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Conclusion

It is worth appreciating that farmers have shown some interest towards accepting these varieties in spite of so many difficulties. Increase in per acre yield is not the only attraction to the farmer unless it is supported by relevant factors making the environment ideal for such cultivation. Many farmers at present have grown high-yielding varieties on less than 1 per cent of total paddy land and that too when these tiny plots are included in the list of "demonstration plots" which ensure supply of inputs at concessional rates. At this rate high-yielding varieties cannot be expected to meet the challenge of increased agricultural production to an appreciable extent. Experience shows that if local varieties like *Prasad Bhog* and *Monohar Sali* are cultivated with the package of practices, the per acre yield will be in no way less than that of high-yielding varieties. Besides, these local varieties are more or less drought and flood resistant, and are less susceptible to diseases and pests attack than the exotic varieties. More of new varieties not susceptible to diseases and pest attack and flood and drought resistant should be evolved to suit the local conditions of cultivation. Therefore, a combined programme covering the improved local varieties may help farmers in accepting the programme easily. Lastly, it may be said that there is a bright prospect for the programme provided confidence is created in the minds of farmers and the infra-structure is strengthened by removing the bottlenecks.

COMPARATIVE STUDY OF ECONOMICS OF HIGH-YIELDING VARIETIES OF WHEAT—PUNJAB STATE

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The "new strategy" in agriculture revolves round the cultivation of high-yielding varieties which are highly responsive to fertilizer and are at the same time more resistant to insect pests and diseases. However, the general impression that prevails in the country is that the Mexican semi dwarf wheat varieties give very good performance at higher levels of fertilizer use but may not compare favourably with indigenous wheats at the rates of fertilizer recommended for the latter. This article shows that some of the dwarf wheats have remarkable adaptability and give better economic performance than the indigenous wheat even at the level of fertilizer use recommeneded for the latter.

An attempt is made here to study the economics of fertilizer use on semi dwarf high-yielding wheat Kalyan 227, and two tall growing indigenous improved wheat varieties, namely, C 273 and C 306 cultivated in the State of Punjab. On an average, semi dwarf wheat Kalyan 227 produces 32.7 per cent more yield than C 306 and 42 per cent more than C 273.

METHOD AND MATERIAL

The fertilizer experiments were conducted in the Punjab Agricultural University Research Stations on Mexican wheat, Kalyan 227 and indigenous wheat varieties C 273 and C 306. The experiments on C 306 and Kalyan 227 were conducted for two years, *i.e.*, 1965-66 and 1966-67 and each experiment had four replications. The experiments on C 273 were conducted in 1963-64 and 1964-65 with four replications each year. The different doses (kgs./hectare) applied to each variety are indicated below :

Treatment	Varieties		
	Kalyan 227	C 306	C 273
N	0, 60, 120	0, 45, 90, 135	0, 27, 54
P_2O_5	0, 40, 80	0, 66	0, 27, 54
K_20	0, 40	0, 45	0, 27, 54

The statistical analysis of the experiments showed that the effect of N and P was significant for all the three varieties, but the interaction of NP was significant only in the case of Kalyan 227 and C 306. Therefore, N and P were selected for further analysis. The production surface of quadratic nature was fitted in each case with the following results :

Variety	*Production Surface*	R^2
C 273*	$Y = 744.54 + 3.45\ N - 5{\cdot}551\ P - .044\ N^2 - .104\ P^2 + .090\ NP$	.8767
C 306	$Y = 2121.41 + 19.499\ N - 36.493\ P - .103\ N^2 - .461\ P^2 + .046\ NP$	.9214
K 227	$Y = 2251.16 + 22.416\ N - 33.667\ P - .155\ N^2 - .329\ P^2 + .188\ NP$	.8817

* For C 273 the yield is in kgs./acre and N, P in kgs./acre.

The marginal physical products of N and P in each case were calculated by differentiating the production surface partially with respect to N and P.

$$\left.\begin{aligned} \frac{dy}{dN} &= 3.451 + .090P - .088\ N \\ \frac{dy}{dP} &= 5.551 + .090N - .208\ P \end{aligned}\right\} \text{C 273}$$

$$\left.\begin{aligned}\frac{dy}{dN} &= 19.499 - .206N + .046\ P \\ \frac{dy}{dP} &= 36.493 - .046N - .922\ P\end{aligned}\right\}\ C\ 306$$

$$\left.\begin{aligned}\frac{dy}{dN} &= 22.416 - .310N + .188\ P \\ \frac{dy}{dP} &= 33.667 - .658P + .188\ N\end{aligned}\right\}\ \text{Kalyan}\ 227$$

Equating each of these equations to zero and solving simultaneously for N and P gave values of N and P which provided the maximum yield.

Optimum level of fertilizer use was calculated for each variety by equating marginal revenue to marginal cost, *i.e.*,

$$\frac{dy}{dN} = \frac{CN}{Cy} \text{ and } \frac{dy}{dP} = \frac{CP}{Cy}$$

where CN = Price of N in Rs./kg. = 1.5152
CP = Price of P in Rs./kg. = 1.3125

To account for fluctuations in prices, wheat prices were fixed at Rs. 70, Rs. 75, Rs. 80 and Rs. 85 per quintal. The optimum combination of N and P_2O_5 gives the level of yield where the profits are maximized.

DISCUSSION

Table I gives the optimum combination of N and P_2O_5 for the three varieties at different levels of product prices. Kalyan 227 yielded the highest profits at all levels of the product prices as compared with C 273 and C 306.

TABLE I—OPTIMUM COMBINATION OF N AND P_2O_5 FOR DIFFERENT PRICES OF THE PRODUCT

Variety	Price of wheat per quintal (Rs.)	Optimum level of		Gross profit (Rs./ hectare)	Fertilizer cost (Rs./ hectare)	Net profit (Rs./ hectare)
		N	P			
C 273	70	58.72*	43.06*	767.13†	66.09†	1,732.26
	75	62.76	45.92	811.45	70.15	1,831.75
	80	66.30	47.48	873.88	73.80	1,977.02
	85	77.81	55.22	835.81	77.02	2,133.07
C 306	70	93.60	42.21	2,761.42	197.07	2,564.35
	75	94.34	42.39	2,960.07	198.43	2,761.64
	80	95.00	42.50	3,158.43	199.50	2,963.05
	85	95.45	42.67	3,356.93	200.48	3,156.45
Kalyan 227	70	114.50	81.03	3,569.47	279.75	3,289.72
	75	115.20	81.42	3,824.99	281.32	3,543.67
	80	115.81	81.77	4,081.41	281.70	3,798.71
	85	116.36	82.07	4,337.76	283.93	4,053.83

* lbs./acre. † Rs./acre.

Table II shows a comparison of net profits[1] at the maximum level and an optimum level of fertilizer use. It will be seen from this table that in the case of C 306, this difference was rather small relative to C 273 and was further narrowed down with the increase in product prices. This gap was still narrower in the case of Kalyan 227, which means farmers should have little hesitation to invest in high-yielding varieties.

TABLE II—COMPARISON OF NET PROFITS AT OPTIMUM LEVEL OF FERTILIZER USE AND MAXIMUM LEVEL

Variety	Price level (Rs./quintal)	Net profits at (Rs./hectare)		Increase in profits at optimum level over maximum level (Rs./hectare)
		Optimum level	Maximum level	
C 273	70	1,732.26	1,710.05	22.21
	75	1,831.75	1,812.63	19.12
	80	1,977.02	1,958.71	18.31
	85	2,122.07	2,104.86	17.21
C 306	70	2,564.35	2,551.32	13.03
	75	2,761.64	2,749.28	12.36
	80	2,963.05	2,951.22	11.83
	85	3,156.45	3,246.22	10.23
K 227	70	3,289.72	3,276.91	12.81
	75	3,543.67	3,532.58	11.09
	80	3,798.71	3,788.28	10.43
	85	4,053.81	4,044.01	9.80

The yield of wheat for different varieties was worked out from the production surfaces and are presented in Table III. It will be seen from this table that the yield declined when one factor was kept constant and the other was varied. But when both the factors were varied, the yield showed an increasing trend. The complementary relationship existed between the two factors at a higher level of inputs. The estimated yields are indicated in the Graphs 1 to 3, showing the response of nitrogen to the three varieties at various levels of phosphorus.

The area cropped under wheat is 1,54,800 hectares in the Punjab which forms roughly 48 per cent of the total acreage under cereals and 35 per cent of the total acreage under foodgrains. The policy implication of this economic analysis is that total fertilizer available in the State could hardly meet 40 per cent of the fertilizer requirements for high-yielding wheat varieties. This is apparent from

1. Gross revenue minus fertilizer cost.

TABLE III—ESTIMATED YIELDS* FOR VARIOUS COMBINATIONS OF NITROGEN AND PHOSPHORUS FOR DIFFERENT VARIETIES OF WHEAT

C 273†

P \ N	40	50	60	70	80	90
20	9.54	9.66	9.70	9.66	9.52	9.43
40	10.12	10.43	10.65	10.78	10.82	10.78
60	9.87	10.36	10.76	11.07	11.29	11.43

C 306

P \ N	40	60	80	100	120
20	33.19	35.21	36.41	36.79	35.88
40	35.32	37.53	38.91	39.47	39.21

Kalyan 227

P \ N	40	60	80	100	120	140
40	40.21	43.09	44.74	45.15	44.32	44.02
60	41.87	45.51	47.90	49.06	48.98	48.32
80	40.89	45.28	48.43	50.35	51.02	50.54

* Yields are in quintals. † yields/quintas/acre.

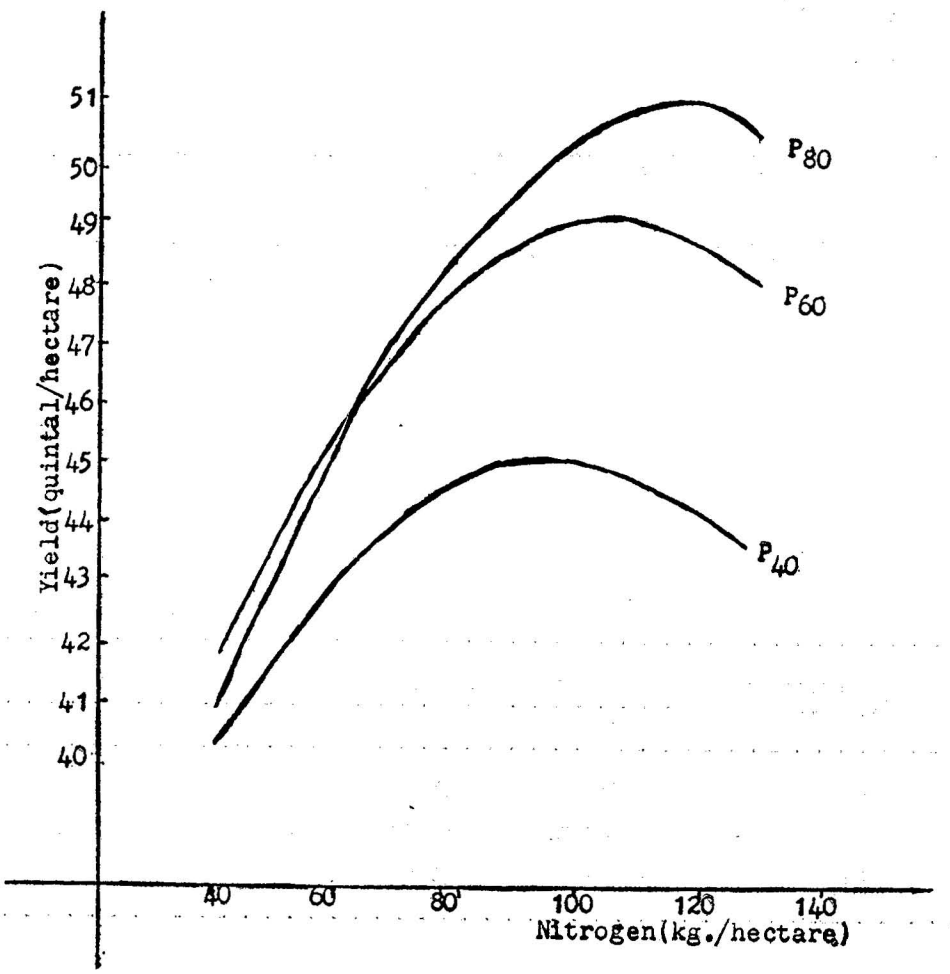

Figure 1—Curves Showing Response of Nitrogen to Various Doses of Phosphorus (Kalyan 227)

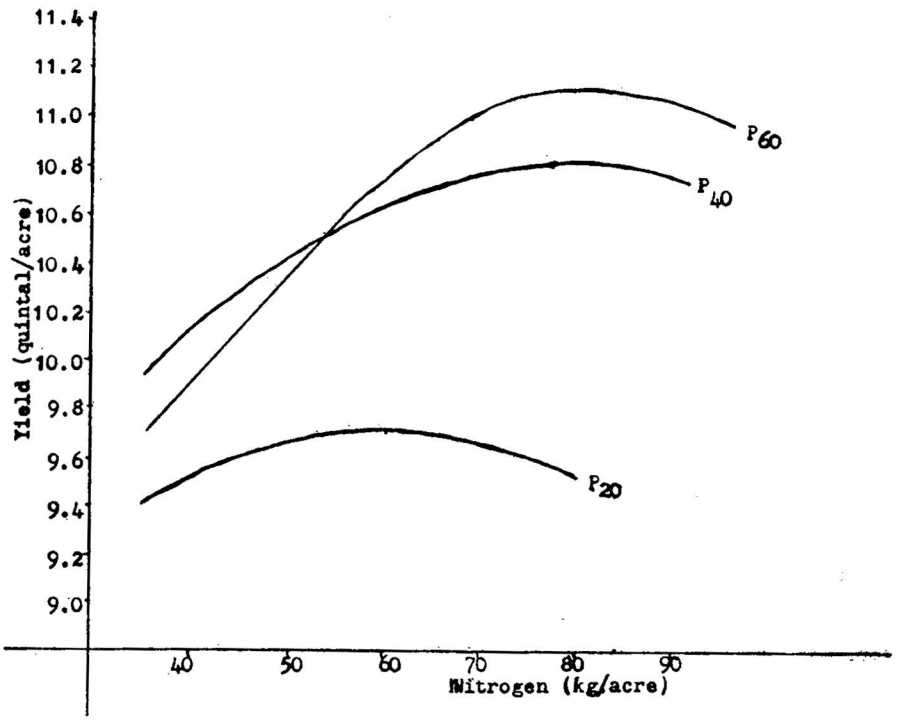

Figure 2—Curves Showing Response of Nitrogen to Various Doses of Phosphorus (C 273)

Table IV where fertilizer requirements of Kalyan 227 are given at optimum level, assuming 60 per cent, 70 per cent, and 80 per cent of the area under this variety and the product price at Rs. 80 per quintal.

TABLE IV—OPTIMUM FERTILIZER REQUIREMENTS AND THE TOTAL FERTILIZER AVAILABLE IN THE STATE

(*in metric tons*)

Percentage area under Kalyan 227	Optimum fertilizer requirements		Total fertilizer available in the State	
	N	P	N	P
60	1,07,564.37	57,371.97		
70	1,25,491.72	88,605.97	43,791.00	10,412.00
80	1,43,419.10	1,01,263.97		

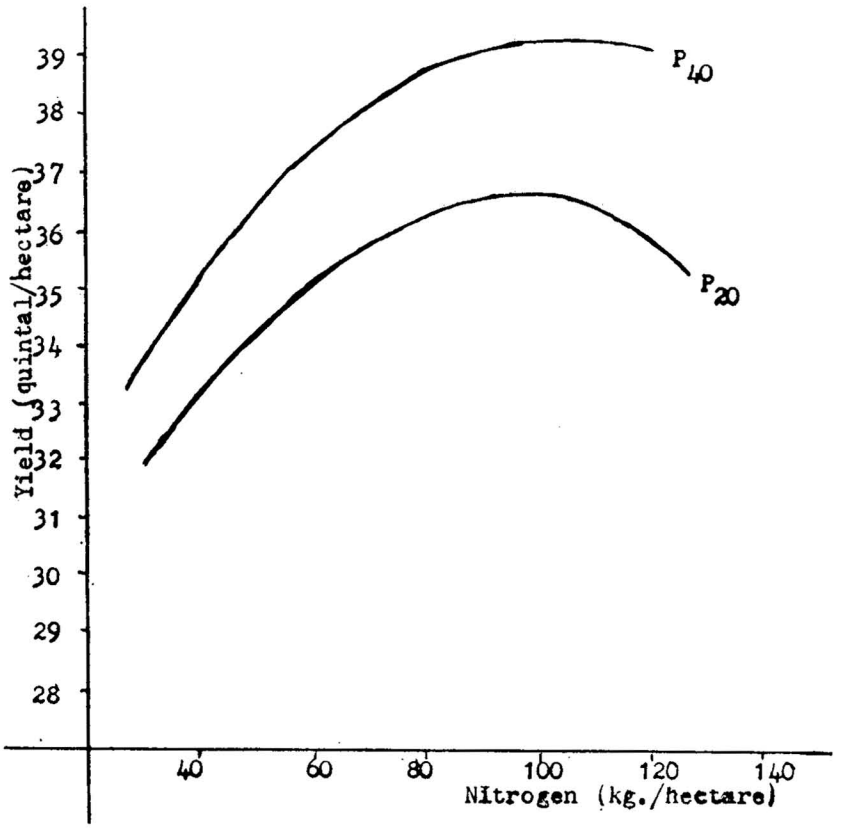

Figure 3—Curves Showing Response of Nitrogen to Various Doses of Phosphorus (C 306)

Further analysis shows that the yield level of Kalyan 227 was higher than C 306 even at the fertilizer level recommended for C 306, *i.e.*, 60 kgs. of N and 30 kgs. of P_2O_5. The yield at these fertilizer rates worked out to be 36.83 quintals for C 306 and 40.90 quintals for Kalyan 227. This is because of the superior plant type of the latter and its adaptability and good performance even under average fertility conditions. This means farmers could cultivate Kalyan 227 (Mexican wheat) with profit over indigenous wheat varieties even at a low level of fertilizer application. Assuming different levels of acreage under Kalyan, the production of wheat at this level of fertilizer use is shown in Table V.

TABLE V

Area under Kalyan 227 (per cent)	Total fertilizer requirements (metric tons)		Total production perspective ('000 metric tons)	Present production (1966-67) ('000 metric tons)
	N(60)	P(30)		
60	55,728.00	27,864.00	4541.83	2444
70	65,016.00	32,508.00	4989.28	
80	74,304.00	37,152.00	5436.57	

It will be seen from Table V that if the area under Kalyan 227 were 60 per cent of the total area under wheat, production would go up by 82.38 per cent; if the acreage under Kalyan 227 were increased to 70 per cent, production would go up by 99.7 per cent and if the acreage were raised to 80 per cent, then wheat production would go up by 117.03 per cent. Although experimental data were not adequate, this economic analysis of the fertilizer use gives a clear indication that it will be more profitable for the farmers to grow high-yielding variety Kalyan 227 even when they could afford to use those levels of fertilizer which were applied to indigenous improved varieties of wheat.

RESPONSE OF SOME MEXICAN RED AND INDIAN AMBER WHEATS TO NITROGEN*

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In view of the farmers' awareness to grow high-yielding crop varieties in the country, a clear understanding of the fertilizer response to crop yields is essential not only to the farmers and the extension workers but also to the Government in allocating the limited quantities of fertilizers to various soil, geographic and climatic areas. The main objective of this paper is to examine the relationship between the quantity of nitrogen applied and wheat yields on the Mexican red and Indian amber varieties of wheat. Other related objectives of this paper are estimating the most profitable levels of nitrogen application for the Mexican and Indian wheats, estimation of net profit incident to application of nitrogen and comparison of net profits between the Mexican and Indian wheat varieties at the most profitable levels of nitrogen application and at the levels recommended by agronomists.

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