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Economics of Different Genotypes of Cotton Planted under Various Planting Densities

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Abstract

A field experiment was conducted in order to evaluate the economics of different genotypes of cotton planted under various planting densities at Agronomic Research Area, University of Agriculture Faisalabad during the summer season in 2013. Sowing was done manually with the help of dibbling method on both sides of the bed in standing water, with bed distance of 75 cm. The crop was sown in May and the experiment comprised of following FH-142, FH-114 at various densities (S_1 = 10 cm, S_2 = 15 cm, S_3 =20 cm, S_4 = 25 cm, S_5 = 30 cm). Data regarding net field benefit, benefit cost ratio, dominance analysis, and marginal rate of return were collected. The experimental results showed that maximum NFB of (Rs. 222,575), (Rs. 202,483) was achieved in FH-142 and FH-114 when planted at a plant spacing of 20 cm and 15 cm respectively. While the maximum benefit cost ratio (BCR) of 1.76 was found in genotype FH-142 at plant spacing of 20 and 25 cm and FH-114 depicted maximum BCR of 1.62 and 1.61 when planted at plant spacing of 15 and 20 cm, respectively. Dominance analysis of FH-142 planted at 10 and 15 cm while FH-114 at plant spacing of 10, 15 and 20 cm was dominated due to their lower net field benefits as compared to other treatments, while maximum marginal rate of return (1494%, 788%) by planting FH-142, FH-114 was obtained at 30 cm and 25 cm recorded respectively.

Keywords

Cotton Genotypes, Spacings, Economic Analysis, Benefit Cost Ratio

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1. Introduction

Cotton being an important cash crop of Pakistan contributes about 60% in the foreign exchange by export of various value added products (Iqbal *et al.*, 2003) [1]. It plays an important role in economy of the world. Pakistan ranked fourth in cotton production worldwide, after China, India, and USA with total production of 13.0 million bales (2210 million kg), against the targeted 14.5 million bales, and third in the leading consumers throughout the world (Akhtar *et al.*, 2010) [2].

Cotton crop is being influenced by various environmental factors. Optimum planting density can contribute in achieving maximum yield of cotton and it varies widely according to cropping system, environmental conditions and cultivars (Halemani and Hallikri, 2002) [3].

Among the various agronomic factors limiting seed cotton yield, low plant population and use of low potential genotypes are primarily important and thus responsible for low yield of cotton crop in the country. Adequate plant population per unit area of cotton seedlings is crucial to achieve high productivity and yield even at global level. Plant spacing has a key role in influencing the growth and yield characteristics of the crop and contributes 22.0% to 32.7% towards cotton yield (Mushtaq *et al.*, 2010) [4].

Mostly, farmers maintain plant spacing and population in the field according to their conventional methods of planting instead of variety requirements and it consequently results in yield penalty. Cotton genotypes showed a diverse nature in their architecture that determines the optimum spacing necessary for it to get profitable yield (Ali *et al*., 2009) [5]. Plant arrangement can be adjusted simply with low cost but it has considerable impact on yield (Severino *et al*., 2006) [6]. However, the optimum plant spacing depends on characteristics of the genotype for example growth habit, height and plant architecture (Bezerra *et al*., 2009) [7].

In Pakistan, the recommended row-to-row distance for cotton crop is 75 cm but plant-to-plant distance varies from 15 to 25 cm with optimum plant population ranging from 60,000 to 75,000 plants·ha^{-1}.

Shah *et al.* (2005) [8] hypothesized that earliness seemed to be function of genotypes in cotton; however, the use of high plant density systems for production of cotton was initially conceived as a way to improve earliness and to decrease production costs.

The studies revealed that growth habit of a crop affects interaction between the plants and consequently needs to be accounted for recommending plant population. Moreover, it becomes imperative to develop such versatile techniques for planting of cotton that ensure efficient nutrient uptake and minimum mutual shading and inter plant competition. To overcome this problem, modern production technology emphasizes the role of proper plant spacing to ensure high productivity of cotton. So, keeping in view the importance of cotton crop the present study was undertaken to examine economics of various cotton genotypes which were planted at various planting densities.

2. Material and Methods

The study was carried out at the Agronomic Research Area, University of Agriculture, Faisalabad, Pakistan (31.25N, 73.09E) during 2013-2014. The experiment was laid out in randomized complete block design (RCBD) under factorial arrangement with three replications. Two factors were studied Factor A = Genotypes V_1 = FH-142 (Spreading type) V_2 = FH-114 (Erect type) Factor B was Plant to Plant Distance S_1 = 10 cm (133,333 plants·ha^{-1}), S_2 = 15 cm (88,888 plants·ha^{-1}), S_3 = 20 cm (66,666 plants·ha^{-1}), S_4 = 25 cm (53,333 plants·ha^{-1}), S_5 = 30 cm (44,444 plants·ha^{-1}). 25 kg/ha seed was used bed distance was 75 cm. Fertilizers were applied at the rate of 200 and 115 kg·ha^{-1}·N and P_2O_5, respectively. 12 irrigations were given to fulfill requirement of crop. Different pesticides were used and also manually control of weeds was done.

The data collected were analyzed statistically using Fisher' analysis of variance technique and Least Significant Difference (LSD) test at 5% level of probability was employed to compare the difference among treatments' means (Steel *et al*., 1997) [9].

3. Result and Discussion

3.1. Net Field Benefits (NFB)

Farmers are more interested in variability in benefits than yields, therefore net field benefits (NFB) were calculated against the variable costs. **Table 1** reveals that maximum NFB of Rs. 222,575 was achieved in FH-142 when planted at a plant spacing of 20 cm against the minimum (Rs. 136,183) in plants spaced at 10 cm apart.

Table 1. Effect of plant spacing on net returns, net field benefits and benefit cost ratio of two cotton genotypes.

	Treatments	Seed cotton yield (kg·ha^{-1})	Gross income (Rs·ha^{-1})	Variable cost (Rs·ha^{-1})	Total cost (Rs·ha^{-1})	Net field benefits (Rs·ha^{-1})	Net returns (Rs·ha^{-1})	Benefit cost ratio (Rs·ha^{-1})
V_1 = FH-142	S_1: 10 cm × 75 cm	2170.78	162808.5	26,625	142686.50	136183.50	20122.00	1.14
	S_2: 15 cm × 75 cm	2514.45	188583.8	22,975	139036.50	165608.75	49547.25	1.36
	S_3: 20 cm × 75 cm	3288.67	246650.3	24,075	140136.50	222575.25	106513.75	1.76
	S_4: 25 cm × 75 cm	3232.11	242408.3	22,050	138111.50	220358.25	104296.75	1.76
	S_5: 30 cm × 75 cm	2528.11	189608.3	17,525	133586.50	172083.25	56021.75	1.42
V_2 = FH-114	S_1: 10 cm × 75 cm	2230.19	167264.3	26,925	142986.50	140339.25	24277.75	1.17
	S_2: 15 cm × 75 cm	3038.11	227858.3	25,375	141436.50	202483.25	86421.75	1.61
	S_3: 20 cm × 75 cm	2999.67	224975.3	22,725	138786.50	202250.25	86188.75	1.62
	S_4: 25 cm × 75 cm	2188.44	164133	17,100	133161.50	147033.00	30971.50	1.23
	S_5: 30 cm × 75 cm	1874.56	140592	14,450	130511.50	126142.00	10080.50	1.08

Seed cotton rate = 3000 Rs/40 kg; Total fixed cost = Rs. 116061.5.

FH-114 showed maximum NFB of Rs. 202,483 at plant spacing of 15 cm. However, minimum NFB of Rs. 126,142 was obtained in FH-114 at plant to plant distance of 30 cm.

3.2. Benefit Cost Ratio (BCR)

Benefit cost ratio (BCR) is also important to farmers because they are interested in the increase in net returns with given increase in the total cost of production. The maximum benefit cost ratio (BCR) of 1.76 was found in spreading genotype FH-142 at plant spacing of 20 and 25 cm (**Table 1**). FH-114 depicted maximum BCR of 1.62 and 1.61 when planted at plant spacing of 15 and 20 cm, respectively. This was due to its less cost of production and more gross income as compare to other treatments.

3.3. Dominance Analysis

As net field benefit (NFB) does not indicate the rate of return in relation to investment, final recommendation for the production technology cannot be specified only on the basis of NFB. Dominance and marginal analysis compares the variable costs with the gross margin, showing the increase in costs required to gain a given increase in gross margin. Treatments were first listed in increasing order of variable costs. Any treatment that had a total gross margin less than (or equal to) those of a treatment with lower total variable costs is dominated. Therefore, dominated treatments have a lower extra gross margin per unit of extra costs than other treatments (CIMMYT, 1988).

Data presented in **Table 2** reveals that NFB of some treatments were less to those with lower cost comparative to an increase in variable cost among treatments. As a result these treatments were dominated (D). The remaining (un-dominated) treatments were further considered for the marginal analysis. It is clear from the Table 4.22 that FH-142 planted at 10 and 15 cm while FH-114 at plant spacing of 10, 15 and 20 cm were dominated due to their lower net field benefits as compared to the preceding treatment.

3.4. Marginal Analysis

Marginal analysis was calculated to check the economic impact of plant to plant spacing on two cotton genotypes. This analysis assists the farmers to get the maximum benefit from the inputs by using the limited resources. Marginal analysis formed the basis of economic reasoning and it showed the effects of a small change in the control variable. As real differences were found in the yield among different treatments, therefore marginal analysis was done. **Table 3** shows the marginal analysis of un-dominated treatments. Maximum marginal rate of return (1494%) was obtained by planting FH-142 at plant spacing of 30 cm. FH-114 recorded maximum marginal rate of return (788%), when planted at a plant to plant distance of 25 cm.

Table 2. Effect of plant spacing on dominance analysis of two cotton genotypes.

Treatments	Cost that vary (PRs·ha^{-1})	Net field benefits (PRs·ha^{-1})
V_2S_5: 30 cm × 75 cm	14,450	126,142
V_2S_4: 25 cm × 75 cm	17,100	147,033
V_1S_5: 30 cm × 75 cm	17,525	172,083
V_1S_4: 25 cm × 75 cm	22,050	220,358
V_2S_3: 20 cm × 75 cm	22,725	202,250 **D**
V_1S_2: 15 cm × 75 cm	22,975	165,609 **D**
V_1S_3: 20 cm × 75 cm	24,075	222,575
V_2S_2: 15 cm × 75 cm	25,375	202,483 **D**
V_1S_1: 10 cm × 75 cm	26,625	136,183 **D**
V_2S_1: 10 cm × 75 cm	26,925	140,339 **D**

D = Dominated.

Table 3. Effect of plant spacing on marginal analysis of two cotton genotypes.

Treatments	Cost that vary (PRs·ha^{-1})	Marginal cost that vary (PRs·ha^{-1})	Net field benefits (PRs·ha^{-1})	Marginal net benefits (PRs·ha^{-1})	Marginal rate of return (%)
V_2S_5: 30 cm × 75 cm	14,450	-	126,142	-	-
V_2S_4: 25 cm × 75 cm	17,100	2650	147,033	20,891	788
V_1S_5: 30 cm × 75 cm	17,525	3075	172,083	45,941	1494
V_1S_4: 25 cm × 75 cm	22,050	7600	220,358	94,216	1240
V_1S_3: 20 cm × 75 cm	24,075	9625	222,575	96,433	1002

V_1 = FH-142; V_2 = FH-114.

It is evident from the results that farmers with poor resources can accomplish maximum benefits by planting FH-142 at plant spacing of 30 cm and FH-114 at 25 cm, respectively. Farmers with better resources can move towards planting cotton at plant to plant distance of 20 and 25 cm in case of FH-142 and 30 cm for FH-114, respectively.

4. Conclusion

Spreading genotype FH-142 gave higher benefit cost ratio (1.76) at plant spacing of 20 and 25 cm. FH-114 depicted maximum BCR (1.62 and 1.61) when planted at plant spacing of 15 and 20 cm, respectively. Maximum marginal rate of return (1494%) was obtained by planting FH-142 at plant spacing of 30 cm. FH-114 recorded maximum marginal rate of return (788%), when planted at the plant-to-plant distance of 25 cm.

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