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RESPONSE TO NITROGEN FERTILISERS OF WHEAT, OATS AND BARLEY IN WESTERN AUSTRALIA

by M. G. Mason and R. N. Glencross

SUMMARY

The response to nitrogen fertilisers of wheat, oats and barley were compared in 18 field trials which included all three crops and in eight other trials where two of the crops were included. These trials were mainly sited in areas normally receiving more than 450 mm average annual rainfall.

Response curves were fitted to each set of data and then averaged to give overall response curves for each crop. There was little difference between the crops in absolute or percentage response to nitrogen fertiliser but the nitrogen fertiliser rate required for maximum yield was highest for wheat and lowest for oats (wheat 99 $kgha^{-1}$, barley 84 $kgha^{-1}$ and oats 75 $kgha^{-1}$). This was largely due to the longer and lower shape of the response curve for wheat and optimum economic rates would depend on the monetary return for each crop.

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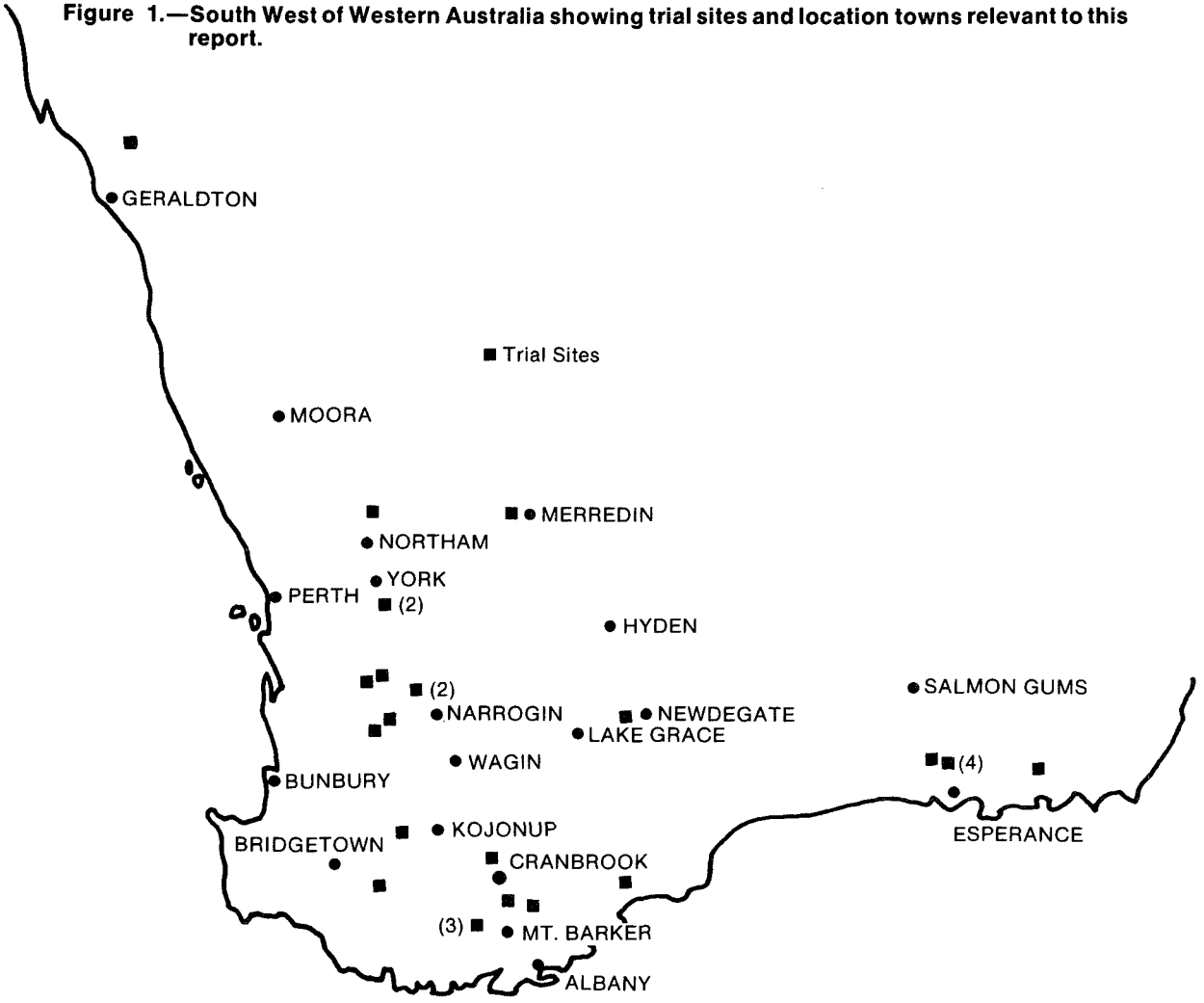
Figure 1.—South West of Western Australia showing trial sites and location towns relevant to this report.



INTRODUCTION

Wheat, oats and barley are important crops in Western Australia, and often give profitable responses to fertiliser nitrogen (Mason 1975). In spite of this, no detailed investigation has been made in W.A. of the comparative responsiveness of each crop to nitrogen applications. For accurate recommendations it is necessary to have an estimate of the response curves for each crop because, if the shapes of the response curves for the crops differ, optimum rates of application of nitrogen for each crop will also differ. The optimum rate of application will then depend on the price received for each crop.

This paper reviews the results of trials comparing response to nitrogen fertiliser by all three crops, or any two, in the same trial. The investigation involved 29 trials over nine seasons.

EXPERIMENTAL DETAILS

Details of soil types, sowing dates, crop varieties, site histories, basal fertiliser treatments, source of nitrogen fertiliser and timing of nitrogen applications are shown in Table 1. All trials except six had three replications. The exceptions were four replications at Popanyinning (1961 and 1962) and Gibson (E.D.R.S. 1961), and two replications at Gibson (1961) and Mount Barker (1977). Rainfall figures for the sites are set out in Table 2 and Figure 1 shows the locations of trial sites.

Trials from 1971-1977 had randomised block designs but in the 1967 and 1968 trials the different crops were each grown in a separate block. Earlier trials had split block design.

In 18 of the 29 trials all three crops were grown in the more than 450 mm rainfall areas. Other trials in these areas included four comparisons between wheat and oats, three of wheat and barley, and one of oats and barley.

RESULTS AND DISCUSSION

Quadratic curves, or in a few cases straight lines, were fitted to each crop response in each trial (Table 3). The responses for the >450 mm rainfall areas were then combined to give several sets of average response curves set out in Table 4 and Figure 2, together with maximum yield increases, percentage yield increases and rates of nitrogen fertiliser required to give maximum yield.

The absolute yield increases for all three crops were not very different being 389-454 $kgha^{-1}$ when all three crops were compared together and 383-566 $kgha^{-1}$ for all trials. Barley tended to give the largest increase. The increase with oats was slightly higher than with wheat for the 18 trials, but the position was reversed when the extra four trials were included. Percentage yield increases were similar for the three crops except where the extra four trials were included in the comparison between wheat and oats. In this comparison the response was greater for wheat than for oats.

The nitrogen fertiliser rate required to give maximum yield was highest for wheat and lowest for oats.

This order is also the same order as the monetary value per unit of crop but the response curve for wheat was longer and flatter than that for either oats or barley, (Figure 2). This has an effect on determination of optimum economic rates so that the optimum economic rates for each of the crops, assuming returns of $85, $55 and $65 per tonne for wheat, oats and barley and nitrogen fertiliser at $400 per tonne N, (prices current at the time of writing), were 40, 25 and 36 $kgNha^{-1}$.

Although most trials were in areas of greater than 450 mm average annual rainfall, exceptions were Beverley and Newdegate (350-450 mm) and Merredin (282 mm).

These results suggest that the three crops are not greatly different in their responsiveness to nitrogen. Although there are some differences in rates of nitrogen fertiliser needed to obtain maximum yield, the rates to be used in practice will be determined mainly by the monetary return received for each crop.

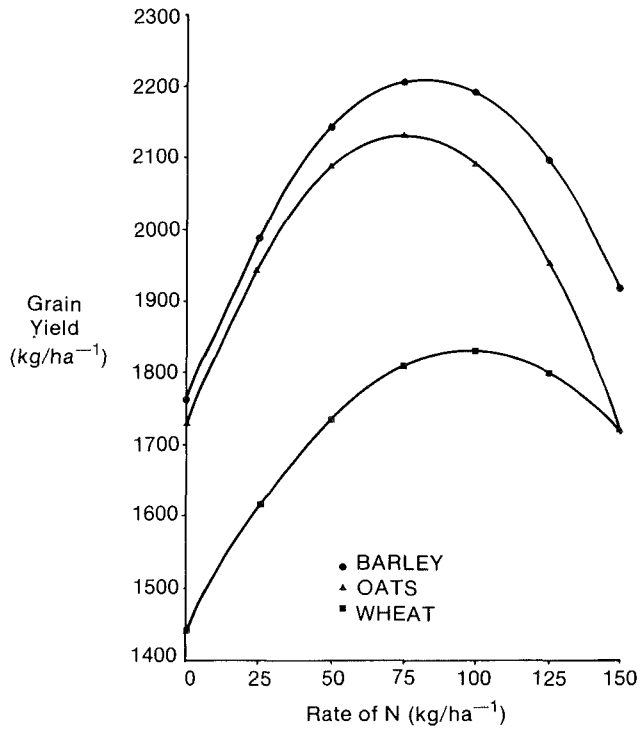


Figure 2.—Average response of wheat, oats and barley to nitrogen fertiliser in 18 trials.

ACKNOWLEDGMENTS

Thanks are due to farmers who made land available for some of these trials. The assistance of Research Station managers and staff, District Office advisers and technical staff and Plant Research Division technical staff who helped in planting these trials and collecting yield data is gratefully acknowledged. Thanks are also due to the Biometrics Section of the Department of Agriculture for statistical treatment of the results.

REFERENCE

Mason, M. G. (1975).—Nitrogenous fertilisers for cereal production. J. Agric. W. Aust. (Series 4) 16:103.

Table 1.—Some details of trials investigating rates of nitrogen fertilisers on wheat, oats and barley.

Site	Soil type	Sowing date	Crop and variety	Site history	Basal fertiliser	Source of N and timing of nitrogen application
Popanyinning	Gravelly sandy loam	12/5/61	Eureka wheat Avon Oats Beecher Barley	First crop on new land fallow.	Copper-Zinc Superphosphate 210 kg/ha	Ammonium Sulphate I.B.S.
Popanyinning	Gravelly sandy loam	15/5/62	Eureka Wheat Avon Oats Beecher Barley	Second successive crop on new land. Stubble of previous crop burnt.	Superphosphate 168 kg/ha	Ammonium Sulphate I.B.S.
West Arthur	Gravelly sandy loam over clay	16/5/61	Eureka Wheat Avon Oats Beecher Barley	First crop on new land fallow.	Copper-Zinc-Manganese Superphosphate 220 kg/ha	Ammonium Sulphate I.A.S.
Darkan	Gravelly sandy loam over clay	9/5/61	Gabo Wheat Avon Oats Beecher Barley	First crop on new land fallow.	Copper-Zinc-Manganese Superphosphate 220 kg/ha	Ammonium Sulphate I.A.S.
Mayanup	Gravelly sandy loam over clay	22/5/61	Kondut Wheat Avon Oats Beecher Barley	First crop on new land fallow.	Copper-Zinc-Manganese Superphosphate 224 kg/ha	Ammonium Sulphate I.A.S.
Gibson (Esperance Downs R.S.)	Grey sand over gravelly clayey sand over yellow and grey mottled clay	19/6/61	Eureka Wheat Avon Oats Beecher Barley	First crop after six years lucerne	Copper-Zinc Superphosphate 205 kg/ha	Ammonium Sulphate One day after sowing
Gibson	Gravelly sand over clay	2/6/61	Eureka Wheat Beecher Barley	First crop on new land fallow.	Copper-Zinc Superphosphate 200 kg/ha	Ammonium Sulphate I.A.S.

Table 1.—Some details of trials investigating rates of nitrogen fertilisers on wheat, oats and barley—*continued.*

Site	Soil type	Sowing date	Crop and variety	Site history	Basal fertiliser	Source of N and timing of nitrogen application
Duranillin	Brown sandy loam over yellow sandy loam over yellow sandy gravel at 75 cm	9/6/71	Darkan Wheat Dampier Barley	First crop after 4 years good clover pasture	Superphosphate 200 kg/ha	Ammonium Nitrate 3 weeks after sowing
Merredin	Grey-yellow loamy sand	16/6/72	Gamenya Wheat Clipper Barley	Second successive crop on old clover land. Stubble of previous crop burnt.	Superphosphate 270 kg/ha top-dressed before sowing.	Urea I.B.S.
Newdegate	Yellow loamy sand over gravel at 15-20 cm	30/6/72	Gamenya Wheat Clipper Barley	Second successive crop on old clover land. Stubble of previous crop burnt.	Superphosphate 270 kg/ha top-dressed before sowing.	Urea I.B.S.
Mt. Barker	Brown loamy sand over gravel	19/6/72	Darkan Wheat Clipper Barley	Second successive crop on old clover land. Stubble of previous crop burnt.	Superphosphate 134 kg/ha	Ammonium Nitrate various
Beverley	Red brown sandy loam	18/6/73	Gamenya Wheat Swan Oats	1972—Peas, 1971—Barley, 1970—clover on old land.	Superphosphate 112 kg/ha	Urea I.B.S.
Mt. Barker	Grey gravelly loamy sand over yellow gravelly loamy sand over gravelly clay at 20 cm	24/5/73	Gamenya Wheat Swan Oats	First crop after clover on old land.	Superphosphate 112 kg/ha	Urea I.B.S.
Woogenellup	Grey loamy sand over yellow loamy sand over very gravelly loamy sand at 30 cm.	9/5/74	Falcon Wheat Swan Oats	First crop after clover on old land.	Copper-Zinc-Superphosphate 200 kg/ha top-dressed plus 122 kg/ha super drilled	Ammonium Nitrate I.B.S.

Table 1.—Some details of trials investigating rates of nitrogen fertilisers on wheat, oats and barley—*continued.*

Site	Soil type	Sowing date	Crop and variety	Site history	Basal fertiliser	Source of N and timing of nitrogen application
Tenterden	Very gravelly grey sand over very gravelly yellow sand at 15 cm. Clay at about 15 cm.	7/6/77	Gamenya Wheat West Oats Clipper Barley	First crop after 3 years clover pasture on old land.	Superphosphate 150 kg/ha	Ammonium Nitrate 4 weeks after sowing
North Dinninup	Grey gravelly loamy sand over yellow gravelly loamy sand at 15 cm. Clay at 35-40 cm.	9/6/77	Gamenya Wheat West Oats Clipper Barley	First crop after clover on old land.	Superphosphate 180 kg/ha	Ammonium Nitrate 3 weeks after sowing
Mt Howick	Fine grey sand over orange domed clay at varying depth—sometimes at the surface	15/7/77	Madden Wheat West Oats Clipper Barley	First crop after clover on old land.	Copper, Zinc, Molybdenum Superphosphate 158 kg/ha	Ammonium Nitrate 3 weeks after sowing
Gibson	Fine grey gravelly sand over sandy gravel at 15 cm.	11/7/77	Madden Wheat West Oats Clipper Barley	First crop after clover on old land.	Superphosphate 90 kg/ha	Ammonium Nitrate 4 weeks after sowing
Boxwood Hills	Brown clay loam over brown clay at 5-15 cm.	8/7/77	Madden Wheat West Oats Clipper Barley	First crop after 2 years clover pasture on old land.	Superphosphate 154 kg/ha	Ammonium Nitrate 3 weeks after sowing
Mt Barker	Brown loamy sand over yellow loamy sand at 15 cm. Clay at 35-45 cm.	3/6/77	Gamenya Wheat West Oats Clipper Barley	Second successive crop on old clover land. Stubble of previous rape crop burnt.	Superphosphate 200 kg/ha	Ammonium Nitrate 3 weeks after sowing
Nabawa	Grey-brown loamy sand	13/6/67	Gamenya Wheat Fulmark Oats Beecher Barley	First crop after clover on old land	Superphosphate 168 kg/ha	Urea I.B.S.

Table 1.—Some details of trials investigating rates of nitrogen fertilisers on wheat, oats and barley—*continued.*

Site	Soil type	Sowing date	Crop and variety	Site history	Basal fertiliser	Source of N and timing of nitrogen application
Gibson	Gravelly sand over gravelly clay	5/7/67	Gamenya Wheat Fulmark Oats Beecher Barley	First crop after clover on old land	Superphosphate 168 kg/ha	Urea I.B.S.
Gibson	Gravelly sand over gravelly clay	30/6/67	Gamenya Wheat Fulmark Oats Beecher Barley	Second successive crop on old clover land. Stubble of previous crop burnt.	Superphosphate 168 kg/ha	Urea I.B.S.
Beverley	Red-brown sandy loam	28/5/68	Falcon Wheat Swan Oats Bussell Barley	Second successive crop on old clover land. Stubble of previous crop burnt.	Superphosphate 200 kg/ha	Urea I.B.S.
Cranbrook	Grey sand over gravelly clay	27/5/68	Falcon Wheat Swan Oats Bussell Barley	Second successive crop on old land originally clover but gone to grass. Stubble of previous crop burnt.	Superphosphate 200 kg/ha	Urea 3 weeks after sowing
Duranillin	Very gravelly sand	28/5/68	Swan Oats Bussell Barley	First crop on new land non fallow.	Copper-Zinc-Molybdenum Superphosphate 433 kg/ha	Urea I.A.S.
Gibson	Gravelly sand over gravelly clay	8/6/68	Gamenya Wheat Swan Oats Bussell Barley	First crop after lucerne on old land.	Superphosphate 168 kg/ha	Urea I.B.S.
Wongamine	Very gravelly brown loamy sand.	1/6/77	Gamenya Wheat West Oats Clipper Barley	First crop after one year clover on old land.	Superphosphate 150 kg/ha	Ammonium Nitrate 3 weeks after sowing

Table 2.—Rainfall at centres near 26 trial sites during the trial year, and long term averages.

Site and Year		Season of Trial		Long Term Averages	
		May-October (mm)	Year (mm)	May-October (mm)	Year (mm)
Popanyinning	1961	327	447	371	461
Popanyinning	1962	427	463	371	461
West Arthur	1961	370	494	388	492
Darkan	1961	483	638	480	583
Mayanup	1961	632	814	532	697
Gibson	1961	259	531	321	477
Nabawa	1967	334	373	381	449
Gibson	1967	289	398	321	477
Beverley	1968	331	434	303	384
Cranbrook	1968	381	523	380	515
Duranillin	1968	466	623	421	564
Gibson	1968	497	791	321	477
Duranillin	1971	411	621	421	564
Merredin	1972	172	205	196	282
Newdegate	1972	204	241	261	393
Mt Barker	1972	409	497	449	622
Beverley	1973	347	385	303	384
Mt Barker	1973	518	692	449	622
Woogenellup	1974	318	466	383	526
Tenderden	1977	427	506	478	655
North Dinninup	1977	497	578	493	610
Mt Howick	1977	298	376	360	511
Gibson	1977	326	402	321	477
Boxwood Hills	1977	633	775	N/A	N/A
Mt Barker	1977	546	667	449	622
Wongamine	1977	326	347	449	541

N/A = Not available.

Table 3.—Fitted response curves for nitrogen fertiliser response of wheat, oats and barley, together with maximum absolute and percentage yield increases, and rates of nitrogen fertiliser required for maximum yields.

Trial and Year		Crop	Fitted Response Curve	R^2	Maximum yield increase (kg/ha)	Yield increase (%)	N Rate to give maximum (kg N/ha)
Popanyinning	1961	Wheat	$Y = 951.9 + 13.34\,N - 0.88\,N^2$	90.3 (N.S.)	506	53	76
		Oats	$Y = 1230.6 + 16.87\,N - 0.086N^2$	99.0	827	67	98
		Barley	$Y = 1021.2 + 16.89\,N - 0.135N^2$	95.4	525	51	63
Popanyinning	1962	Wheat	$Y = 343.3 + 24.34\,N - 0.147N^2$	99.4	1008	293	83
		Oats	$Y = 552.6 + 21.99\,N - 0.123N^2$	99.2	1033	187	89
		Barley	$Y = 500.7 + 13.29\,N - 0.061N^2$	96.9	724	145	109
West Arthur	1961	Wheat	$Y = 805.5 + 6.58\,N - 0.025N^2$	87.1	433	54	132
		Oats	$Y = 1246.4 + 8.61\,N - 0.055N^2$	95.8	337	27	78
		Barley	$Y = 993.7 - 2.57\,N + 0.131N^2$	88.0 (N.S.)	0	0	0
Darkan	1961	Wheat	$Y = 379.9 + 13.76\,N - 0.037N^2$	99.8	1279	337	186
		Oats	$Y = 606.2 + 30.3\,N - 0.192N^2$	98.2	1195	197	79
		Barley	$Y = 332.3 + 21.38\,N - 0.16\,N^2$	100	714	215	67
Mayanup	1961	Wheat	$Y = 285.8 + 15.05\,N - 0.091N^2$	99.7	622	218	83
		Oats	$Y = 244.3 + 28.75\,N - 0.167N^2$	99.6	1237	507	86
		Barley	$Y = 181.8 + 19.54\,N - 0.126N^2$	100	758	416	78
Gibson (EDRS)	1961	Wheat	$Y = 392.3 + 6.41\,N - 0.061N^2$	100	168	43	53
		Oats	$Y = 1360.7 + 10.74\,N - 0.094N^2$	98.3	307	23	57
		Barley	$Y = 707 + 9.32\,N - 0.076N^2$	88.5 (N.S.)	286	40	61
Gibson	1961	Wheat	$Y = 286.5 + 2.55\,N + 0.093N^2$	92.9			*
		Barley	$Y = 652.4 + 30.26\,N - 0.283N^2$	98.7	809	124	53
Nabawa	1967	Wheat	$Y = 2396.8 + 23.73\,N - 0.153N^2$	94.9	920	38	78
		Oats	$Y = 1345 - 4.66\,N + 0.008N^2$	99.3	0	0	0
		Barley	$Y = 3251.9 + 8.55\,N - 0.148N^2$	94.6	123	4	29
Gibson	1967 (1)	Wheat	$Y = 2209.4 - 2.68\,N$	99.3	0	0	0
		Oats	$Y = 745 + 2.47\,N - 0.02\,N^2$	50.9 (N.S)	76	10	62
		Barley	$Y = 2125 - 1.41\,N - 0.016N^2$	89.3	0	0	0
Gibson	1967 (2)	Wheat	$Y = 2446.8 + 9.31\,N - 0.046N^2$	78.0	471	19	101
		Oats	$Y = 924.4 + 5.54\,N - 0.028N^2$	92.4	274	30	99
		Barley	$Y = 2226.7 + 17.98\,N - 0.122N^2$	95.9	662	30	74
Beverley	1968	Wheat	$Y = 2163.3 + 22.84\,N - 0.127N^2$	83.3	1027	47	90
		Oats	$Y = 2500.7 + 26.6\,N - 0.318N^2$	72.8 (N.S.)	556	22	42
		Barley	$Y = 2423.1 + 21.4\,N - 0.168N^2$	83.5	682	28	64

* Maximum yield responses are indeterminate because of the shape of the fitted response curve or straight line.

Table 3.—Fitted response curves for nitrogen fertiliser response of wheat, oats and barley, together with maximum absolute and percentage yield increases, and rates of nitrogen fertiliser required for maximum yields—*continued.*

Trial and Year		Crop	Fitted Response Curve	R^2	Maximum yield increase (kg/ha)	Yield increase (%)	N Rate to give maximum (kg N/ha)
Cranbrook	1968	Wheat	$Y = 1312.4 + 6.77\ N$	94.5			*
		Oats	$Y = 2540.1 + 17.74\ N - 0.09\ N^2$	97.9	819	32	95
		Barley	$Y = 2041.4 + 30.35\ N - 0.167N^2$	97.6	1379	68	91
Duranillin	1968	Oats	$Y = 620 + 23.83\ N - 0.099N^2$	98.6	1434	231	120
		Barley	$Y = 589.4 + 31.64\ N - 0.109N^2$	98.3	2296	390	145
Gibson	1968	Wheat	$Y = 1605 + 5.98\ N$	98.4			*
		Oats	$Y = 1756 + 4.23\ N + 0.018N^2$	90.2			*
		Barley	$Y = 2118.7 + 7.09\ N + 0.018N^2$	97.3			*
Duranillin	1971	Wheat	$Y = 2555.6 + 20.42\ N - 0.128N^2$	81.3	814	32	80
		Barley	$Y = 2099.6 + 12.25\ N - 0.065N^2$	82.1	577	27	94
Merredin	1972	Wheat	$Y = 1570.5 + 8.02\ N - 0.091N^2$	75.1 (N.S.)	177	11	44
		Barley	$Y = 922.5 + 12.96\ N - 0.135N^2$	85.8 (N.S.)	311	34	48
Newdegate	1972	Wheat	$Y = 1591.1 + 11.07\ N - 0.138N^2$	93.9	222	14	40
		Barley	$Y = 1448.2 + 8.36\ N - 0.093N^2$	95.5	188	13	45
Mt Barker	1972	Wheat	$Y = 2774 + 32.7\ N - 0.336N^2$	79.0 (N.S.)	796	29	49
		Barley	$Y = 3130.9 + 20.94\ N - 0.189N^2$	99.4	580	19	55
Beverley	1973	Wheat	$Y = 2911.9 + 4.92\ N + 0.16\ N^2$	93.8			*
		Oats	$Y = 2435.6 + 8.82\ N - 0.012N^2$	72.0 (N.S.)	1621	67	368
Beverley	1973	Wheat	$Y = 1399.4 + 0.84\ N + 0.009N^2$	14.6 (N.S.)			*
		Oats	$Y = 777.3 + 7.86\ N - 0.052N^2$	92.5	297	38	76
Mt Barker	1973	Wheat	$Y = 3329.1 + 15.64\ N - 0.14\ N^2$	87.4	437	13	56
		Oats	$Y = 2706.6 + 17.98\ N - 0.186N^2$	97.3	435	16	48
Woogenellup	1974	Wheat	$Y = 825.3 + 2.06\ N + 0.138N^2$	97.6			*
		Oats	$Y = 1171.9 + 9.64\ N - 0.158N^2$	98.8	147	13	31
Tenterden	1977	Wheat	$Y = 898 + 3.07\ N - 0.03\ N^2$	78.5	80	9	52
		Oats	$Y = 2280.3 + 15.53\ N - 0.084N^2$	87.0	715	31	92
		Barley	$Y = 1864.5 + 12.48\ N - 0.091N^2$	94.3	428	23	69
Nth Dinninup	1977	Wheat	$Y = 1196.5 + 4.61\ N - 0.01\ N^2$	42.5	548	46	238
		Oats	$Y = 2362.9 + 6.52\ N - 0.038N^2$	34.8	279	12	85
		Barley	$Y = 2212 + 14.27\ N - 0.064N^2$	94.9	798	36	112
Mt Howick	1977	Wheat	$Y = 2118.9 + 5.68\ N - 0.018N^2$	84.8	445	21	157
		Oats	$Y = 1747.6 - 1.36\ N + 0.004N^2$	32.3	0	0	0
		Barley	$Y = 1966.9 - 1.18\ N - 0.005N^2$	81.9	0	0	0

* Maximum yield responses are indeterminate because of the shape of the fitted response curve or straight line.

Table 3.—Fitted response curves for nitrogen fertiliser response of wheat, oats and barley, together with maximum absolute and percentage yield increases, and rates of nitrogen fertiliser required for maximum yields—*continued.*

Trial and Year		Crop	Fitted Response Curve	R^2	Maximum yield increase (kg/ha)	Yield increase (%)	N Rate to give maximum (kg N/ha)
Gibson	1977	Wheat	$Y = 2602.4 - 2.13\,N + 0.004N^2$	48.3	0	0	0
		Oats	$Y = 2031.8 - 1.27\,N - 0.009N^2$	97.4	0	0	0
		Barley	$Y = 2416.1 - 4.71\,N$	95.8	0	0	0
Boxwood Hills	1977	Wheat	$Y = 1265.9 - 1.04\,N - 0.005N^2$	38.8	0	0	0
		Oats	$Y = 2089.7 + 0.78\,N - 0.009N^2$	43.3	16	1	42
		Barley	$Y = 2534.9 + 6.15\,N - 0.03\,N^2$	53.7	317	12	103
Mt Barker	1977	Wheat	$Y = 3476.4 + 0.25\,N - 0.002N^2$	6.2	0	0	0
		Oats	$Y = 5141.6 - 6.52\,N + 0.023N^2$	34.0	0	0	0
		Barley	$Y = 3816.4 + 0.15\,N - 0.021N^2$	84.1	0	0	0
Wongamine	1977	Wheat	$Y = 1509.4 + 9.83\,N - 0.028N^2$	87.0	852	56	173
		Oats	$Y = 1739.9 + 9.3\,N - 0.05\,N^2$	97.2	437	25	94
		Barley	$Y = 2139 + 14.99\,N - 0.083N^2$	87.6	675	32	90

Table 4.—Average response curves for nitrogen fertiliser response of wheat, oats and barley, together with maximum absolute and percentage yield increases, and rates of nitrogen fertiliser required for maximum yields.

No. of trials Averaged	Crop	Curve	Maximum yield increase ($kgha^{-1}$)	YIELD INCREASE %	Rate of N to give maximum yield ($kgha^{-1}$)
18	Wheat	$Y = 1442.4 + 7.89\,N - 0.04\,N^2$	389	27	99
	Oats	$Y = 1727.8 + 10.9\,N - 0.073N^2$	407	24	75
	Barley	$Y = 1756.8 + 10.87\,N - 0.065N^2$	454	26	84
*22	Wheat	$Y = 1565 + 7.52\,N - 0.025N^2$	566	36	150
	Oats	$Y = 1736 + 10.93\,N - 0.078N^2$	383	22	70
*21	Wheat	$Y = 1503.8 + 9.41\,N - 0.52N^2$	426	28	90
	Barley	$Y = 1786 + 12.34\,N - 0.081N^2$	470	26	76
*19	Oats	$Y = 1669.5 + 11.58\,N - 0.074N^2$	453	27	78
	Barley	$Y = 1695.4 + 11.96\,N - 0.067N^2$	534	31	89

*These include the 18 trials involving all three crops.

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