EFFECT OF TREE WINDBREAKS ON THE YIELD OF WHEAT IN THAL DESERT UNDER IRRIGATED CONDITIONS

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Summary

The effect of tree windbreaks/shelterbelts has been studies in Thal desert (Pakistan) on the yield of wheat crop in 1984 grown under irrigated conditions. Wheat was sampled in $1M^2$ plots along transect lines on the leeward side. The results obtained indicata a net gain in grain yield. There was also a loss of grain near the tree row which could be minimized by improved cultural practices and control of weeds. However, the economic gain from the sale of wood obtained from windbreaks more than compensated the loss.

Introduction

Thal is sandy desert in the province of Punjab (Pakistan) lying between longitudes $70^{o}43'$ and $72^{o}18'$ east; and latitudes $29^{o}58'$ and $32^{o}35'$ north, 9000 square miles (25,310 km^2) in size, covering Mianwali, Sargodha, Dera Ismail Khan, Muzaffargarh, Jhang, Dera Ghazi Khan, Leiah, Bhakkar and Khushab administrative districts (Higgins, *et al* 1970). To harness this potential natural resources of 88,000 ha of commandable area, a network of irrigation system was commissioned in 1947 by building Kalabagh dam on river Indus (Rashid, 1981). The region is arid and his characteristic of frequent and strong winds dominated by monsoon winds (Ahmad, 1966) in summer coming from south, south-east and east while in winter the direction is almost reserved. The agrometerological data (FAO, 1980) of the representative station covering the sites of this investigation is reproduced below:

Meterological data of the Station nearest to the sites

Station: Sargodha
Latitude: 32.04; Longitude: 72.43; Elevation 187 m

Months	Precipitation (mm)	Temperature Average (C^{o})	Vapour pressure (mm)	Wind speed 2m (m/s)	Evaporation (mm)
January	14	11.8	9.5	1.6	36
February	23	14.6	10.6	2.0	69
March	24	19.7	14.4	2.7	120
April	21	25.4	16.3	3.3	198
May	16	29.7	16.4	3.6	272
June	29	34.1	20.0	3.4	274
July	95	32.7	29.7	3.9	222
August	96	31.1	31.0	3.4	191
September	39	30.1	25.5	2.4	156
October	5	25.3	17.9	1.9	130
November	2	17.7	12.5	1.4	58
December	9	13.3	9.6	1.2	36
Year	373	23.8	17.8	2.6	1762

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The need of planting shelterbelts/windbreaks to control wind-erosion of soil and sand to protect canals, rivers, roads, rail-track, habitation and agricultural fields has been suggested (Said, 1954; Khan, 1958, Shah 1962) and quite a number of such windbreaks can be seen today throughout the area.

The results reported here have been obtained from the data collected from agricultural fields already planted with windbreaks of various species over a period of time and the effect of wheat has been assessed.

Investigation Sites:

The following three sites were selected in Thal area during wheat harvest season in 1984 to assess the effect of tree rows providing shelter against prevailing hot and cold winds and influencing the wheat yield:

- Mianwali Agriculture Farm
- Sandan-Wala Farm (Harnoli)
- Ghazanfar Farm-Kotla Jam (Bhakkar-Darya Khan Road)

Material, Methods and Results:

Site 1. Mianwali Agriculture Farm:

About 25 year old shisham tree growing in three different rows, each 190 m in length and 68 m apart oriented north-south, were selected for their influence on wheat yield. The trees, which were planted 3 m apart, had an average height of about 20 m and dbh of about 30 cm. The farm is canal irrigated. Wheat variety Pak–81 was shown in November 1983 with a drill in lines showing at the rate 35 kg seed per acre (87 kg/ha) after 6 ploughings with a power-cultivator. Irrigation was applied after every 21 days and fertilizers like DAP (one-bag) mixed with half bag urea was applied at seed bed preparation and subsequently one bag urea at first irrigation after sowing.

To collect wheat yields data, one m^2 sample plots were taken at random along a tran sect line running laterally from one row of trees to the next one at every 5 m intervals in the leeward side. In all 4 transects were within the sample plot was cut manually, tagged for respective distances, sun dried, threshed and grain yield recorded. It was observed visually that the wheat crop at 3 m distance from tree row. 10 samples (1 m^2) were also taken from control plots and yield was recorded which on projection comes to 28 md^1)/ac. The average grain yield from respective samples of the four transects is tabulated below and is also projected on hectare/acre basis alongwith difference from the control:

Table 1. Yield of Wheat at various distances from the tree rows

Distance (m) from tree–row of sample (1 m^2)	Average yield (gm/1 m^2)	Projected Av. yield		Projected difference from control (md/ac)
		Kg/ha	md/ac	
0–3	251	2510	25.1	– 2.9
3–5	265	2650	26.5	– 1.5
5–10	312	3120	31.2	+ 3.2
10–15	335	3350	33.5	+ 5.5
15–20	335	3350	33.5	+ 5.5
20–25	338	3380	33.8	+ 5.8
25–30	355	3550	35.5	+ 7.5
30–35	384	3840	38.4	+ 10.4
35–40	365	3650	36.5	+ 8.5
40–45	345	3450	34.5	+ 6.5
45–50	332	3320	33.2	+ 5.2
50–55	362	3260	32.6	+ 4.6
55–60	315	3150	31.5	+ 3.5
60–65	270	2700	27.0	+ 1.0
		Total =	452.8	+ 60.8
		Average =	32.3	+ 4.3

1) md. : 1 maund = 40 kilos.

The projected average yield (md/ac) and the yield from control plots at respective distance from the tree-row is leeward direction is also plotted graphically in Figure 1.

It is evident from the data tabulated above from the trend of the yield curve in Figure–1 that trees had depressed the yield upto a distance of 5 m on either side as compared to that of the control. However beyond 5 m distance windbreak did provide positive influence on the yield with gradual increase as compared to control yield lies at 30–35 m distance from tree row, which is about 1½ times that of the tree height. Beyond this point the yield has still an edge over that of control but has a declining trend. The projected average yield of all the sample plots comes to be about 32 md/ac which is 4 md/ac more than the crop under control plots.

It is important to point out here that shisham belongs to biological nitrogen fixer group of plants and competes little with associated crops for nutrients. Besides, it remains leafless during winter and casts little shade effect in the late spring when it starts foliage. More over one shisham tree of 25 years fetches lot of money in the market and more than compensates for the loss in grain, if any.

Site 2. Sandan-Wala Farm – Harnoli:

On this farm, effect on wheat of a single row of poplar (*Populus euramericana* cv-I-214)

trees which were on the average about 20 m tall with dbh in the range of 30 to 40 cm and growing 2.5 m apart over a length 200 m as windbreak was studies. One row of shisham was also growing at 35 m away from poplar row. It, therefore, had its own influence from the other side. Both the windbreaks were oriented north-south.

The farmer had shown wheat – a I : I mixture of the varieties sonaleka and Lyallpur-73 in November 1983 at the seed rate of 45 kg/ac (112 kg/ha) by broadcasting and four ploughings. The soil is sandy and sterile. Fertilization with one bag DAP at seed bed preparation; one bag ammonium sulphate at first irrigation and another one at second irrigation were applied. Irrigation with canal water was applied after every third week.

Sampling of wheat was conducted along four transects, two each one either side of the poplar windbreak. A sample plot of 1 m^2 was used and sampling procedure was exactly the same as already explained for site–1. Ten sample plots of 1 m^2 were also taken from the control plots having no influence of trees. The average value of respective sample points in all the transects is tabulated below and is also projected on hectare/acre basis alongwith the projected difference from the average yield of control plots (14 md/ac).

Table 2. Yield of Wheat grain at different distances from the tree row

Distance (m) from tree row	Average yield (gm/m^2)	Projected Av. yield Kg/ha	md/ac	Projected difference from control (md/ac)
0–3	110	1100	11.0	– 3.0
3–5	135	1350	13.5	– 0.5
5–10	135	1350	13.5	– 0.5
10–15	155	1550	15.5	+ 1.5
15–20	173	1730	17.3	+ 3.3
20–25	178	1780	17.8	+ 3.8
25–30	195	1950	19.5	+ 5.5
30–35	195	1950	19.5	+ 5.5
35–40	202	2020	20.2	+ 6.2
40–45	195	1950	19.5	+ 5.5
45–50	190	1900	19.0	+ 5.0
50–55	182	1820	18.2	+ 4.0
55–60	150	1500	15.0	+ 1.0
60–65	145	1450	14.5	+ 0.5
		Total:	234.0	+ 37.8
		Average:	16.7	+ 2.7

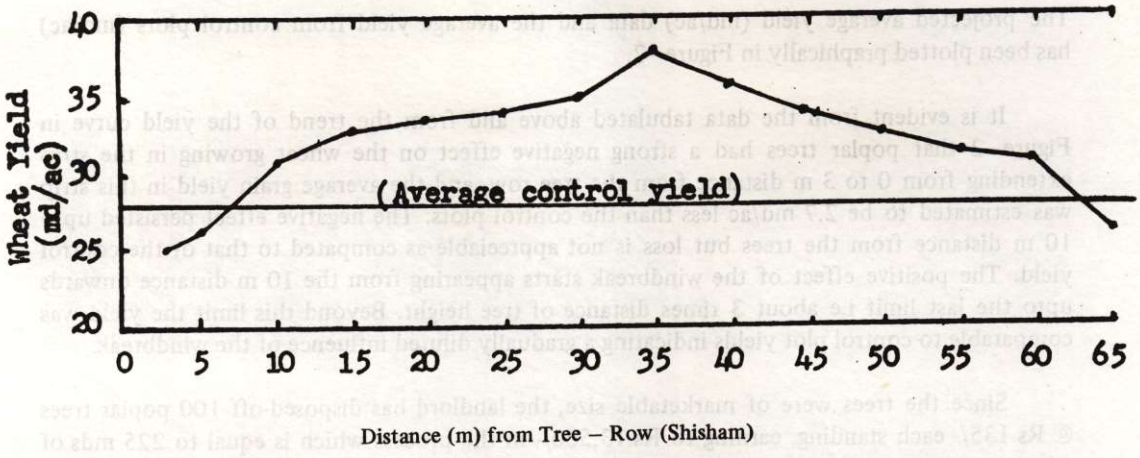

Fig. 1. Projected wheat grain yield (md/ac) of Pak-81 variety at different distances from wind break at Mianwali Agriculture Farm studied in 1984.

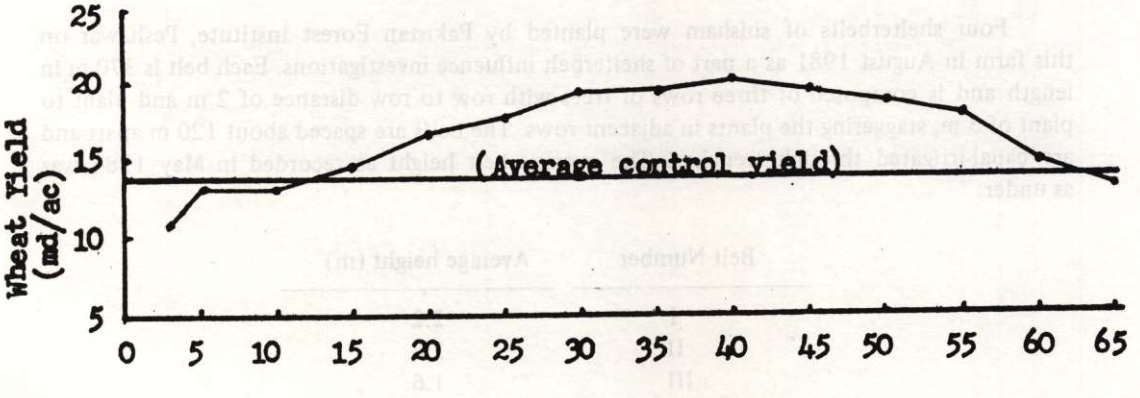

Fig. 2. Projected wheat grain yield (md/ac) of Sonaleka + Lyallpur – 73 variety at different distances from windbreak at Sandan-Wala Farm – Harnoli studied in 1984.

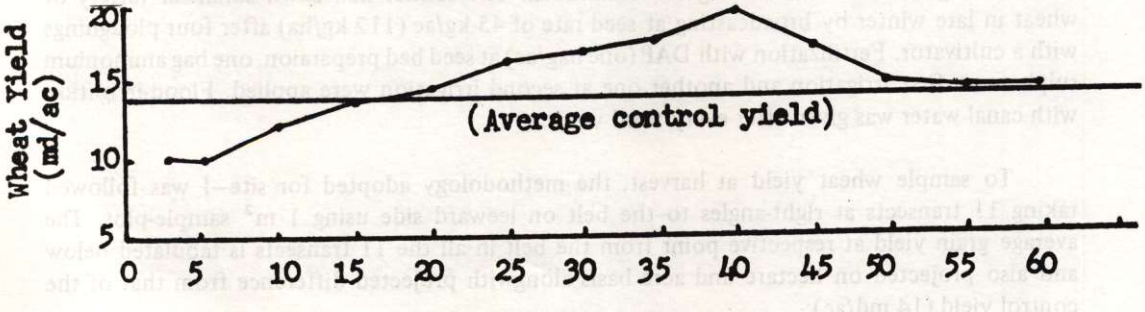

Fig. 3. Projected wheat grain yield (md/ac) of Sonaleka variety at different distances from belt at Ghazanfar Farm (Kotla Jam) studied in 1984.

The projected average yield (md/ac) data and the average yield from control plots (md/ac) has been plotted praphically in Figure–2.

It is evident from the data tabulated above and from the trend of the yield curve in Figure–2 that poplar trees had a strong negative effect on the wheat growing in the strip extending from 0 to 3 m distance from the tree row, and the average grain yield in this strip was estimated to be 2.7 md/ac less than the control plots. The negative effect persisted upto 10 m distance from the trees but loss is not appreciable as compated to that of the control yield. The positive effect of the windbreak starts appearing from the 10 m distance onwards upto the last limit i.e about 3 times distance of tree height. Beyond this limit the yield was comparable to control plot yields indicating a gradually diluted influence of the windbreak.

Since the trees were of marketable size, the landlord has disposed-off 100 poplar trees @ Rs.135/- each standing, earning to Rs.13,500/- in the process which is equal to 225 mds of wheat according to the current market price.

Site–3. Ghzanfar Farm: Kotla Jam:

Four shelterbelts of shisham were planted by Pakistan Forest Institute, Peshawar on this farm in August 1981 as a part of shelterbelt influence investigations. Each belt is 370 m in length and is composed of three rows of trees with row to row distance of 2 m and plant to plant of 3 m, staggering the plants in adjacent rows. The belts are spaced about 120 m apart and are canal-irrigated through trenches. The average belt height as recorded in May 1984 was as under:

Belt Number	Average height (m)
I	2.2
II	2.6
III	1.6
IV	2.5

The site is sandy, sterile, with lot of local weeds amongst which *Carthamus* sp. (Pohli) being the most vigorous one under irrigated conditions. The farmer had sown sonaleka variety of wheat in late winter by broadcasting at seed rate of 45 kg/ac (112 kg/ha) after four ploughings with a cultivator. Fertilization with DAP (one bag/ac) at seed bed preparaion, one bag ammonium sulphate at first irrigation and another one at second irrigation were applied. Flood-irrigation with canal water was given after every third week.

To sample wheat yield at harvest, the methodology adopted for site–I was followed taking 11 transects at right-angles to the belt on leeward side using 1 m^2 sample-plot. The average grain yield at respective point from the belt in all the 11 transects is tabulated below and also projected on hectare and acre basis alongwith projected difference from that of the control yield (14 md/ac):

Table 3. Yield of wheat grain at different distance from the shisham shelterbelt

Distance (m) from tree of sample (1 m^2)	Average yield (gm/m^2)	Projected average yield Kg/ha	md/ac	Projected difference from control (md/ac)
0–3	100	1000	10.0	– 4.0
3–5	100	1000	10.0	– 4.0
5–10	125	1250	12.5	– 1.5
10–15	140	1400	14.0	0.0
15–20	145	1450	14.5	+ 0.5
20–25	165	1650	16.5	+ 2.5
25–30	175	1750	17.5	+ 3.5
30–35	185	1850	18.5	+ 4.5
35–40	200	2000	20.0	+ 6.0
40–45	175	1750	17.5	+ 3.5
45–50	150	1500	15.0	+ 1.0
50–55	145	1450	14.5	+ 0.5
55–60	145	1450	14.5	+ 0.5
		Total :	195	+ 13.0
		Average :	15	+ 1.0

The projected average yield data at different points from the belt is plotted graphically in Figure–3 alongwith average control yield.

It appears from the tabulated data and the trend of the yield curve at different distances from belt that maximum negative effect of these trees was visible upto 5 m distance from belt resulting in 4 md/ac loss as compared to open control plots. One of the major reasons for such an affect, is not due to trees which at present are obviously very young but the practice of removing soil after sowing to strengthen the water courses which are not easy to maintain in sandy soil. This of course applies to all other sandy sites and has been observed personally by the data collectors. Another pertinent reason is vigorous growth of weeds along belts which prefer moist and shady site on either side of the belts.

Beyond 10 m distance from the belt the yield curve shows positive trend as compared to control and indicates a gain over a distance upto 60 m from the belt. The peak gain rests at 35 m distance from belt which falls within 14 times tree height zone from the belt. A very visible effect of shelterbelt was minimum lodging in the protected area resulting in an increase as indicated in the table above.

Conclusion:

1. There is net gain in the wheat yield due to effect of the windbreak in the desert areas.

2. There is definite loss of grain in the vicinity of the tree which can be attributed to the

effect of competition for water and nutrients and the tree species. The loss as observed is also attributed to removal of the seed and rich soil at some distance from the tree rows for strengthen the water course on which trees are growing. This effect is very obvious in sandy soils where the earth has to be lifted time and again to pile it up on the water course to keep it running.

3. Weeds tend to grow profusely arround the water courses depressing the wheat and other crops to a very great extent.

4. Nevertheless, gain through sale of wood is potential and more than compensates for the losses.

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