Grain-yield evaluation of 'Kopara 73' and 'Takahe' wheat cultivars

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(Received 7 January 1975)

ABSTRACT

Grain yield performance of two recently released wheat cultivars, 'Takahe' and 'Kopara 73', was evaluated under field trial conditions during the 1972-73 and 1973-74 wheat-growing seasons.

Where powdery mildew (Erysiphe graminis) occurred, greater (by 9%) yield increases were obtained with 'Takahe' than with 'Aotea'. The corresponding grain-yield increase under mildew-free conditions was 3.4%.

Consistent yield increases (mean 6.7%) were measured for the reselection 'Kopara 73' compared with the initial bulk 'Kopara' release. Relative to 'Aotea' and 'Takahe', 'Kopara 73' mean yield increased by 13.4% and 7.0% respectively.

Grain-yield responses to applied nitrogen were similar for 'Aotea' and 'Takahe', but both were inferior to that for 'Kopara 73'. No cultivar x superphosphate interactions were recorded.

INTRODUCTION

Since its release in 1971, 'Kopara' has rapidly become an established New Zealand wheat cultivar, its contribution being 11.9% of the total wheat received by the New Zealand Wheat Board from the 1973 harvest season (Department of Statistics 1974). 'Kopara' grain yield performance under field trial conditions has previously been documented (Douglas et al. 1971), as has its breeding history and agronomic characteristics (Copp 1972; Smith 1974; Copp & Cawley 1974).

Descending from one third-generation plant, the 'Kopara' bulk line showed much variability in plant type, and a normal reselection programme was instigated in 1968 by Crop Research Division, DSIR. From this programme a reselection line, 1020.01/6, was selected for multiplication and subsequently released as 'Kopara 73'. Copp & Cawley (1974) describe the details of reselection and the plant characteristics of this newly released cultivar.

A Crop Research Division selection, bred by extensive backcrossing of 'Aotea' and tested under the number 1877.02, has also been recently released for commercial growing. This red-grained cultivar, 'Takahe', was bred and selected for improved sprout and mildew resistance relative to 'Aotea' (McEwan, pers. comm.).

This paper is based on the results of field trials in which grain yield performance of these two recent releases, as their appropriate Crop Research Division numbered line, was tested.

EXPERIMENTAL

Comparative data were analysed from 34 field trials, 30 Ministry of Agriculture and Fisheries and 4 Crop Research Division, conducted during the 1972-73 and 1973-74 seasons. Only 1 trial was in the North Island, the remainder being evenly spread through the major wheat growing areas of the South Island.

Although the trials were primarily for performance testing of 4–6 cultivars, factorial designs involving replicated, randomised blocks were used to incorporate nitrogen and/or superphosphate treatments in many of the trials. The cultivar 'Aotea' was included in all comparisons and taken as the standard wheat. In areas other than South Otago–Southland, where sowings were conducted during September–October, the sowing period was late May–June. Seeding rates ranged...
from 100–150 kg/ha and, if superphosphate was not a factorial treatment, 250 kg/ha superphosphate was drilled as a basal dressing at sowing. Initial plot widths and lengths ranged from 1.05–1.25 and 30–50 m respectively, with a range in final harvested area of 30–50 m². If fertiliser treatments were included, superphosphate was drilled at sowing at 250 kg/ha and/or nitrogen (as nitrolime) was broadcast at mid tillering (Feekes 5) at 75 kg N/ha. When necessary, weed and insect pest control was carried out as recommended for local conditions. All trials were header harvested and final grain yields were standardised to 15% grain moisture.

Variability in absolute grain yield levels between trials was high. Therefore, logarithmic mean yield differences were used for all analyses except those involved with simple linear regressions, in which ratios of logarithmic mean yields were fitted to absolute mean yields.

RESULTS

'Takahe'

In 30 of the 34 analysed trial comparisons the grain yield of 'Takahe' was superior to that of 'Aotea'. 'Takahe' mean grain yield, 4720 kg/ha, was significantly greater than the 4450 kg/ha recorded for 'Aotea' (Table 1). The calculated mean logarithmic difference of 0.0250 corresponded to a mean 'Takahe'/'Aotea' yield ratio of 105.9%, with associated lower and upper 95% confidence limits of 102.3% and 109.6% respectively.

'Takahe'/'Aotea' grain yield ratios were indicated as being independent of absolute 'Aotea' yield levels when a simple linear-regression test failed to reach significance (r = 0.07). Absolute grain yield differences between 'Takahe' and 'Aotea' would therefore appear to be no more than proportional to grain yield.

No trend relating the grain yield ratios of 'Takahe' and 'Aotea' with geographic positioning of the trial sites was apparent within the considered trial data. If, however, trials were separated into those in which powdery mildew, *Erysiphe graminis*, was either reported as being absent or present for an unspecified period within the duration of the trial (see Table 2), a significant difference in mean yield ratios for the two conditions existed at the 5% level. Whereas the mean 'Takahe'/'Aotea' yield ratio for non-mildew conditions was 103.7%, with a lower confidence limit of only 101.0%, the corresponding mean value for mildew-infected trials was 109.0% (confidence limits 105.8%, 112.3%).

'Kopara 73'
The grain yield of 'Kopara 73' was superior to 'Aotea' in 30 and to 'Takahe' in 26 of the

### Table 1 — 'Kopara 73', 'Takahe', and 'Aotea' grain yield comparison

<table>
<thead>
<tr>
<th></th>
<th>Logarithmic</th>
<th>Natural</th>
</tr>
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<tbody>
<tr>
<td>Kopara 73</td>
<td>3.7032</td>
<td>5050 (4930, 5170) kg/ha</td>
</tr>
<tr>
<td>Takahe</td>
<td>3.6736</td>
<td>4720 (4600, 4830) kg/ha</td>
</tr>
<tr>
<td>Aotea</td>
<td>3.6486</td>
<td>4450 (4340, 4560) kg/ha</td>
</tr>
<tr>
<td>Yield ratio</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kopara 73/Aotea</td>
<td>0.0546</td>
<td>113.4 (109.6, 117.3) %</td>
</tr>
<tr>
<td>Kopara 73/Takahe</td>
<td>0.0296</td>
<td>107.0 (104.5, 109.9) %</td>
</tr>
<tr>
<td>Takahe/Aotea</td>
<td>0.0250</td>
<td>105.9 (102.3, 109.3) %</td>
</tr>
</tbody>
</table>

( ) 95% confidence limits
s.e. of log. mean = 0.0052
s.e. of log. ratio = 0.0073

### Table 2 — Effect of mildew on 'Takahe'/'Aotea' mean grain-yield ratios

<table>
<thead>
<tr>
<th></th>
<th>Logarithmic difference</th>
<th>Natural ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mildew absent</td>
<td>0.0158</td>
<td>105.7 (101.0, 106.4) %</td>
</tr>
<tr>
<td>Mildew present</td>
<td>0.0374</td>
<td>109.0 (105.8, 112.3) %</td>
</tr>
</tbody>
</table>

( ) 95% confidence limits
s.e. = 0.0042
F-test value: 6.12*
34 analysed comparisons. The mean grain yield of 'Kopara 73', 5050 kg/ha, was significantly greater than the 4450 kg/ha recorded for 'Aotea' and the 4720 kg/ha for 'Takahe' (see Table 1). Calculated mean logarithmic differences of 0.0546 and 0.0296 corresponded to mean yield ratios of 113.4% and 107.0% for 'Kopara 73'/Aotea' and 'Kopara 73'/Takahe' respectively.

In all 11 comparisons, 'Kopara 73' consistently outyielded the bulk line of 'Kopara', mean yields being 5450 kg/ha and 5110 kg/ha respectively (Table 3). The associated grain yield difference was significant at the 0.1% level and corresponded to a grain yield ratio of 106.7%, with lower and upper 95% confidence limits of 105.0% and 108.4%.

For both 'Aotea' and bulk 'Kopara' comparisons with 'Kopara 73', logarithmic mean yield ratios were fitted to absolute yield levels by a simple linear-regression test. As with the 'Takahe' and 'Aotea' comparison, however, no significant relationship existed.

Logarithmic mean yield differences between 'Kopara 73' and 'Aotea' were also analysed in relation to associated paddock history. If preceding agronomic ventures were considered, a lower mean 'Kopara 73'/Aotea' grain yield ratio was determined for non-cereal crop situations (114.3%) compared with pasture based situations (119.4%). Similarly, the mean ratio for preceding cereal crop ventures (107.3%) was lower than that of non-cereal crop situations. These differences, however, all failed to reach the 5% level of statistical significance (F = 2.81). Ratios tended to decrease with successive cropping, but these, too, were not significantly different (F = 3.20) because of the relative variability of the considered data.

**Fertiliser response**

Nitrogen treatments, 0 and 75 kg N/ha, were included in 23 of the cultivar comparison trials. Of these, 8 showed no response, 13 responded positively, and 2 responded negatively. Significant cultivar x nitrogen interactions were recorded in 10 of the 13 responsive trials.

The mean cultivar response levels to applied nitrogen for the 23 trials, calculated by logarithmic differences, are presented in Table 4. Although the response levels of 8.2% and 9.6% for 'Aotea' and 'Takahe', respectively, were not significantly different, both were significantly lower than the 14.8% response for 'Kopara 73'.

Of the 15 possible 0 and 250 kg/ha superphosphate comparisons, 9 positive responses were recorded and 6 showed no significant response. No cultivar x superphosphate interactions were recorded, and therefore the data were not further analysed.

**DISCUSSION**

'Takahe'

Although the overall mean grain yield improvement by 'Takahe' compared with 'Aotea' was 5.9%, probably only a minimal yield advantage over 'Aotea' could be expected if using the former cultivar in mildew-free conditions. Under such trial conditions, mean grain yield improvement was 3.7%, with only a 1.0% increase as a likely lower limit. However, the 9.0% yield increase over 'Aotea' by 'Takahe' in trials in which powdery mildew infection occurred suggests that, in areas...
and seasons where mildew infection is potentially high, 'Takahe' has a distinct yield advantage over 'Aotea'. This observed resistance to existing races of powdery mildew, combined with improved sprout resistance, should make 'Takahe' a most suitable replacement for 'Aotea', especially in wheat-growing areas of higher rainfall such as South Otago and Southland.

As yield ratios between 'Takahe' and 'Aotea' were not correlated with absolute grain yields and as no significant differences exist in response patterns to fertiliser applications, it would appear that 'Takahe' has similar cultural requirements to those of 'Aotea'.

**Kopara 73**

The yield superiority for bulk 'Kopara' over 'Aotea', previously established by Douglas et al. (1971), was also evident for the reselected cultivar, 'Kopara 73'. Douglas et al. (1971) also found regional and sowing-time variation in the superiority for bulk 'Kopara', which was not evident for 'Kopara 73' in the considered trial data.

The available results showed that 'Kopara 73' has the potential to outyield 'Takahe' in all trial regions, although this yield advantage may be marginal in South Otago and Southland. In these areas the resistance to powdery mildew inherent in 'Takahe' and the continuing problem of eyespot (*Cercosporella herpotrichoides*) infection in 'Kopara 73', as was also reported for bulk 'Kopara' by Douglas et al. (1971), reduce the potential superiority of 'Kopara 73' over 'Takahe'.

The consistent yield improvements associated with 'Kopara 73' over bulk 'Kopara' and the improved milling quality (Copp & Cawley 1974) make the reselection an adequate substitute for the bulk line. The 6.7% mean yield increase gained through this reselection is of a similar magnitude to that previously obtained with a reselection programme before the release of 'Aotea' wheat (Copp 1959).

The lack of a differential response to super-phosphate by 'Kopara 73' and 'Aotea' in any of the considered trials was at variance with previously reported interactions for bulk 'Kopara' and 'Aotea' (Douglas 1970; Douglas et al. 1971). However, the interactions reported here between 'Kopara 73' and 'Aotea' with nitrogen applications do indicate a preference by 'Kopara 73' for higher soil nitrogen levels. The nature of 'Kopara 73'/'Aotea' yield-ratio trends, as influenced by preceding agronomic ventures and/or the degree of successive cropping, further supports this conclusion. Decreasing ratios with successive cropping for bulk 'Kopara' and 'Aotea' comparisons have previously been reported by Douglas et al. (1971).

The failure of regression analyses to relate 'Kopara 73'/'Aotea' yield ratios positively with absolute yield levels and thereby depict a relationship with soil fertility levels would, in part, be due to other edaphic and climatic factors differing at each individual trial location.

**Acknowledgments**

Ministry of Agriculture and Fisheries and Crop Research Division, DSIR, for technical assistance; Dr G. H. Jowett for statistical advice.

**REFERENCES**


