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One name, different plants: farmer perceptions and within-lot phenotypic variation in amaranth in Niger

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Abstract

Amaranth gardeners in Niamey buy seed lots under one local name and manage them as one crop. We asked whether that name describes phenotypically uniform plants or a unit of seed management. Of 40 gardeners, 29 judged their plot similar overall, 30 reported differences among plants and 19 did both; enumerators rated visible variation as moderate or strong in 30 plots. One gardener cited uniformity as a criterion for choosing seed plants. In a separate trial, height in one black-seeded lot had a CV of 39.4 %, and 88 % of its variance lay within 9 m² plots. A named seed lot can remain one management unit while containing substantial phenotypic variation. The genetic basis of this variation was not tested.

Keywords: Farmer knowledge, informal seed systems, leafy vegetables, local names, Niger, within-population variation

Introduction

Urban and peri-urban gardens are an established part of food production in Niamey, Niger (Graefe et al., 2008), and amaranth (*Amaranthus* spp.) is grown there as a leaf vegetable. Gardeners commonly refer to the crop as tchapata in Zarma-Songhay or aleyyahou in Hausa, while seed lots may differ in origin and seed colour. What that name describes is less obvious than it seems.

Surveys of farmer-managed diversity and genebank records often count named units, which implies that a name identifies a reasonably uniform population. Current definitions of landraces point the other way and emphasise dynamic, farmer-managed populations (Casañas et al., 2017). In sorghum in northern Cameroon, 30 % of total SSR variation lay within named landraces (Barnaud et al., 2007). In rice in The Gambia, names did not consistently correspond to variety identity and reflected the recent history of exchange among villages (Nuijten and Almekinders, 2008). Seed supply gives a further reason for caution: across 40 crops in six countries, smallholders obtained 90 % of their seed from informal systems and about half from local markets (McGuire and Sperling, 2016), and farmer seed networks move diversity in ways that are often underestimated (Coomes et al., 2015).

Previous work on urban amaranth in Niamey documented substantial phenotypic variation within a black-seeded lot (Naino Jika et al., 2026). Here, we extend this observation by examining how gardeners perceive and manage amaranth diversity, alongside measurements from two experimental seed lots. We ask whether a shared local name implies phenotypic uniformity.

Material and Methods

Gardener survey: Structured interviews were held with 40 amaranth gardeners in Niamey in 2025, with oral informed consent. All respondents were men. No sampling frame was documented, so the counts describe this sample and not the gardeners of the city. The questionnaire recorded the local name, seed source, renewal frequency, three ranked criteria for choosing plants for seed and three for choosing leaves at harvest (weighted 3-2-1 and summed), and the importance of seed colour. Gardeners judged overall plot similarity on a four-level scale, then stated whether individual plants differed and

in which traits. The enumerator separately rated visible diversity in the plot as low, moderate or strong. This rating came from the same visit and is a second observer, not an independent measurement.

Field measurements: Plants came from a trial set up for another purpose at the Faculty of Agronomy, Abdou Moumouni University (13°29' N, 2°05' E), on sandy loam in the 2024 rainy season. Two lots were sown on 27 July at 30 cm spacing with at least ten seeds per hill: a black-seeded lot from one gardener, called Burkina tchapata and obtained close to the faculty, and a white-seeded lot whose local name and provenance were not recorded. Each lot occupied 12 plots of 9 m², four in each of three blocks, and 15 plants per plot were sampled at random (180 plants per lot). Hills were thinned to one plant and gaps filled with thinned seedlings. Height and leaf number were recorded on 24 August, 28 days after sowing. Measurements from the black-seeded lot were previously reported by Naino Jika et al. (2026).

Data analysis: Associations in the survey were examined with Fisher exact tests and Cohen's kappa, and are exploratory. Variance components for blocks, plots within blocks and residual variation were estimated by REML (lme4, R 4.6.1). Confidence intervals for the CV came from a two-stage bootstrap of plots and plants. Persistence was assessed using Spearman's correlation between measurements centred on their respective plot means at each date. Centring removes additive differences between plots, allowing the analysis to focus on the relative phenotypic positions of individual plants. Gardeners and plots were not paired, so the trial is a separate observation from the same local seed system and cannot validate any individual answer.

Results and Discussion

One name, several seed types: Thirty-nine gardeners used *tchapata* and one *aleyyahou*. Thirty-one bought seed at the Karagué roundabout market, three at other markets and six produced their own; 31 renewed seed at every cycle and nine once a year. The name did not follow seed colour: 25 gardeners grew black seed only and 15 grew black and white seed, 14 of them under the name *tchapata*. Black colour mattered to 33 gardeners, for market demand or profitability (10), resistance (9) and rapid growth or germination (6); other reasons were less frequent or not stated. It mattered to 24 of the 25 who grew black seed only and to nine of the 15 who grew both ($p = 0.007$). These reasons are farmer interpretations and were not tested in the field.

Uniformity is not a stated objective: Growth rate and plant height dominated the choice of seed plants, whereas leaf size and leaf colour dominated leaf harvest (Figure 1). Uniformity was cited by one gardener, in third position. Regrowth was cited by 25 gardeners and was not measured in the trial. These are stated criteria. Because 34 of the 40 gardeners bought their seed, many of them may seldom select seed plants themselves, and the survey did not record how often they do. The data therefore show that uniformity was rarely articulated as an objective. They do not show that farmer selection shaped the lots.

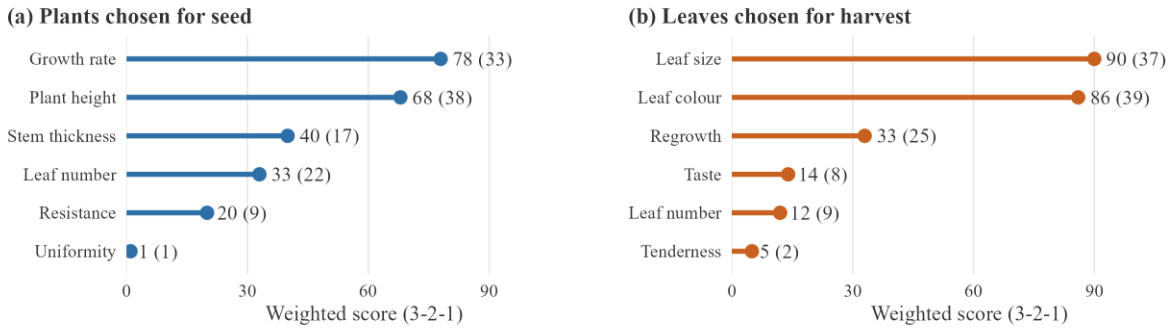


Figure 1: Criteria for choosing seed plants and harvesting leaves (n = 40; weighted score, with citing gardeners in parentheses).

Similar overall, different plant by plant: Twenty-nine gardeners judged their plot similar overall, 30 reported differences among individual plants, and 19 did both (Figure 2a). The traits named were leaf colour (24), plant height (22), leaf size (10) and density (3). All 11 gardeners who judged their plot

different reported differences, against 19 of the 29 who judged it similar (p = 0.038). Enumerators rated variation as moderate or strong in 30 plots, including 20 of the 29 that gardeners called similar. The two sets of 30 overlapped only partly (25 plots; kappa = 0.33), so gardeners and enumerators did not simply report the same thing. We see no contradiction in the gardeners' answers. "Similar overall" can describe the crop as it is recognised and managed, and "the plants differ" describes individuals within it.

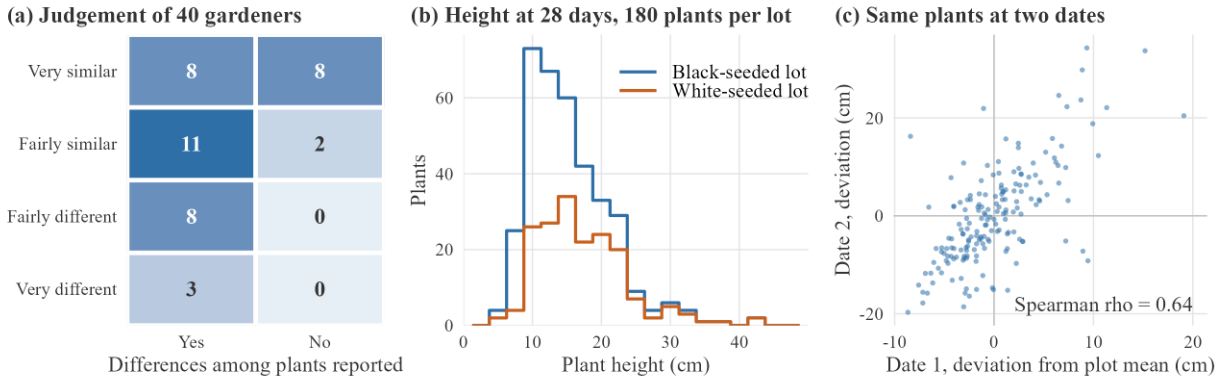


Figure 2: (a) Overall judgement against reported differences. (b) Plant height in the two lots. (c) Height of black-seeded plants at two dates, as deviation from plot mean (n = 178; two plants not remeasured).

Measured variation lies mostly within plots: In the black-seeded lot, height ranged from 5.0 to 32.5 cm and leaf number from 4 to 18, with CVs of 39.4 % and 27.2 % (Table 1). The white-seeded lot gave similar values, so the pattern is not specific to one lot. Block variance was estimated at or near zero, with only three blocks. Plots accounted for 12 to 19 % of the variance, suggesting heterogeneity at that scale associated with soil conditions, emergence, gap filling or seed sampling. Most of the variance, 79 to 88 %, lay among plants of the same 9 m² plot; this residual also contains microenvironment and measurement error. Phenotypic ranks also persisted: the within-plot rank correlation between dates was 0.64 (95 % CI 0.52-0.74) for height and 0.50 for leaf number, and 41 of 49 plants in the top quarter of their plot remained above the plot median.

Table 1: Early vegetative traits at 28 days after sowing (n = 180 per lot, 15 plants in each of 12 plots).

Lot	Trait	Mean (SD)	Range	CV, % (95 % CI)	CV within plot, %	Variance components, % (block / plot / residual)
Black	Height, cm	12.4 (4.9)	5.0-32.5	39.4 (33.5-44.6)	37.2	0 / 11.6 / 88.4
	Leaf number	9.0 (2.4)	4-18	27.2 (21.9-32.2)	25.1	0 / 16.3 / 83.7
White	Height, cm	16.2 (6.7)	5.0-42.5	41.2 (33.6-47.0)	38.1	0 / 15.4 / 84.6
	Leaf number	8.7 (2.6)	3-20	30.4 (24.3-36.1)	27.4	1.9 / 19.0 / 79.1

These measurements do not establish that the variation is genetic. Emergence extended over five days, seed per hill was not weighed, caterpillars attacked seedlings, and an unknown share of plants had been transplanted into gaps. Persistence does not resolve this, because a plant that starts early can keep its lead. Microenvironment can also structure on-farm populations (Tiranti and Negri, 2007). Three explanations remain open and may combine: one variable population, several lineages within a lot, or a mixture of species. A preliminary check of flowering plants in the black-seeded lot putatively identified *A. cruentus* and *A. hybridus* (Naino Jika et al., 2026), so mixture is plausible, but its contribution is unknown. Market blending cannot be inferred from this trial, because the lot came from one gardener and not from Karagué. Differences were reported by 22 of 31 Karagué buyers and eight of nine other gardeners (p = 0.40), a sample too small to compare seed sources. Finally, the survey covers men only. Gender shapes participation in African seed systems (Kramer and Trachtman, 2024), so these results describe part of the seed system.

Conclusions and Outlook

A named seed lot can remain one management unit while containing substantial phenotypic variation. Gardeners' answers, enumerators' ratings and field measurements are consistent with this conclusion, within the limits of two lots, one site, one season and two early traits. For anyone recording farmer-managed diversity, the consequence is modest: a local crop name may encompass phenotypically variable seed material and should not, on its own, be taken as evidence of a uniform biological variety.

Three steps follow. First, multiple named seed lots should be sampled across gardeners, markets and sites, keeping each lot's provenance and name. Second, maternal families should be evaluated across seasons and environments, recording emergence date and transplanting for each plant and adding regrowth, which gardeners value. Third, individual plants should be genotyped, as pooled samples would hide within-lot diversity, to characterise genetic diversity and test taxonomic assignments; SSR and ISSR markers have been applied to amaranth in Ghana (Siamey et al., 2025). The survey should also be extended to women.

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