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EFFECT OF DIFFERENT IRRIGATION AND FERTIGATION STRATEGIES ON CORN PRODUCTION UNDER DRIP IRRIGATION

Junaid Nawaz Chauhdary[1,*], Allah Bakhsh[1], Muhammad Arshad[1] and Muhammad Maqsood[2]

[1]Department of Irrigation and Drainage, University of Agriculture, Faisalabad, Pakistan; [2]Department of Agronomy, University of Agriculture, Faisalabad, Pakistan
[*]Corresponding author's e-mail:mjunaidnawaz@yahoo.com

Crop and water productivity can be improved by sowing crops under drip irrigation coupled with fertigation and proper management scheme. The study was conducted, during spring seasons of 2015 and 2016, at Faisalabad, Pakistan to investigate the corn response under different irrigation frequencies including daily: daily irrigation, 3rd day: cumulative irrigation at every third day and 5th day: cumulative irrigation at every 5th day. Also, three rates of recommended dose of fertigation (RDF) including 100% of RDF, 75% of RDF and 50% of RDF were investigated for both imported water soluble fertilizer (IM) and indigenously developed water soluble fertilizer (NB) to check their effect on corn production and its net profit. The experiment was laid under "Randomized Complete Block Design (RCBD)". Crop growth was measured in terms of plant height, dry matter weight, grain yield, harvest index and water productivity. The results revealed that plant height, dry matter weight, grain yield, harvest index and water productivity were statistically highest under daily frequency followed by 5th day and 3rd day irrigation frequency, respectively. The results also showed that the highest plant height (192.8 cm), dry matter weight (18.17 t/ha), grain yield (9.47 t/ha) and water productivity (3.41 kg/m^3) were produced by NB 100. Treatment under daily irrigation with NB 100 produced highest grain yield (9.98 t/ha) and net profit (Rs. 210342/ha) among all other treatments. Therefore, it is recommended that corn sown under drip irrigation should be fertilized by NB 100 with daily irrigation frequency for economically better production in the semi-arid area of Faisalabad, Pakistan.
Keywords: Corn, fertigation, irrigation frequency, net profit, water productivity

INTRODUCTION

The population of Pakistan is growing rapidly at the rate of 1.92% and is expected to reach 320 million by 2050 (GOP, 2015), posing challenges for meeting sharply growing water and food demand. This food demand can only be achieved by shifting from conventional to conservation agriculture by improving water use efficiency. Drip irrigation, being a proven technology, has offered special agronomical, economical, and agro-technical advantages for efficient use of water and fertilizer (Tayel *et al*., 2008; Dagdelen *et al*., 2009; Mansour *et al*., 2013; Mansour *et al*., 2015; Biswas *et al*., 2015) and it can replace flood irrigation having 50% application efficiency with an efficiency of 90%. Along with water saving, drip irrigation can apply fertilizer efficiently by coupling fertigation with irrigation that ultimately increase crop yields.

In drip irrigation, mostly water soluble fertilizers are used (Munir *et al*., 2004) as conventional fertilizers can clog drip emitters with suspended and un-dissolved particles. However, most of the water soluble fertilizers are being imported from foreign countries to Pakistan that's why their market price is too high. There is a need to adopt indigenously developed water soluble fertilizers to decrease production cost and get better productivity. With increase in crop productivity under drip irrigation, there are some limitations with its use like salinity buildup in root zone. The problem of salts accumulation in root zone under drip irrigation becomes more severe with groundwater (saline water) that can ultimately affect crop growth. In Punjab, Pakistan use of groundwater, which is mostly saline in nature, for irrigation has approached to 50% of crop water requirement due to shortage of canal water (Shah, 2007) especially for regular water application to crops under drip irrigation. A conventional remedy, which is mostly used to leach down these salts from root zone, is to apply one to two flood irrigations during a cropping season, which can fall water productivity. Another potential approach to leach down these salts from root zone is through drip irrigation system itself by use of different irrigation frequencies (Amin *et al*., 2015; Anjum *et al*., 2014). It will create a healthy environment for root development for better crop production. The research work of Sacksa and Bernsteinb (2011) and Min *et al*. (2014) showed the feasibility of drip irrigation system for saline water under different irrigation regimes and alternate use, respectively.

Keeping in view the above discussion, this study has been designed to investigate the effects of different irrigation frequencies on corn growth and a comparison was made between different rates of indigenously developed water soluble fertilizer and imported water soluble fertilizer for corn production in Faisalabad, Pakistan.

MATERIALS AND METHODS

The two year study, during spring seasons of 2015 and 2016, was conducted at the experimental area of Water Management Research Centre (WMRC), University of Agriculture, Faisalabad (UAF) situated at 31° North (latitude), 73° East (longitude) and 184 m above mean sea level (ASP, 2006). The study area represents semi-arid region of Pakistan with mean annual rainfall of 350 mm and temperature of area ranges from freezing point (in winter) to 50°C (in summer). Soil of the field was sandy loam with bulk density of 1.52 g/cm^3 at depth of 0.3 m.

A water soluble fertilizer was developed by Nuclear Institute for Agriculture and Biology (NIAB) in collaboration with WMRC, UAF. This locally developed water soluble fertilizer named as NB fertilizer (NPK 19-19-19) is half in price than the imported water soluble fertilizer named IM fertilizer (NPK 20-20-20), which is most popular (Jafar fertilizer) among all fertilizers that are available in market. NB fertilizer was more acidic in nature than IM fertilizer as it has pH less than 3 which is lower than that of IM fertilizer (pH=6).

To optimize the use of fertilizers under drip irrigation, three percentages i.e. 100, 75 and 50% of recommended dose of fertigation (RDF) were taken for both NB and IM fertilizers. According to Punjab Agriculture Department, Pakistan, the recommended dose of fertigation (RDF) for corn is N:P:K= 250 kg/ha: 125 kg/ha: 125 kg/ha. As in NB fertilizer (N:P:K= 19:19:19) and IM fertilizer (N:P:K= 20:20:20), N:P:K were available in equal fraction in compound form so Urea was used to acquire the required N:P:K fraction (2:1:1). The required quantities of water soluble fertilizer and Urea for both NB and IM fertilizers for 100% RDF, 75% RDF and 50% RDF are given in Table 1.

Table 1. Quantity of water soluble fertilizer and Urea for NB and IM fertilizers.

Fertilizer treatment	Water soluble fertilizer kg/ha)	Urea (kg/ha)
NB 100	658	272
NB 75	494	204
NB 50	329	136
IM 100	625	272
IM 75	469	204
IM 50	313	136

Moreover, the response of different irrigation frequencies including daily irrigation, 3rd day irrigation and 5th day irrigation for groundwater under drip irrigation was evaluated. Under daily irrigation frequency, irrigation was applied according to daily crop water requirement. Under 3rd day irrigation frequency, the cumulative water of three days was applied on 3rd day. Under 5th day irrigation frequency, the cumulative water of five days was applied on every 5th day.

Eighteen treatments including six treatments for fertigation (three rates for NB fertilizer and three rates for IM fertilizer) and three treatments for irrigation frequencies were investigated in the experiment. These treatments are enlisted as T_1: NB 100+ daily irrigation, T_2: NB 100+ 3rd day irrigation, T_3: NB 100+ 5th day irrigation, T_4: NB 75+ daily irrigation, T_5: NB 75+ 3rd day irrigation, T_6: NB 75+ 5th day irrigation, T_7: NB 50+ daily irrigation, T_8: NB 50+ 3rd day irrigation, T_9: NB 50+ 5th day irrigation, T_{10}: IM 100+ daily irrigation, T_{11}: IM 100+ 3rd day irrigation, T_{12}: IM 100+ 5th day irrigation, T_{13}: IM 75+ daily irrigation, T_{14}: IM 75+ 3rd day irrigation, T_{15}: IM 75+ 5th day irrigation, T_{16}: IM 50+ daily irrigation, T_{17}: IM 50+ 3rd day irrigation and T_{18}: IM 50+ 5th day irrigation. The experiment was laid out under Randomized Complete Block Design (RCBD) with three replicates. The experimental layout is shown in figure 1. Total field area (63 x 27 m^2) was divided into 54 plots; each plot size was 3 x 8 m^2 and path width was 1.5 m. Laterals were placed at a distance of 90 cm from each other on flat land followed by conventional land preparation (cultivator + disk harrow + planking) as given in table 8. Corn was sown on both sides of laterals in zigzag pattern at a distance of 10 cm from lateral to plant and plant to plant spacing was 23 cm.

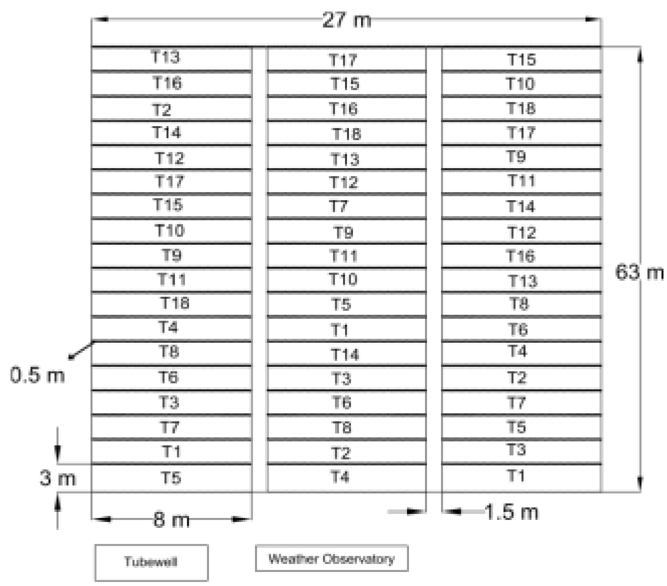

Figure 1. Layout of the experiment.

For irrigation, crop water requirement (CWR) of corn was calculated using past ten year climatic data of study area through Cropwat software. Then irrigation was applied according to that CWR. Except irrigation and fertigation, all the required agronomic and management practices were performed uniformly at all the treatments throughout the growing season.

Field data collection:

***Germination rate*:** To observe germination rate, per square meter approach was used. The three consecutive corn rows were included in one square meter area according to the crop geometry. After emergence of corn plants, counting of emerged plants was performed to observe germination rate.

***Plant height*:** Before starting application of experimental treatments, nine plants were tagged randomly in each plot along the plot length (from head to tail). Plants height was obtained using staff rod at the time of crop harvesting.

***Plant dry matter weight*:** To measure dry matter weight, pre-tagged plants were harvested from ground level at the time of crop harvesting, three in number from each plot. Leaves and stem of plants were chopped and oven dried at 70°C for 48 hours (Anjum *et al*., 2014) to measure their dry matter weights.

***Grain yield*:** To obtain plant samples for measurement of grain yield, again per meter approach was used. The plants included in one square meter at three locations (head, middle and tail) in each plot were harvested and threshed manually to measure grain yield. Later on, this yield was converted into tones/ha.

***Irrigation water and water productivity*:** The water depth under drip irrigation was calculated from irrigation schedules which were designed using Cropwat (version 8.0) software. Total irrigation time was multiplied with system flow rate to calculate volume of irrigation water. Water productivity (WP) was calculated using equation 1.

$$\text{Water Productivity} = \frac{\text{Grain yield (kg/ha)}}{\text{Volume of water applied (m}^3\text{/ha)}} \quad (1)$$

***Harvest index*:** Harvest index is an indicator which represents the efficiency of system to convert the fraction of dry matter weight into grain yield. It is the ratio of grain yield to dry matter weight and was calculated using equation 2.

$$\text{Harvest Index} = \frac{\text{Grain yield (tons/ha)}}{\text{Dry matter weight (tons/ha)}} \quad (2)$$

***Statistical and economic analysis*:** The data were analyzed using analysis of variance technique adopted by Chauhdary *et al.* (2015) to determine significance level of treatment effects on crop parameter and comparison of treatment means was made using least significance difference at 5 percent probability level ($LSD_{0.05}$).

For acceptability of any new agronomic practice by the farmers, economic analysis has significant importance, as the farmers are often interested in benefits in term of net profit of a certain technology. The net profit is an indicator that shows profitability and adoptability of any technology. The net profit was calculated regarding each treatment according to procedure adopted by Chauhdary *et al*. (2016).

RESULTS AND DISCUSSION

***Germination rate*:** Germination rate for corn seedlings was observed after emergence of corn plants in every experimental plot. It may be kept in view that applications of the fertigation and irrigation treatments were started after completion of germination, therefore the results were self-governing and did not represent any treatment effects (Table 2).

Table 2. Germination rate for various treatments (Nos./m^2).

Fertigation treatments	Irrigation Frequency		
	Daily	3rd day	5th day
NB 100	11	12	11
NB 75	11	11	11
NB 50	12	12	11
IM 100	11	11	12
IM 75	12	12	11
IM 50	11	11	11

***Plant height*:** It was observed that effect of irrigation frequency on plant height was statistically significant ($P \leq 0.05$). Plant heights were 183.7, 177.4 and 180.1 cm for daily, 3rd day and 5th day irrigation frequency, respectively. An interesting phenomenon was emerged, when comparison for plant height was made for various irrigation frequencies. It was observed that plant height was highest under daily irrigation frequency, which was decreased when irrigation frequency was moved from daily to 3rd day irrigation. The plant height was again increased, when irrigation frequency was moved from 3rd day to 5th day irrigation (Table 3). This phenomenon is, due to the fact that soil salts remain in diluted form under daily irrigation frequency and did not retard growth as compared to the 3rd day irrigation frequency. In case of 5th day frequency, the applied water quantity is enough to leach down the salts out of root zone making soil environment friendly for plant growth. The extracted EC values for top 15 cm soil layer (effective root zone) were 2.97 ds/m, 2.64 ds/m and 1.83 ds/m for daily irrigation, 3rd day irrigation and 5th day irrigation frequency, respectively. The effect of irrigation frequencies on plant height was also studied by Jiotode *et al*. (2002), Kumar and Mugalkhod (2005), Anjum *et al*. (2014) and they reported similar kind of results.

Variations in plant height in response to different rates of NB fertilizer and IM fertilizer are shown in Table 3. The plant height under treatments with NB fertilizer was statistically higher than that under corresponding rates of IM fertilizer. The highest plant height was produced by NB 100 (192.8 cm) that is statistically higher than that under NB 75 (182.6 cm) and NB 50 (172.9 cm), respectively. The plant height under IM 100 (187.6 cm) was statistically lower than NB 100 and higher than that under IM 75 (177.6 cm) and IM 50 (168.8 cm), respectively. Better plant height under higher rate of fertigation to an optimum level has also been reported by Inamullah *et al*. (2011) and Haque and Jakhro (1996).

Table 3. Effect of different irrigation and fertigation treatments on plant height (cm).

Fertigation treatment	Irrigation Frequency			Average
	Daily	3rd day	5th day	
NB 100	195.9	189.3	193.2	192.8a
NB 75	184.8	180.4	182.7	182.6c
NB 50	175.9	170.1	172.7	172.9e
IM 100	190.8	184.2	187.8	187.6b
IM 75	182.3	174.4	176.2	177.6d
IM 50	172.6	165.8	168.2	168.8f
Average	183.7a	177.4c	180.1b	--

Treatment means with different letters are significantly different (p=0.05).

***Dry matter weight*:** Corn produced 16.85, 15.78 and 16.47 t/ha of dry matter under daily, 3rd day and 5th day irrigation frequency, respectively. Similar to plant height, the dry matter was decreased significantly as the irrigation frequency increased from daily to 3rd day then dry matter increased significantly as the irrigation frequency increased from 3rd day to 5th day irrigation (Table 4). These results are in accordance with the work of Amin *et al*. (2015) and Anjum *et al*. (2014) who studied the impact of 2 day, 4 day and 6 day irrigation frequency on corn dry matter production.

The data (Table 4) showed significant differences among different fertigation treatments for dry matter yield. Maximum dry matter was recorded in corn plants fertilized with NB 100 (18.17 t/ha) followed by IM 100 (17.38 t/ha), NB 75 (16.58 t/ha), IM 75 (15.94 t/ha), NB 50 (15.47 t/ha) and IM 50 (14.67 t/ha), respectively. The variation in dry matter production with respect to fertigation rates has also been reported by other researchers like Inamullah *et al*. (2011) and Muhammad *et al*. (2002). Dry matter production of corn under NB fertilizer showed better performance than that under IM fertilizer. This may be due to acidic nature of NB fertilizer. Similar phenomenon under acidic fertilizers has been studied by Muhammad *et al*. (2013) and Khaled and Fawy (2011).

Table 4. Effect of different irrigation and fertigation treatments on dry matter weight (t/ha).

Fertigation treatment	Irrigation Frequency			Average
	Daily	3rd day	5th day	
NB 100	18.78	17.35	18.37	18.17a
NB 75	17.00	16.20	16.55	16.58c
NB 50	15.77	15.25	15.38	15.47d
IM 100	17.93	16.67	17.53	17.38b
IM 75	16.37	15.40	16.07	15.94d
IM 50	15.25	13.82	14.93	14.67e
Average	16.85a	15.78c	16.47b	--

Treatment means with different letters are significantly different (p=0.05).

***Grain yield*:** Grain yield under different treatments showed (Table 5) significant impact. The grain yield under daily irrigation (8.58 t/ha) was significantly higher than that under 3rd day irrigation (7.44 t/ha) and 5th day irrigation (8.03 t/ha). Grain yield under 5th day irrigation was statistically higher than that under3rd day irrigation. These results are in accordance with the work of Amin *et al*. (2015), who reported that smaller irrigation frequency produced better results in terms of crop yield. The trend of better yield under smaller irrigation interval has also been reported by many researchers (Karlberg *et al*., 2012; Anjum *et al*., 2014; Dagdelen *et al*., 2006; Istambulluoglu *et al*., 2002).

The highest and lowest grain yields were observed under treatment fertilized with NB 100 (9.47 t/ha) and IM 50 (6.37 t/ha), respectively. The yield under NB fertilizer was higher than that under corresponding rate of IM fertilizer. This phenomenon is due to acidic nature of NB fertilizer that affects the nutrient uptake of plants. Better corn yield under acidic fertilizers has also been reported by Muhammad *et al*. (2013) and Khaled and Fawy (2011). Also, the fertigation rates i.e. 100% RDF, 75% RDF and 50% RDF affected grain yield as NB 100, NB 75 and NB 50 produced 9.47 t/ha, 8.44 t/ha and 6.68 t/ha, respectively. The yield under IM 100 (9.06 t/ha) was significantly higher than that under IM 75 (8.07 t/ha) and IM 50 (6.37 t/ha), respectively. The effect of fertigation rate on corn yield was studied by Ali *et al*. (2002), Abayomi *et al*. (2006), Mahdi and David (2005), Dooby *et al*. (2002), Maqsood *et al*. (2001) and Mukhtar *et al*. (2011) who reported similar kind of results regarding grain yield.

Table 5. Effect of different irrigation and fertigation treatments on grain yield (t/ha).

Fertigation treatment	Irrigation Frequency			Average
	Daily	3rd day	5th day	
NB 100	9.98	9.05	9.38	9.47a
NB 75	8.89	8.05	8.38	8.44c
NB 50	7.18	6.26	6.61	6.68e
IM 100	9.68	8.39	9.11	9.06b
IM 75	8.72	7.33	8.17	8.07d
IM 50	7.02	5.59	6.51	6.37f
Average	8.58a	7.44c	8.03b	--

Treatment means with different letters are significantly different (p=0.05)

***Irrigation water and water productivity*:** The total depth of irrigation water throughout cropping season was same for all irrigation frequencies due to same drip operation time. The volume of water was 2735 m^3/ha for 2015 season and 2820 m^3/ha for 2016 season. Daily irrigation and NB 100 produced statistically highest water productivity among all irrigation frequencies (3.09 kg/m^3) and fertigation treatments (3.41 kg/m^3), respectively. The highest water productivity was observed under NB 100 with daily irrigation (3.59 kg/m^3) which was 21% more than that under IM 50 with 3rd day irrigation frequency (2.01 kg/m^3). The results regarding water productivity for different treatments are shown in Table 6. Better water productivity and water saving under drip irrigation has also been reported by Ashraf (2014).

Table 6. Effect of different irrigation and fertigation treatments on water productivity (kg/m^3).

Fertigation treatment	Irrigation Frequency			Average
	Daily	3rd day	5th day	
NB 100	3.59	3.26	3.38	3.41a
NB 75	3.20	2.90	3.02	3.04c
NB 50	2.59	2.25	2.38	2.41e
IM 100	3.48	3.02	3.28	3.26b
IM 75	3.14	2.63	2.94	2.90d
IM 50	2.53	2.01	2.34	2.29f
Average	3.09a	2.68c	2.89b	--

Treatment means with different letters are significantly different (p=0.05).

***Harvest index (HI)*:** Harvest index is a cumulative descriptor of the system (Irrigation frequency and fertigation) that helps in estimating physiological efficiency of plant to convert its dry matter to grain yield. The effects of different kinds and rates of fertigation and different irrigation frequencies on harvest indices of corn were statistically examined (Table 7). Crop under daily irrigation frequency showed statistically higher HI (0.507) than that under 3rd day (0.468) and 5th day (0.486). These results are similar to those reported by Amin *et al*. (2015) and Anjum *et al*. (2014).

Different rates of fertigation significantly affected the harvest index as IM 100 produced highest HI (0.523), which was statistically non-significant than that under NB 100 (0.521) and statistically significant than that under NB 75 (0.508), IM 75 (0.504), NB 50 (0.432) and IM 50 (0.433). The HI produced by NB 100 (0.521) and NB 50 (0.432) were significantly similar than that produced by NB 75 (0.508) and IM 50 (0.433), respectively. These results regarding improvement in harvest index with increase in fertigation rate to an optimum level has also been reported by Inamullah *et al*. (2011), Maqsood *et al*. (2001) and Mukhtar *et al*. (2011).

Table 7. Effect of different irrigation and fertigation treatments on harvest index.

Fertigation treatments	Irrigation Frequency			Average
	Daily	3rd day	5th day	
NB 100	0.532	0.522	0.510	0.521ab
NB 75	0.523	0.497	0.505	0.508bc
NB 50	0.455	0.410	0.432	0.432d
IM 100	0.542	0.505	0.522	0.523a
IM 75	0.532	0.473	0.508	0.504c
IM 50	0.460	0.403	0.437	0.433d
Average	0.507a	0.468c	0.486b	--

Treatment means with different letters are significantly different (p=0.05).

Table 8. Cost of production of corn (Rs. /ha)

Operation/Input	Quantity/Amount	Unit price (Rs.)	Cost/ha (Rs.)
Tillage practices	1+1+1	2000+4000+1500/ha	7500
Cultivator + Disk Harrow + Planking			
Seed charges	25 kg/ha	600/kg	15000
Sowing charges			
Manual sowing (Choka)	--	2000/ha	2000
Fertigation			
F_1= NB 100	NB= 658 kg/ha	NB= 70/kg	55852
	Urea= 272 kg/ha	Urea= 36/kg	
F_2= NB 75	NB= 494 kg/ha	NB= 70/kg	41924
	Urea= 204 kg/ha	Urea= 36/kg	
F_3= NB 50	NB= 329 kg/ha	NB= 70/kg	27926
	Urea= 136 kg/ha	Urea= 36/kg	
F_4= IM 100	IM= 625 kg/ha	IM= 140/kg	97292
	Urea= 272 kg/ha	Urea= 36/kg	
F_5= IM 75	IM = 469 kg/ha	IM= 140/kg	73004
	Urea= 204 kg/ha	Urea= 36/kg	
F_6= IM 50	IM = 313 kg/ha	IM= 140/kg	48716
	Urea= 136 kg/ha	Urea= 36/kg	
Irrigation (Tubewell)	--	3155	3155
Intercultural practices			
Dual gold (Spray)	2 liter/ha (1 dose)	790/ 800 ml bottle	1975
Proclain (Spray)	500 ml/ha (1 dose)	585/ 200 ml bottle	1463
Furadan (Granular)	20 kg/ha (1 dose)	845/ 8 kg Packet	2113

Note: The harvesting and shelling cost were taken as zero because crop biomass was paid to labor against harvesting and shelling cost.

Economic analysis**:** Total production cost of corn was calculated and showed in Table 8. The net profit for each combination of fertigation and irrigation frequency was calculated using production cost and income and presented in Table 9. The data regarding net profit revealed that the highest net profit was obtained under the treatment irrigated with daily irrigation and fertilized with NB 100 (Rs. 210342/ha). The lowest net income was obtained for 3rd day irrigation frequency fertilized by IM 50 (Rs. 85778/ha). The results regarding net profit are shown in Table 9.

To assess the net profit regarding different rates of fertigation, economic models were developed regarding fertigation rates for both NB and IM fertilizer for daily, 3rd day and 5th day irrigation frequencies. These models are shown in Table 10 and Figure 2. As shown by coefficient of determination (R^2) of models, a strong relationship exists between fertigation rates and net profit. An interesting trend can be observed from models (Figure 2) that net profit is increased by increasing amount of fertigation up to an optimum level (vertex) and after that started to fall. It indicates that the net profit will decrease if the fertigation is increased beyond that optimum level. The vertex of the curves (Table 10) are higher in case of NB fertilizer than IM fertilizer that shows the potential of NB fertilizer to produce more yields. Lower vertex values for IM fertilizer are due to higher price of IM fertilizer than its production potential.

Table 9. Net profit of corn under different treatments.

Treatment	Total income (Rs./ha)	Total production cost (Rs./ha)	Net profit (Rs./ha)
T1=NB 100+ Daily irrigation	299400	89058	210342
T2=NB 100+ 3rd day irrigation	271500	89058	182442
T3=NB 100+ 5th day irrigation	281400	89058	192342
T4=NB 75+ Daily irrigation	266700	75130	191570
T5=NB 75+ 3rd day irrigation	241500	75130	166370
T6=NB 75+ 5th day irrigation	251400	75130	176270
T7=NB 50+ Daily irrigation	215400	61132	154268
T8=NB 50+ 3rd day irrigation	187800	61132	126668
T9=NB 50+ 5th day irrigation	198300	61132	137168
T10= IM 100+ Daily irrigation	290400	130498	159902
T11= IM 100+ 3rd day irrigation	251700	130498	121202
T12= IM 100+ 5th day irrigation	273300	130498	142802
T13= IM 75+ Daily irrigation	261600	106210	155390
T14= IM 75+ 3rd day irrigation	219900	106210	113690
T15= IM 75+ 5th day irrigation	245100	106210	138890
T16= IM 50+ Daily irrigation	210600	81922	128678
T17= IM 50+ 3rd day irrigation	167700	81922	85778
T18=IM 50+ 5th day irrigation	195300	81922	113378

Total income was calculated as Rs. 30000/ton of corn grain.

Table 10. Economical model of net profit for different rates of NB and IM fertilizers under daily, 3rd day and 5th day irrigation frequency.

Treatment	Model	R^2	Vertex
Daily Irrigation with NB fertilizer	$y = -14.62x^2 + 3309x + 25442$	$R^2 = 0.989$	113
3rd day irrigation with NB fertilizer	$y = -19.14x^2 + 3988x - 25037$	$R^2 = 0.989$	104
5th day irrigation with NB fertilizer	$y = -18.13x^2 + 3823x - 8567$	$R^2 = 0.974$	108
Daily irrigation with IM fertilizer	$y = -17.74x^2 + 3282x + 8974$	$R^2 = 0.934$	93
3rd day irrigation with IM fertilizer	$y = -16.22x^2 + 3145x - 31103$	$R^2 = 0.950$	97
5th day irrigation with IM fertilizer	$y = -17.46x^2 + 3210x - 3594$	$R^2 = 0.864$	92

Y= net profit, x= fertigation rate, R^2 = Coefficient of determination

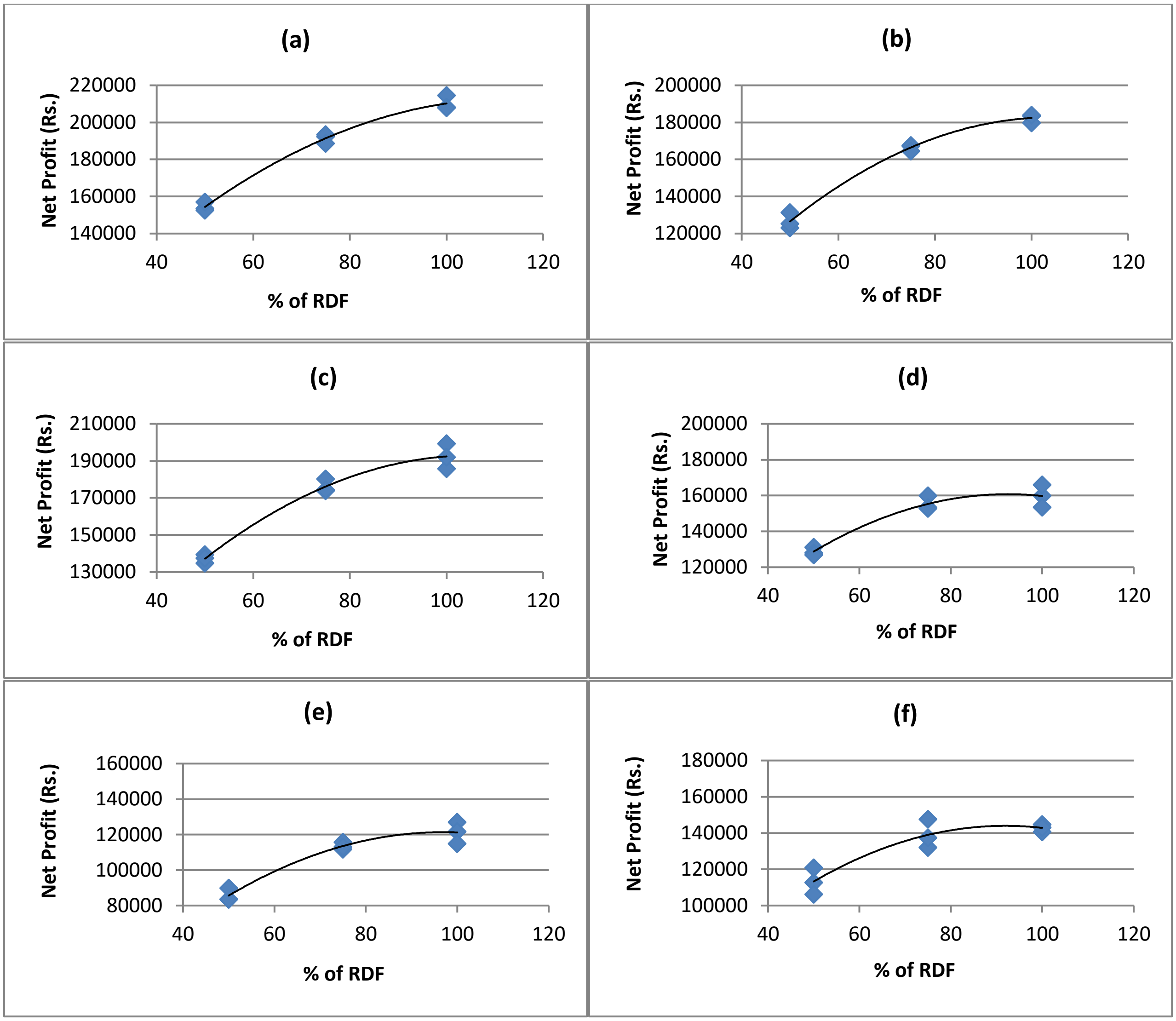

Figure 2. Economical models of net profit for (a) Daily irrigation+NB fertilizer, (b) 3rd day irrigation+NB fertilizer, (c) 5th day irrigation+NB fertilizer, (d) Daily irrigation+IM fertilizer, (e) 3rd day irrigation+IM fertilizer, (f) 5th day irrigation+IM fertilizer.

***Conclusions*:** Based on field experiments conducted for two kinds of fertilizers (NB and IM fertilizer), three rates of fertigation (100% of RDF, 75% of RDF and 50% of RDF) and three irrigation frequencies (Daily, 3rd day and 5th day), it was concluded that irrigation frequency and fertigation treatments influenced corn yield and growth parameters. Plant height, dry matter weight, grain yields, harvest index and water productivity were highest under daily irrigation frequency. These parameters were reduced when irrigation frequency changed from daily to 3rd day irrigation and again improved when irrigation frequency moved from 3rd day to 5th day irrigation. NB 100 showed better performance regarding crop growth and yield parameters among all other fertigation treatments. It was also concluded that treatment T_1 (Daily irrigation+NB 100) produced highest plant height, dry matter weight, grain yield, water productivity and net profit. All these parameters were observed lowest under T_{17} (3rd day irrigation+IM 50). Therefore, it is recommended that corn sown under drip irrigation should be fertilized by NB 100 with daily irrigation frequency for economically better production in the semi-arid area of Faisalabad, Pakistan.

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