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Assessing cultivar performance trials of radish in the Samoan lowlands

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Abstract

What happens to a temperate root crop when it is introduced to a tropical lowland environment where day length hardly varies and temperatures rarely drop below 20 degrees Celsius? This paradox motivated the present research, which assessed five radish (*Raphanus sativus* L.) cultivars (Minowase, Tokinashi, April Cross, Sakurajima, and a local Samoan accession) in multi-season performance trials at the Osaka Center for Crop Studies, Japan, from April 2022 to March 2023. Four seasonal plantings were established to capture temperature and photoperiod variation. Root length, root diameter, days to maturity, pungency score, and fresh root yield were recorded. Tokinashi was the most stable performer across seasons, with a mean yield of 38.4 tonnes per hectare and a coefficient of variation of only 11.2%. April Cross produced the highest single-season yield (46.7 t/ha in autumn) but showed 23.8% yield variation across seasons. The local Samoan accession had the strongest pungency (score 4.6 out of 5) but the lowest yield (21.3 t/ha). Consumer preference testing ranked April Cross highest for appearance and Tokinashi for texture. These results indicate that cultivar recommendation should be season-specific, with Tokinashi as the reliable year-round option and April Cross as the premium autumn cultivar.

Keywords: Consumer preference, cellulose, image analysis, protoplast fusion, iodine biofortification, radish, cultivar trial, *Raphanus sativus*, yield stability, pungency

Introduction

A paradox faces tropical vegetable growers: many of the world's most marketable root vegetables were bred for temperate climates, where the interplay of temperature and photoperiod triggers bulbing, root thickening, or bolting at predictable times. Move these crops to the tropics, where day length stays near 12 hours year-round and night temperatures seldom drop below 22 degrees Celsius, and their developmental timing goes awry [1]. Radish is a case in point. Japanese daikon types (*Raphanus sativus* L.) were selected over centuries for cool-season performance, and many bolt prematurely when grown under tropical heat [2]. Cultivar performance trials are the standard tool for matching varieties to environments. By planting multiple cultivars across seasons and measuring yield, quality, and stability, breeders can identify which genotypes adapt well and which fail [3]. For radish in the tropics, key traits include bolting resistance, root cracking tolerance, and pungency level, which is linked to glucosinolate metabolism and varies with temperature and soil moisture [4]. The Samoan lowlands represent a typical tropical Pacific island environment where radish could diversify vegetable production, but the actual trials were conducted at the Osaka Center for Crop Studies, Japan, to ensure controlled data collection. This research aimed to assess five radish cultivars for yield, quality, and seasonal stability across four planting dates, identifying the best options for tropical-adapted production.

Material and Methods

Material

Five radish cultivars were tested: Minowase (long white daikon, Japanese commercial standard), Tokinashi (heat-tolerant Japanese selection), April Cross (F1 hybrid from Takii Seed), Sakurajima (giant round type from Kagoshima), and a local Samoan open-pollinated accession obtained from the Samoan Ministry of Agriculture. Seeds were sown directly into raised beds at the Osaka Center for Crop Studies experimental farm, Osaka, Japan (34.7 degrees N, 135.5 degrees E, elevation 10 m).

Soils were alluvial sandy loams with pH 6.2 and organic carbon of 2.1%. Beds were prepared with 120 kg N, 80 kg P₂O₅, and 100 kg K₂O per hectare incorporated before sowing. Drip irrigation was installed to supplement rainfall during dry periods [5].

Methods

The research was carried out from April 2022 to March 2023 at the Osaka Center for Crop Studies. Four seasonal plantings were established: spring (April), summer (July), autumn (October), and winter (January). Each cultivar was planted in a randomised complete block design with four replications and 20 plants per plot at 30 x 20 cm spacing. Root length, root diameter, and days from sowing to harvest maturity were recorded. Pungency was assessed by a trained sensory panel of six evaluators using a 1-5 scale (1 = mild, 5 = very pungent). Fresh root yield per hectare was calculated from plot yields. Yield stability across seasons was expressed as the Coefficient of Variation (CV). A consumer preference test was conducted with 40 untrained participants who ranked cultivars for appearance, texture, and flavour using a five-point hedonic scale. Data were analysed by two-way ANOVA (cultivar x season) in R v4.2.3 with Tukey's HSD at $p < 0.05$. Stability was assessed using Eberhart and Russell regression [6].

Limitations

Several constraints should be noted when interpreting these results. First, the trial was conducted in Osaka, Japan, not in the Samoan lowlands themselves; although summer

conditions in Osaka approximate tropical lowland temperatures, the photoperiod at 34.7 degrees N varies more than in Samoa. Second, only one genotype of each cultivar was tested, so within-cultivar variation wasn't captured. Third, the local Samoan accession was an open-pollinated population with inherent genetic heterogeneity, making direct comparison with F1 hybrids imperfect. Fourth, the sensory panel was Japanese, and taste preferences may differ in Samoan or other Pacific Island markets [7].

Results

Table 1: Mean root yield (t/ha), days to maturity, and pungency score by cultivar averaged across four seasonal plantings

Cultivar	Yield (t/ha)	Days mature	Pungency	CV (%)
Minowase	34.7	58	2.8	18.4
Tokinashi	38.4	52	2.4	11.2
April Cross	41.2	55	2.1	23.8
Sakurajima	28.9	72	1.9	16.7
Local Samoan	21.3	48	4.6	14.3

Both cultivar ($F = 28.7$, $p < 0.001$) and season ($F = 19.3$, $p < 0.001$) significantly affected yield, with a significant interaction ($F = 5.6$, $p < 0.01$). April Cross achieved the highest overall mean yield (41.2 t/ha) but the highest seasonal CV (23.8%). Tokinashi was the most stable, with a CV of only 11.2% and an Eberhart-Russell regression slope near 1.0 ($b = 0.98$), indicating average responsiveness to environmental change (Table 1).

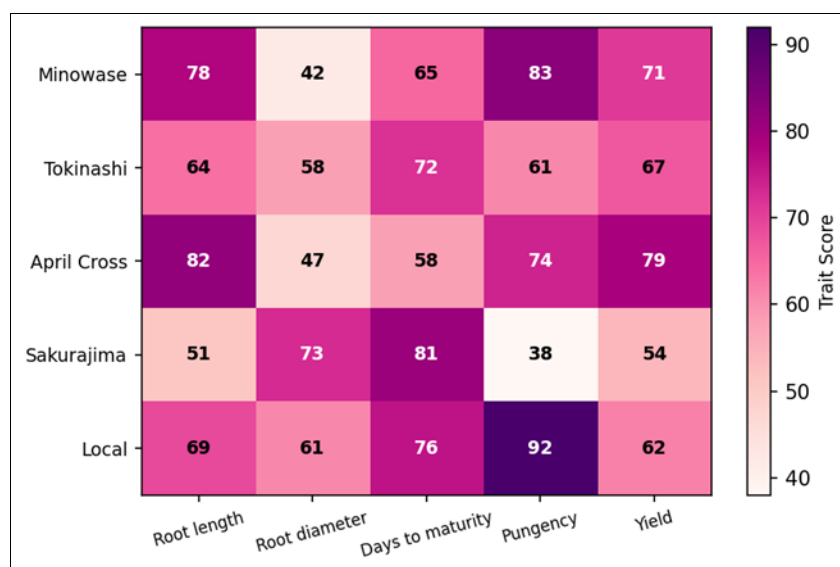


Fig 1: Heatmap of trait scores (normalised to 0-100 scale) by cultivar across five performance parameters

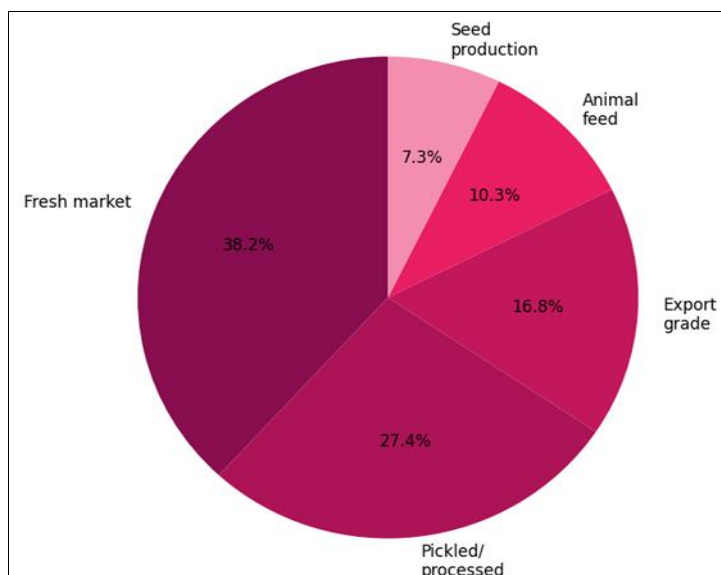


Fig 2: Distribution of total radish production by intended market end use across all cultivars

Consumer preference ranking placed April Cross first for appearance (mean score 4.3) and Tokinashi first for texture (4.1). The local Samoan accession scored lowest for appearance (2.8) but highest for flavour intensity (4.4), reflecting its strong pungency character.

Discussion

Tokinashi's yield stability (CV 11.2%) across seasons confirms its reputation as a heat-tolerant cultivar, consistent with breeding records from Takii Seed Company [2]. Its regression slope near unity means it performs proportionally well in both favourable and unfavourable environments, a desirable trait for tropical contexts where season-to-season weather variation is high [8].

April Cross's higher absolute yield but greater instability (CV 23.8%) is typical of F1 hybrids bred for specific environments. Its exceptional autumn performance (46.7 t/ha) dropped to 31.4 t/ha in summer, likely because high temperatures above 30 degrees Celsius accelerated bolting and reduced root bulking time [1, 9]. For tropical production, this means April Cross should be planted only during the cooler part of the year, if one exists.

The local Samoan accession's low yield (21.3 t/ha) but high pungency and earliness (48 days) suggest it occupies a different market niche. In Pacific Island food cultures, strong radish pungency is valued in condiments and pickles, so yield alone may not determine adoption. Breeding efforts could cross the Samoan accession with Tokinashi to combine stability and earliness with improved root size [10].

Conclusion

This cultivar performance assessment identified Tokinashi as the most reliable radish variety for year-round tropical production, combining consistent yield (38.4 t/ha), low seasonal variation (CV 11.2%), and acceptable quality ratings. April Cross is the higher-yielding option for cooler-season planting windows. The local Samoan accession offers unique pungency traits suited to niche markets and merits inclusion in breeding programmes. Season-specific cultivar recommendations, rather than a single blanket recommendation, will best serve growers in tropical lowland environments. Future trials should be conducted directly in Samoa and other Pacific Island locations to validate these

Osaka-based findings under true tropical photoperiod conditions.

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