprets the genotypic path coefficient analysis reported for 24 indigenous accessions evaluated under container gardening at Raipur, Chhattisgarh, during 2017–18 and 2018–19. The original experiment was conducted in a completely randomized design with three replications. In the reported genotypic path analysis, number of nodes per vine had the largest positive direct effect on green foliage yield per container (4.48), followed by dry weight of leaves (2.84), green foliage yield per plant (1.83), internode length (1.30), leaf width (1.18) and number of vines per plant (0.95). Vine length (−4.15), fresh weight of leaves (−2.83) and number of leaves per vine (−1.11) had negative direct effects. Number of nodes per vine also had positive indirect effects through vine length (3.72), number of leaves per vine (2.38) and internode length (2.30). The reported residual value was −0.2681, which is not a conventional non-negative residual path coefficient and requires verification. The results suggest that selection based solely on simple correlations may be misleading where component traits are interrelated. Because raw observations and the complete analysis output were unavailable, the path estimates are reported as supplied and have not been independently recalculated. The proposed selection implications should therefore be treated as provisional pending validation of the original path model.

Keywords: Water spinach, *Ipomoea aquatica*, path coefficient, direct effect, indirect effect, foliage yield, container gardening

1. Introduction

Water spinach (*Ipomoea aquatica* Forssk.; Convolvulaceae) is a leafy vegetable native to tropical and subtropical regions of the Old World to Australia, and its accepted taxonomic status is recorded by the Royal Botanic Gardens, Kew (n.d.). Under container gardening, the harvested foliage yield is the outcome of several interacting plant attributes, including vine growth, leaf production, leaf dimensions, leaf biomass and moisture status.

Correlation coefficients describe the strength and direction of pairwise relationships, but they do not reveal whether an association reflects a direct contribution or an indirect relationship through another trait. Path coefficient analysis addresses this limitation by partitioning correlations into direct and indirect effects under an explicitly specified causal structure. Wright introduced the path coefficient framework, and its application to crop component analysis was demonstrated by Dewey *et al.* (1959) [1]. Path coefficients are standardized partial regression effects and should be interpreted as model-dependent statistical decompositions rather than proof of biological causation (Niles, 1922) [2].

The present study focuses on the genotypic path analysis reported in the supplied document for 24 water spinach accessions grown in containers. The objectives were to identify the traits with the largest reported direct effects on green foliage yield per container, describe important indirect pathways and discuss the implications and limitations for selection.

2. Materials and Methods

2.1 Experimental material and design

The experiment was conducted at the Research and Instructional Farm, Department of Vegetable Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India, during 2017–18 and 2018–19. Twenty-four indigenous water spinach accessions collected from different locations in Chhattisgarh were evaluated in a completely randomized design with three replications.

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2.2 Container preparation and crop management

Containers measuring 1.0 × 0.75 × 0.598 m (reported net area 0.75 m^2) were filled with a 50:50 mixture of black soil and paddy husk. Vine cuttings of 20 cm were planted on 5 November in both years at 15 plants per container. The source document reports fertigation with 19:19:19 water-soluble fertilizer at 6–7-day intervals, irrigation at 1 day after planting and then every 3–4 days according to substrate moisture, manual weeding and a preventive copper-fungicide application at 30 days after transplanting.

2.3 Recorded traits and dependent variable

The source lists 15 traits: vine length, number of primary vines per plant, number of leaves per plant, internode length, number of nodes per vine, leaf length, leaf width, petiole length, leaf-to-vine weight ratio, fresh weight of leaves, dry weight of leaves, dry matter percentage, moisture percentage, green foliage yield per plant and green foliage yield per container. The path table includes 14 explanatory characters, with green foliage yield per container as the dependent variable. A terminology inconsistency occurs because the correlation table calls trait 3 number of leaves per plant, whereas the path table calls it number of leaves per vine.

2.4 Path coefficient analysis

The supplied document states that genotypic correlations were partitioned into direct and indirect effects using the method described by Wright (1921) and elaborated for crop selection by Dewey *et al.* (1959) [1]. In a path model, the correlation between a predictor and the dependent variable is decomposed into its direct path coefficient plus the sum of its indirect contributions through the other included predictors. The source describes solving the simultaneous equations in matrix form and calculating a residual effect.

The numerical effects in this paper are transcribed from the source path table and its accompanying results narrative. No independent estimation was possible because the genotype-level or replication-level raw observations, full covariance matrix and statistical software output were not supplied. Accordingly, no new standard errors, confidence intervals or significance tests are claimed.

3. Results

3.1 Direct effects on green foliage yield per container

The accompanying results narrative identifies number of nodes per vine as the largest positive direct contributor to foliage yield per container, with a path coefficient of 4.48. It was followed by dry weight of leaves (2.84), green foliage yield per plant (1.83), internode length (1.30), leaf width (1.18) and number of vines per plant (0.95). These estimates indicate that, within the specified path model, variation in these traits was associated with positive direct contributions to container yield after accounting for the other included traits.

The largest negative direct effect was reported for vine length (−4.15), followed by fresh weight of leaves (−2.83), number of leaves per vine (−1.11) and petiole length (−0.13). The negative direct effect of fresh leaf weight, despite its positive biological relationship with dry leaf weight, illustrates why direct path coefficients should not be interpreted in isolation. Strong correlations among predictors can produce suppression effects or unstable partial regression estimates.

Explanatory trait	Reported direct effect	Direction
Number of nodes per vine	4.48	Positive
Dry weight of leaves	2.84	Positive
Green foliage yield per plant	1.83	Positive
Internode length	1.30	Positive
Leaf width	1.18	Positive
Number of vines per plant	0.95	Positive
Vine length	−4.15	Negative
Fresh weight of leaves	−2.83	Negative
Number of leaves per vine	−1.11	Negative
Petiole length	−0.13	Negative

Note: These are values explicitly stated in the source results narrative. The path table contains additional diagonal entries and some formatting/label ambiguity; all entries should be checked against the original statistical output before publication.

3.2 Important indirect effects

Number of nodes per vine showed the largest positive indirect contribution through vine length (3.72), followed by the pathway through number of leaves per vine (2.38) and internode length (2.30). These pathways suggest that the association of node number with container yield was not limited to its direct path coefficient; the trait was also linked to other dimensions of vegetative architecture.

The path table also reports several substantial counteracting indirect effects. For example, the row for number of nodes per vine includes a negative contribution through green foliage yield per plant (−0.99). Such positive and negative pathways can offset one another, explaining why a trait may have a large direct effect but a weak or negative overall correlation with yield.

3.3 Relationship between path effects and simple correlations

A key result is the contrast between the reported direct effect of number of nodes per vine (4.48) and its negative genotypic correlation with container yield (−0.568). This contrast indicates that the negative overall association is produced by indirect pathways that counterbalance the positive direct component. Conversely, green foliage yield per plant had a positive genotypic correlation with container yield (0.980) and a positive direct effect (1.83), making it a particularly consistent candidate for selection under the tested container system.

Vine length showed a negative direct effect (−4.15) and a weak negative genotypic correlation with container yield (−0.198). Leaf width had a positive direct effect (1.18) and a positive genotypic correlation with yield (0.177). The correspondence between direct and total association is therefore trait-specific; selection decisions should consider both the correlation and the path decomposition.

4. Discussion

The path analysis points to number of nodes per vine, dry leaf weight and plant-level foliage yield as important direct contributors within the fitted model. However, number of nodes per vine had a negative overall genotypic correlation with container yield. This is not necessarily contradictory: a positive direct path may be outweighed by negative indirect effects through correlated traits. The result demonstrates the value of examining the full decomposition rather than selecting traits solely by their direct coefficients or bivariate correlations.

Green foliage yield per plant stands out because its association with container yield was strongly positive and its direct path effect was also positive. Under a fixed number of plants per container, this trait is closely related to the aggregate yield measure. Its use as a selection

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criterion is therefore plausible for the same production configuration, although it may be partly mathematically coupled to the dependent variable. The authors should clarify how plant-level and container-level yields were calculated and whether the latter was simply the sum or mean-scaled total of plant yields.

The negative direct effect of fresh leaf weight alongside a positive direct effect of dry leaf weight may reflect multicollinearity, shared measurement components or suppression in the multiple-predictor model. Fresh weight includes water mass, while dry weight represents the solid fraction of the foliage. Their strong reported genotypic correlation (0.936) means that simultaneous inclusion may create substantial collinearity. A robust re-analysis should inspect variance inflation factors, condition indices and the stability of path coefficients under alternative predictor sets.

Path analysis is conditional on the assumed causal ordering and the set of variables included. A large standardized path coefficient is not proof that manipulating the corresponding trait will cause a proportional yield response. Wright's framework has long been discussed in relation to the distinction between correlation and causation (Niles, 1922) [2], while crop applications emphasize its usefulness for decomposing component associations (Dewey *et al.*, 1959) [1]. The current findings should therefore be treated as exploratory selection evidence rather than causal confirmation.

5. Breeding and selection implications

For the container conditions evaluated, green foliage yield per plant is the most internally consistent selection indicator because it combines a strong positive genotypic correlation with a positive direct effect. Dry weight of leaves and leaf width may be considered complementary traits. Number of nodes per vine deserves further investigation because it had a large positive direct effect but a negative overall correlation, indicating substantial indirect effects. It should not be used as a stand-alone selection criterion until the underlying pathways and the trait-label issue are resolved.

A practical selection strategy should compare accessions using actual marketable container yield, repeated harvest performance and quality traits. The path model should be validated in independent seasons or locations and, if possible, with a reduced predictor set that avoids severe multicollinearity.

6. Methodological cautions and required verification

Several issues must be resolved before this paper is submitted as a final research article. First, the source reports a residual value of −0.2681. A conventional residual path effect is calculated as a square root and should not be negative; the reported value may be a transcription or calculation error and must be checked rather than silently changed. Second, the source narrative and the displayed path table should be reconciled, particularly for the direct-effect diagonal and the trait-3 label. Third, the high correlation between fresh and dry leaf weights may cause multicollinearity. Fourth, the near-deterministic relationship between plant yield and container yield may inflate the apparent importance of plant-level yield if both measures share the same underlying harvest data. Fifth, the original data are needed to verify model assumptions, predictor ordering, sample size, residual calculation and coefficient stability.

7. Conclusion

The reported path analysis identified number of nodes per vine, dry weight of leaves, green foliage yield per plant, internode length, leaf width and number of vines per plant as traits with positive direct effects on green foliage yield per container. Number of nodes per vine also had important positive indirect pathways through vine length, leaf number and internode length, although its overall correlation with yield was negative. Green foliage yield per plant showed the clearest agreement between correlation and direct effect. These findings can guide further evaluation of selection criteria for container-grown water spinach, but the path model and residual value must be verified using the original data before publication.

References

1. Dewey DR, Lu KH. A correlation and path-coefficient analysis of components of crested wheatgrass seed production. Agron J. 1959;51(9):515–518.
2. Niles HE. Correlation, causation and Wright's theory of 'path coefficients'. Genetics. 1922;7(3):258–273.
3. Royal Botanic Gardens, Kew. *Ipomoea aquatica* Forssk. Plants of the World Online. 2026.
4. Miller PA, Williams JC, Robinson HF, Comstock RE. Estimates of genotypic and environmental variances and covariances in upland cotton and their implications in selection. Agron J. 1958;50(3):126–131.
5. Chauhan H, Singh J, Sharma D. Genetic variability and heritability estimation in water spinach (*Ipomoea aquatica* Forsk.) genotypes. Int J Curr Microbiol Appl Sci. 2017;6(9):3018–3024.
6. Dubey RK, Waiba KM, Singh AK, Sisodia A, Rai N, Kumar R. Genetic variability and selection strategies for yield improvement in water spinach (*Ipomoea aquatica*) under upland field conditions. Veg Sci. 2025;52(2):267–275.
7. Fardous A, Ullah S, Mahmud S. Growth, yield, and quality performance of swamp cabbage (*Ipomoea aquatica*) cultivars under NFT hydroponic system. Int J Hortic. 2026;16(1):27–43.

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