Indian J. Agric. Res., 49 (2) 2015: 125-133
Print ISSN:0367-8245 / Online ISSN:0976-058X

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
www.arccjournals.com/www.ijarjournal.com

Determination of suitable nitrogen doses for growing second product maize (*Zea mays* L.) varieties in chickpea planting fields and its economic analysis

Yusuf Dogan, Mehmet Behzat Ekinci[1], Necat Togay*[2] and Yesim Togay[2]

Deparment of Field Plants, Kiziltepe VHS,
Mardin Artuklu University, 47000, Mardin, Turkey.
Received: 26-12-2014 Accepted: 27-03-2015 DOI: 10.5958/0976-058X.2015.00018.9

ABSTRACT

The experiment was executed in three repetitions according to "The Split Plots in Randomised Blocks Design" in the 2013-14 growing seasons. As material; commercial maize varieties Dekalp 5401, Dekalp 5783, Pioneer PR32T83 and Syncero were selected. Three nitrogen doses [0, 150, and 300 kg ha^{-1} (Ammonium nitrate)] and 80 kg ha^{-1} phosphorus (P_2O_5: TSP: triple super phosphate) were used. According to the two year results, the highest seed yield was obtained with Syncero (9.527 kg ha^{-1}) and Dekalp 5401 (9.491 kg ha^{-1}), the lowest was provided with Dekalp 5783 (823.1 kg ha^{-1}). In terms of the effect of nitrogen doses on seed yield, the highest value was obtained from 300 kg ha^{-1} application at 10.212 kg ha^{-1}, the lowest value was obtained through the control plot (0 kg ha^{-1}) at 7.844 kg ha^{-1}. The economic analysis, showed that yield level increased as the dose raises. The highest revenue-generating dose was 300 kg ha^{-1} among the nitrogenous fertilizer applications. In this context, a profit of USD 2.87 was made in return for a cost of USD 1.00. As further doses should be applied for a net determination, it is difficult to estimate if this is the most profitable dose. Under the circumstances, however, it can be stated that the highest profitability is possible through this application (the 3rd).

Key words: Economic development, Maize, Nitrogenous dose, Sustainable agriculture, Yield.

INTRODUCTION

Maize, due to its variety richness and high adaptive capability, is a culture plant that could be cultivated almost throughout the world (Sezer and Yanbeyi, 1997). Maize production increased significantly following the awareness that maize can be grown as both a preliminary and secondary product in those regions whose climates are suitable such as the Aegean,s the Mediterranean, and the South East Anatolia region of Turkey. A necessary factor in increasing maize productivity, is a high level of nitrogen fertilizer (Marschner, 1986). The worldwide planting area of maize is 184192053 ha^{-1}. Its level of production amounts to 1016736092 tons, and its yield is 5520 kg ha^{-1}. These data for Turkey are currently 660000 ha^{-1}; 5900000 tons, and 8934 kg ha^{-1} (FAO, 2013). Intensive fertilisation is required for higher productivity. However, as the amount of commercial fertilizer rises, the soil suffers loss of fertility. Furthermore, increasing fertilizer costs make difficulties for the farmers. Environmental problems caused by an imbalance in use, and any increase in the price of commercial fertilizers restricts their use (Sözüdogru *et al.* 1996). The point of this research is to determine both a suitable nitrogen dose and the importance of a preliminary plant for maize after chickpea. It also aims to determine the effect of these factors on the agricultural features of maize plus the economic aspects with regard to the productivity of suitable nitrogenous fertilizer for a sustainable agricultural production.

MATERIALS AND METHODS

This research was carried out in an experimental field run by Kiziltepe Vocational Higher School, Mardin Artuklu University in the 2013-14 planting seasons. The experiment was executed three times according to "the Split Plots in Randomised Blocks Design". Varieties were planted in the main plots while fertilizer doses were placed in sub-plots. As material; commercial hybrid maize types *viz.* Dekalp 5401 (V1), Dekalp 5783 (V2), Pioneer PR32T83 (V3), and Syncero (V4) were used. For the experiment, 36 plots were used, each of which was 5x3.5 m, a total area of 17.5 m^2 with a 2 m space between both each block and plot. After harvesting the chickpea, the soil was cultivated using second-hand equipment. Soil warm enough and moist enough to promote good plant growth was seeded by hand in the shape of 70x20

*Corresponding author's e-mail: necattogay@hotmail.com.
[1]Deparment of Economics, FEAS, Mardin Artuklu University, 47000, Mardin, Turkey.
[2]Yuzuncu Yil University, Faculty of Agriculture, Department of Field Crops, Van, Turkey.

cm following irrigation. Three nitrogen (ammonium nitrate) doses of 0 (D1), 150 (D2), and 300 (D3) kg ha^{-1} and phosphorus (P_2O_5: TSP: triple super phosphate) of 80 kg ha^{-1} were used. All the phosphate fertilizer was applied by mixing it with the soil during sowing time. Half the nitrogenous fertilizer was applied during sowing and plants were 40 cm tall. All planting processes plus irrigation, fertilising, weeding, and combatting illnesses and pests were followed regularly. Harvesting and measurements were done on the remaining area (4 mx2.1 m = 8.4 m^2) by excluding one row from the plot sides and 50 cm from the plot tops. Monthly climate data for 2013-2014 and their long term averages (LTA; 1960-2014) are given in Table 1. Annual climate data were provided by Mardin Meteorology Directorate (2014) and are given. As available in Table 1, while the total rainfall for 2013 (6.5 mm) has been lower than LTA (37.2 mm), the total rainfall for 2014 (40.9 mm) has been higher. The average temperature values for 2014 has been higher than the LTA. The values for relative humidity, on the other hand, have been lower than the LTA. Observations and measurements were made in accordance with the method (Cesurer, 1990). A variance analysis was made using data obtained from the research by using MSTAT-C as Düzgünes *et al.* (1987) and comparisons were made according to the Duncan test. Economic data were analysed using the marginal analysis method. In this context, the practice used by Özkan (1997) was followed. Partial budgeting was carried out and the most profitable level(s) determined by using the marginal cost=marginal revenue approach.

RESULTS AND DISCUSSIONS

Variance analysis results for the effects of "determination of suitable nitrogenous fertilizer doses for growing 2nd product maize in chickpea planting fields" on some agricultural features are available in Table 2. The averages concerning these features plus difference grouping according to Duncan, are given in Table 3.

According to the variance analysis results in Table 2, cob number per plant is statistically significant. While one cob height and unit field grain productivity for the second year were both found to be significant at $p<0.05$ level, other features were found significant at $p<0.05$ level. On average, the cob length was found significant at $p<0.05$ level, other features were found significant at $p<0.01$ level. Nitrogen doses for both each year (1st year and 2nd year individually) and the average (average value of 1st and 2nd years) were found to be significant at $p<0.01$ level. The results of variance analysis in terms of years were found to be statistically insignificant. The interaction of "variety x nitrogen doses" in terms of average cob length and one cob productivity was found significant at $p>0.01$ level. 1.000 grain weight for the first year was found significant at $p>0.05$ level. Other features, were found to be statistically insignificant. On the other hand, 1,000 grain weight was found significant at $p>0.01$ level, other features were found statistically insignificant in the interaction of "variety x year". The highest value in terms of plant height for the first year was obtained from V1 (195.30 cm). The highest value in terms of plant height for the second year was also obtained from V1 (187.85 cm) and the other varieties were as follows consecutively: V3 (185.42 cm) and V4 (185.28 cm). Thus, the highest average value was obtained from V1 (191.57 cm) and the lowest from V2. These findings show similarity with those of Dok (2005); Keskin *et al*. (2005); and Idikut and Kara (2013) demonstrating that plant height changes according to varieties used. In terms of the effects of nitrogen doses on plant height, the highest values of 194.12 cm, 192.77 cm, and 192.72 cm were obtained from D3 application for both each year and the average, while the lowest values were at the D1 control plot. These findings are compatible with those of Sekhon and Aggarwal (1994); Tüfekçi and Karaaltin (2001); Canlý (2003) and Celep (2006) confirming that the higher the level of a nitrogenous fertilizer used, the taller a plant gets. In terms of initial cob height, while the highest cob height was obtained from V1 for both years and the average, the lowest average was through V2. On the other hand, the difference between V3 and V4 was found to be statistically nonsignificant. These results are

TABLE 1: Monthly and long term averages of temperature, rainfall and humidity values of Mardin

Months	Temperature (°C)			Rainfall (mm)			Humidity (%)		
	2013	2014	LTA	2013	2014	LTA	2013	2014	LTA
June	26.3	31.4	25.6	4.0	4.7	4.7	21.7	22.1	32.3
July	26.9	35.6	29.9	-	1.3	1.3	17.8	19.8	27.7
August	29.7	36.1	29.5	-	0.2	0.2	18.7	17.1	28.4
September	23.9	26.2	25	2.5	1.8	1.8	24.0	27.7	32.6
October	19.1	20.1	18.4		32.9	32.9	22.5	25.6	45.1
Total				6.5	40.9	37.2			
Average	25.2	29.9	25.7				20.9	22.5	33.2

LTA: Long term averages (1960-2014).
Source: Mardin Meteorology Directorate (2014).

TABLE 2: Variance analysis results for the effects on some agricultural features of "determination of suitable nitrogenous fertilizer doses for growing 2nd product maize varieties in chickpea planting fields"

	Years	Plant height	One Cob height	Cob number per plant	Cob length	Grain number per cob	One cob productivity	1000 seed weight	Seed yield
	1st year				**				
	2nd year				*				
Blocks	United years		**		**				
	1st year	**	**		**	**	**	**	**
Varieties	2nd year	**	*		**	**	**	**	*
	United years	*	**		**	**	**	**	**
	1st year	**	**		**	**	**	**	**
Nitrogen doses	2nd year	**	**		**	**	**	**	**
	United years	**	**		**	**	**	**	**
Year									
	1st year							*	
Variety x Nitrogen	2nd year								
doses	United years				**		**		
Variety x Year								**	
Nitrogen doses x Year									
Variety x Nitrogen doses x Year									

* Significant at p<0.05 level ** Significant at p<0.01 level.

TABLE 3: Effects of "determination of suitable nitrogenous fertilizer doses for growing 2nd product maize varieties in chickpea planting fields" on yield and yield components

		Variety				Nitrogen doses (kg ha^{-1})		
		Dekalp 5401	Dekalp 57 83	Pioneer PR32T83	Syncero	0	150	300
Plant height (cm)	1st year	195.3 a*	178.41 c	182.37 b	182.78 b	175.55 c	184.48 b	194.12 a
	2nd year	187.85 a	172.57 c	185.42 a	185.28 a	176.26 b	179.31 b	192.77 a
	Mean	191.57 a	175.13 c	183.90 b	183.42 b	175.90 c	181.9 b	192.72 a
Initial cob height (cm)	1st year	72.32 a	62.46 b	63.16 b	61.35 b	58.50 c	64.31 b	71.65 a
	2nd year	70.17 a	62.71 b	63.26 b	64.81 b	59.80 b	62.58 b	73.33 a
	Mean	71.25 a	62.58 b	63.21 b	63.08 b	59.15 c	63.45 b	72.49 a
Cob number per plant (unit/plant)	1st year	1.06	1.03	1.15	1.20	1.06	1.15	1.11
	2nd year	1.04	1.08	1.10	1.08	1.06	1.06	1.11
	Mean	1.05	1.05	1.12	1.14	1.06	1.10	1.11
Cob length (cm)	1st year	20.77 a	19.48 c	19.47 c	20.14 b	18.72	20.05 b	21.13 a
	2nd year	20.74 a	19.41 c	19.66 bc	20.20 ab	18.83 c	20.10 b	21.08 a
	Mean	20.76 a	19.45 b	19.57 c	20.17 b	18.77 c	20.07 b	21.10 a
Grain number per cob	1st year	452.82 a	416.42 c	414.14 c	438.13 b	410.75 c	433.05 b	447.32 a
	2nd year	456.02 a	408.73 c	413.26 c	433.54 b	410.63 c	430.93 b	442.10 a
	Mean	454.42 a	412.57 c	413.70 c	435.83 b	410.49 c	431.99 b	444.71 a
One cob yield (g)	1st year	213.71 a	156.57 d	191.33 c	206.63 b	174.88	180.12	184.91
	2nd year	212.44 a	159.02 c	195.00 b	208.24 a	176.31 c	192.94 b	211.77 a
	Mean	213.07 a	157.81 d	193.16 c	207.43 b	175.27 c	191.04 b	212.30 a
1000 seed weight (g)	1st year	340.18 d	361.68 c	381.21 b	396.55 a	361.86 c	369.57 b	378.29 a
	2nd year	347.85 c	368.92 b	390.62 a	383.88 a	358.15 b	380. 87 a	379.44 a
	Mean	344.02 c	365.30 b	385.17 a	390.98 a	360.57 b	375.37 a	378.15 a
Seed yield (kg ha^{-1})	1st year	9668.1 ab	8156.70 c	8996.1 b	9835.30 a	7972.6 c	9229.1 b	10290.5 a
	2nd year	9315.0 a	8321.40 b	8914.8 ab	9219.10 a	7716.4 c	8977.4 b	10134.0 a
	Mean	9491.5 a	8239.10 c	8955.5 b	9527.20 a	7844.5 c	9103.2 b	10212.2 a

*The difference between the average values shown in the same row by the same letters are insignificant at p<0.05 level.

compatible with those of Paradkar and Sharma (1993); Türkay *et al.* (2002); and Celep (2006) confirming that initial cob height changes according to the variety of maize. The effects of nitrogen doses on initial cob height, the highest value was obtained through D3 application for both each year and the average, while the lowest values were at the control plot. These findings are compatible with those of Paradkar and Sharma (1993); Tüfekçi and Karaaltin (2001); Canlý (2003); and Celep (2006), saying that the more nitrogenous fertilizer used, the higher an initial cob height gets, as was found for plant height.

In terms of varieties and nitrogen doses, no statistically significant difference was found between the years or the average with regard to cob number per plant. These results are compatible with those of Celep (2006), studied 2nd product maize in chickpea planting fields in Kahramanmaras, Turkey, stated that the differences between varieties and nitrogen doses (0.96-1.01 unit/plant) were insignificant. Moreover, our findings are also supported by Hutchinson *et al.,* (1989) who assert that nitrogenous fertilizer does not increase cob number per plant. In terms of cob length, the highest values were obtained from V1 for both each year and the average. The lowest average was through the V2 (Table 3). Thus, our findings are similar to those of Tüfekçi and Karaaltin (2001); Öz and Kapar (2001); and Türkay *et al.* (2002) who state that there may be differences between varieties in terms of cob length. The effects of nitrogen doses on cob length; while the highest values were obtained from D3 application for both each year while, the lowest values were in the control plot. Celep (2006) revealed in his study that the highest average cob length was obtained through D3 at 18.96 cm and the lowest was through the control plot at 17.01 cm. Our findings are compatible with those of Nimje and Seth (1988) and Canli (2003) who state that an increased nitrogen dose raises cob length together with vegetative parts. In terms of grain number per cob, the highest units of 452.82, 456.02, and 454.42 were obtained from V1 for both each year and the average. Although V2 and V3 provided the lowest values, there was no statistical difference between them. Our findings are compatible with those of Öz and Kapar (2001) and Türkay *et al.* (2002) who state that there are differences among varieties in terms of grain number per cob. The effect of nitrogen doses on the grain number per cob, the highest values were obtained through D3 application for both each year and the average. For instance, the highest average value was 444.71 units. The lowest values were obtained from the control plot and the lowest average value was 410.49 units. Dickson *et al.,* (1993); Paradkar and Sharma (1993); Tüfekçi and Karaaltin (2001); and Canli (2003) state that increasing nitrogenous fertilizer affects nitrogen metabolism positively, particularly protein synthesis in maize, and this results in both a longer cob and more grain.

In terms of one cob yield, the highest value in the first year was obtained from of V1, it was repeated in the second year from (212.44 g) the same variety. The difference between 208.24 g of V4 and V1 was found to be statistically insignificant. The highest average value was obtained through 213.07 g of V1 while the lowest values were obtained from V2 for both each year and the average. Our findings are supported by those of Difonzo *et al.,* (1982); Türkay *et al.* (2002); and Celep (2006) who state that there are differences among the varieties in terms of one cob productivity. In terms of the effect of nitrogen doses on one cob yield; the highest values were obtained from D3 application for both second year and the average, the lowest values were obtained through the D1 control plot. Paradkar and Sharma (1993); Türkay *et al.* (2002); Canli (2003); and Tosun (2005) also reveal that increasing nitrogenous fertilizer raises one cob productivity.

In terms of 1000 seed weight, the highest value in the first year was obtained from V4 (396.55 g), it was from V3 in the second year. The highest average value was also from V4. However, there was no significant difference between V3 and V4. On the other hand the lowest values were obtained from V1 for both each year and the average. Our findings are supported by those of Sezer and Gülümser (1999) and Türkay *et al.* (2002) who state that the 1,000 seed weight differs as to varieties and environmental conditions. The effect of nitrogen doses on 1000 seed weight; while the highest value was obtained from D3 at 378.29 g in the first year, it was t from D2 at 380.87 g in the second year, however, they showed no statistical difference. The highest average values were obtained from D3 (378.15 g) and D2 (375.37 g), however, no statistical difference was found between them. The lowest values, on the other hand, were obtained from the D1 control plot as of both each year and the average. Hutchinson *et al.* (1989); Dickson *et al.* (1993); Canli (2003); and Tosun (2005) state that nitrogenous fertilizer increases 1,000 grain weight to some extent. But Chen *et al.,* (1994); and Apak, *et al.,* (1995) state that it decreases the weight after reaching a certain level. Our findings support those of the first group of researchers.

While the highest seed yield was obtained from V4 at 9835.30 kg ha^{-1} in the first year, it was from V1 at 9315.0 kg ha^{-1} in the second year. Furthermore, the difference between V1 and V4 (9219.1 kg ha^{-1}) was found to be insignificant. The highest value as of the average was obtained from 9527.2 kg ha^{-1} of V4 and its statistical difference with V1 (9491.5 kg ha^{-1}) was nonsignificant. The lowest values were obtained through V2 at 8156.7; 8321.4; and 8239.1 kg ha^{-1} respectively. Inal (2002) and Tosun (2005) state that legumes should be grown in planting time as the productivity of cereals grown following the harvesting of legumes increases. However, actual productivity increases differ depending upon the varieties of legumes used as preliminary plants. Ram *et al.,* (1993) say that higher yield of 720-1380 kg ha^{-1} is obtained compared to grains feed plants, if maize is grown after legumes. Idikut and Kara (2013), in their research in Kahramanmaras, Turkey, reveal that unit field grain productivity of maize varieties changes from 7350 to 12340 kg ha^{-1}. Our findings on grain productivity of maize varieties (or seed yield) show similar results to those of Cesurer et al., (1999); Keskin *et al.* (2005); and Saruhan *et al.,* (2007). This means that production values of varieties may change depending upon ecological conditions. Halauer and Miranda (1987) comment that maize has such complicated characteristics that, in addition to the effect of genotype, environmental conditions and growing techniques from seeding to harvesting may contribute to changing grain productivity levels in maize. It can be said, therefore, that changes in seed yield in different maize genotypes and varieties may result from genetic factors, and this is to be expected. These observations are supported by our findings. While the highest seed yield were obtained from D3 application at 10290.5; 10134.0 kg ha$^{-1;}$ and 10212.2 kg ha^{-1} respectively for both each year and the average, the lowest values were obtained from the D1 control plot at 7972.6; 7,716.4; and 7844.5 kg ha^{-1} respectively. Sönmez (2001), in his research in Tokat Erbaa, Turkey, also states that seed yield differed from 4311 to 9868 kg ha^{-1} following different applications and doses of various nitrogenous fertilizers. Özkan and Ülger (2011), in their study in Çukurova, Turkey, found that while unit field grain productivity had its lowest value at a dose of 0 kg ha^{-1} in the control plot, it had the highest value in the plot where a dose of 250 kg ha^{-1} was applied. Similarly, Sezer and Yanbeyi (1997) state that as nitrogen dosage was increased, productivity raised. Roy and Singh (1986); and Pissaia *et al.,* (1996) determined that the highest productivity was obtained through a 100 kg ha^{-1} application. Sezer and Yanbeyi (1997); and Padmaja *et al.,* (1999), on the other hand, determined that the highest grain productivity was possible at doses of 150 and 160 kg ha^{-1}. While Jovanovic (1999) provided data to show the highest grain productivity at a dosage of 180 kg ha^{-1}; Öktem *et al.,* (2001) obtained it at 240 kg ha^{-1}. Such different results are sourced from the differences between research areas and maize varieties.

With reference to Table 4, the effects of different varieties x nitrogen doses interaction on 1000 seed weight, cob length and one cob yield in corn varieties was found to be statistically significant. In the first year (2013), the highest 1000 seed weight was obtained from Syncero 300 kg ha^{-1} nitrogen application (402.7 g). The difference between this application and the one based on Pioner PR32T83 150 kg ha^{-1} nitrogen was found to be statistically insignificant first years. The lowest values of 1000 seed weight were found in Dekalp at 5401 0 kg ha^{-1} nitrogen applications (333.9 g). The highest cob length was obtained from Dekalp 5401 with 300 kg ha^{-1} nitrogen application (21.6 cm). The lowest values of cob length were found in Dekalp 5783 and Pioner PR 32T83 with 0 kg ha^{-1} nitrogen applications (18.5 cm). In Table 4, the highest one cob yield was obtained from Dekalp 5401 with 300 kg ha^{-1} nitrogen application (233.1 g). The lowest values of one cob yield were found in Dekalp 5783 with 0 kg ha^{-1} nitrogen applications (146.6 g).

Economic analysis: In this study, marginal anlysis is carried out. The principle of the marginal approach in economics means that a production factor should be employed until an increase by its last unit occurs in the total production [Marginal product (MP)=Marginal revenue (MR)] is equal to its cost (MC) (O'Sullivan *et al.,* 2014). This analysis in Economics focuses on examining the effects of small changes between two variables (Klein, 2014). Marginal analysis in Mathematics means dealing with the effects of a change in an independent variable on a dependent variable by using derivatives (Siniksaran *et al.,* 2011). This analysis can be executed by various methods, the major of which are as

TABLE 4: The effect of interaction of different nitrogen dose applications on 1000 grain weight, cob length and one cob yield in maize varieties

	1000 grain weight(2013)			Cob length(United years)			One cob yield(United years)		
Varieties	0kg ha^{-1}	150kg ha^{-1}	300kg ha^{-1}	0kg ha^{-1}	150kg ha^{-1}	300kg ha^{-1}	0kg ha^{-1}	150kg ha^{-1}	300kg ha^{-1}
Dekalp 5401	333.9 h*	338.3 h	351.6 g	19.6 c	20.9 ab	21.6 a	192.5 d	213.6 c	233.1 a
Dekalp 5783	357.9 f	362.8 e	3643 e	18.5 d	19.0 cd	20.8 ab	146.6 g	153.3 g	173.5 f
Pioneer PR32T83	371.7 d	378.6 c	388.7 b	18.5 d	19.5 c	20.6 b	177.1 ef	186.2 de	216.1 bc
Syncero	391.8 b	399.5 a	402.7 a	18.4 d	20.7 ab	21.4 ab	184.8 df	210.9 c	226.5 ab

* The differences between the average values shown in the same row by the same letters are insignificant at p=0.05 level.

follows (Özkan, 1997): forming a partial budget, without using a production function, and by using a production function. The aim of all three methods, in the context of this study, is to determine the most suitable nitrogenous fertilizer (independent variable) for the highest product/productivity (dependent variable). Although these methods are different, their results are the same and the first of these is to be preferred by considering the dictum "everything else being equal, the simplest is the best". The most suitable nitrogenous fertilizer dose (kg ha^{-1}) is determined by forming a partial budget in the context of the first method. The partial budget consists of average productivity values (kg ha^{-1}), gross production values (USD ha^{-1}), total variable costs [cost of fertilizer (USD ha^{-1}), fertilising cost (USD ha^{-1})] and thus, net revenue (profit/loss). Then, as Özkan (1997) did, dominance analysis was made and residuals calculated. In this research, three nitrogenous fertilizer doses of 0, 150, and 300 kg ha^{-1} were applied for maize varieties in June 2013 and June 2014. Ammonium nitrate was applied as a pure nitrogenous fertilizer. The amounts of ammonium nitrate used for each application were as follows: 0 kg ha^{-1}; 454.5 kg ha^{-1}; and 909 kg ha^{-1}. The effects of fertilizer on productivity in each application were as follows for the two years (kg ha^{-1}): 2013: 7,972.6; 9,229.1; and 10,290.5. 2014: 7,716.4; 8,977.4; and 10,134. The results in terms of kg ha^{-1} show that the productivity levels of 2013 were higher than those of 2014. The following arithmetical mean for both years' values were considered in the paper (kg ha^{-1}): 7,844.5; 9,103.25; and 10,212.25. The observed result was that as the applied dose increased, productivity level also rose. The partial budgeting is available in Table 5. A kg price of maize was taken from the markets of Mardin and its surroundings at the current average price of 0.276 USD (275.56 USD/ton). Similarly a kg price of ammonium nitrate is 0.42 USD (21.11 USD/50 kg). Pure nitrogen was priced at 33% of a kg (0.42 USD/kg*0.33=0.139 USD/kg). The reason for preparing a partial budget is that the analysis concentrated particularly on the determination of suitable nitrogen doses. Therefore, among the total variable costs, only the costs of pure nitrogen and fertilising were taken into account. Total variable costs include those of raw material, energy, labour etc. which increase parallel to production (Dinler, 2013). However, as they remain the same for every dose, all costs except those of pure nitrogen and fertilising were excluded in the budgeting. In fact, in addition to ammonium nitrate, phosphorus (P_2O_5; triple super phosphate; 42%) was also used at a fixed dose of 80 kg ha^{-1}. However, since only ammonium nitrate was used for pure nitrogen, phosphorus was omitted from the total variable costs. Fertilising costs at seeding and intermediary weeding are other elements of total variable costs besides that of fertilizer. Consequently, profits are as follows for each application: 2,165.08 USD ha^{-1} for 0 kg ha^{-1}; 2,433.50 USD ha^{-1} for 150 kg ha^{-1}; and 2,660.59 USD ha^{-1} for 300 kg ha^{-1}. That is, each application resulted in an increase in profit. The dominance analysis was made following the partial budgeting. The application which increases total variable costs but decreases revenue is neglected in the dominance analysis. It is based upon "the Law of Diminishing Returns": if one factor changes in the case that all other factors remain constant, total product initially increases in speedy fashion (the case of increasing marginal return/productivity). However, if increases in that variable factor continue, total production then increases in diminishing fashion (the case of diminishing marginal return/productivity). If increases in that variable factor still continue, total product decreases after a specific point (the case of absolute diminishing marginal return/productivity) Thus, production could, depending on the costs, be continued until the point of absolute diminishing marginal return/productivity. The production (revenue, profit) is at maximum level at this point where marginal productivity is equal to zero (Seyidoðlu, 2002; Ertek, 2011; Krugman and Wells, 2012).

Naturally, each factor employed in production (here, costs of fertilizer and fertilizing) initially provides increasing, followed by decreasing production/productivity. That is, marginal production diminishes or, in other words, marginal cost rises. However, total variable costs related to the applied doses in this study increase, profit (total production/ productivity) also rises in parallel fashion. Therefore, no negligible dose is available in the dominance analysis and all three applications are examined in the marginal analysis. Marginal profitability is determined under marginal analysis. Marginal profitability rate (MPR; $\Delta\pi/\Delta q$) is calculated by the first degree derivative of profit function (Siniksaran *et al.*, 2013):

$$\pi = TR - TC$$

$$TR = TR\ (q);\ MR = \Delta TR/\Delta q$$

$$TC = TC\ (q);\ MC = \Delta TC/\Delta q$$

$$\Delta\pi/\Delta q = (\Delta TR/\Delta q) - (\Delta TC/\Delta q) = 0$$

$$(\Delta TR/\Delta q) = (\Delta TC/\Delta q)$$

As "ΔTR/Δq" is equal to marginal revenue (MR) and ""TC/"q" is equal to marginal cost (MC), maximum profit is realised at "MR=MC (MR-MC=0)". It should be noted that, as a partial budgeting is calculated in this study, that is as total cost (TC) it includes only fertilizer and fertilising costs, total variable cost (TVC) is used instead of total cost in marginal profitability calculation.

Marginal profitability rates (MPR) for each application are as follows (Table 6):

TABLE 5: A partial budgeting concerning nitrogenous fertilising in maize varieties

	Pure nitrogen doses (kg ha^{-1})		
	0	150	300
Total production/productivity amount (q) (kg ha^{-1})	7844.5	9103.25	10212.25
Total production value (TR=p1*q) (USD ha^{-1})	2165.08	2512.50	2818.58
Fertilizer costs (USD ha^{-1})			
3.1. Ammonium nitrate (%33) (p2*0.33*454.5 or 909 kg ha^{-1})	0	62.99	125.99
3.2. Phosphorus (P_2O_5; triple super phosphate; %42) (80 kg ha^{-1})	0	0	0
Fertilising costs (USD ha^{-1})			
4.1. At seeding (USD ha^{-1})	0	5.33	10.67
4.2. At intermediary weeding (USD ha^{-1})	0	10.67	21.33
Total variable costs (TVC) (USD ha^{-1})	0	78.99	157.99
Profit/loss (π=TR-TVC) (USD ha^{-1})	2165.08	2433.50	2660.59

- Maize price (p1) (USD/kg): 0.276 (275.56 USD/ton)
- Ammonium nitrate price (p2) (USD/kg): 0.42 (21.11 USD/50 kg)
- USD/TL: 2.25

TABLE 6: Determination of marginal profitability concerning nitrogenous fertilising in maize varieties

Application(Nr)	Dose (kg ha^{-1})	Total variable costs (TVC)(USD ha^{-1})	Profit/loss(ð) (USD ha^{-1})	Marginal profitability rate [MPR=(Δπ/ΔTVC)*100](%)	Residuals(USD ha^{-1}) (π-TVC)
1	0	0	2165.08		2165.08
2	150	78.99	2433.50	339.80	2354.51
3	300	157.99	2660.59	287.48	2502.61

· MPR in the 2nd application (150 kg ha^{-1}) is %339.80 and calculated as: $MPR_2=(\Delta\pi/\Delta TVC)*100=[(2,433.50-2,165.08)/(78.99-0)]*100=\%339.80$

· MPR in the 3rd application (300 kg ha^{-1}) is %287.48 and calculated as:
$MPR_3=[(2,660.59-2,433.50)/(157.99-78.99)]*100=\%287.48$.

That is, while a profit of USD 3.40 is made in return for a cost of USD 1 for fertilizer and fertilizing in the 2nd application, a profit of USD 2.87 is made in return for USD 1 in the 3rd application.

As can be seen, although there is a relative decrease in MPR following the 3rd application, in absolute terms the profit increases. Therefore, since production is still far from the point of absolute diminishing marginal return/productivity, the test for nitrogen dose effect on production could be continued. This being so, production level could be determined when marginal productivity is equal to zero and marginal cost is at its peak. However, as only two nitrogen doses (excluding the 1st application; 0 kg ha^{-1}) were used experimentally in this research, both levels (150 and 300 kg ha^{-1}) whose net revenues are both positive, could be applied. Nevertheless, for determination of the best level, residuals should also be checked. As available in Table 6, the highest residuals are possible as a result of the 3rd application (300 kg ha^{-1}). As mentioned before, it is difficult to estimate whether this is the most profitable dose or not. However, under the circumstances it can be stated that the most profitable level is possible through the 3rd application.

CONCLUSION

Nitrogen, as plant food, is the most taken-up mineral in the soil. As the maize plant grows in size, the amount of nitrogen it takes from the soil rises. As a factor in increasing the productivity of maize, nitrogen is paramount. However, the overuse of nitrogenous fertilizer damages soil structure. This research confirmed that legumes should be grown early in the planting season as the productivity of cereals grown later is thereby increased. Moreover, in our region (South East Anatolia, Turkey) growing maize with legumes will result in both higher seed yield per area and an increase in stalk productivity, thus, reducing to a great extent the problem of high feed shortage in stock raising. Therefore, by decreasing the costs of both vegetable and animal production, it will also contribute to economic development. In addition, this research offers evidence that nitrogenous fertilizer at the dose of 300 kg ha^{-1} for growing 2nd product maize in chickpea planting fields provides higher productivity**.**

ACKNOWLEDGEMENT

We are grateful to the Directorate of Scientific Research Projects, Mardin Artuklu University for the financial support it has given to first year of this research (Project nr: MAU, BAP-14, KMYO-04). Our special thanks go to Mrs. Natalia Tari, Mardin Artuklu University for editing the manuscript.

REFERENCES

Apak, R., Sönmez, F., Ülker, M. and Yildirým, B., (1995). A Research on the Determination of Suitable Planting Time and Nitrogen Dose for Maize Varieties in Van. *YYU Journal AGR SCI* **5**(2): 13-27.

Canlý, Y. (2003). The Effects of Various Nitrogen and Phosphorus Applications on Productivity and Quality of Maize (*Zea Mays* L.) as a 2nd Product. Msc. Thesis. KS University Field Crops Kahramanmaras, Turkey.

Celep, H. (2006). The Effect of Preliminary Plant and Various Nitrogen Doses on Some Characteristics of Maize. Msc. Thesis. KS University Field Crops Kahramanmaraº, Turkey.

Cesurer, L. (1990). The Determination of Productivity and Various Related Characteristics of Commercial Hybrid Maize (*Zea Mays* L.) Suitable for Watery Conditions in the Çukurova Region. Msc. Thesis. CukurovaUniversity Field Crops Adana, Turkey.

Cesurer, L., Çölkesen, M., Dokuyucu, T. and Çiçek, A., (1999). The Determination of Early Growing and Highly Productive 2nd Product Hybrid Maize Varieties. Cereals Agriculture Problems Simposium in Middle 08-10 June, Konya, 635- 639.

Chen, H.Y., Zhang, J.H., Jing, X.L. and He, Y.H., (1994). Effects of Nitrogen on Yield and Leaf Structure in Pop-corn. J*ournal of Shanghai Agric. College,* **12**(4): 253-256.

Dinler, Z. (2013). *Microeconomics*, 24.press, Ekin publications, Bursa.

Dickson, T., Aitken, R.L. and Dwyer, J. C., (1993). Prediction of Nitrogen Fertilizer Requirements of Maize in Subtropical Queensland. *Aust. J. of E. Agric.,* **33:** 53-58.

Difonzo, N., Motto, M., Maggiore, T., Sabatino, R. and Salamini, F. (1982). N-Uptake, translocation, and relationships among N-related traits in maize as affected by genotype. *Agronomic,* **2**(9): 789-796.

Düzgünes, O., Kesici, T. and Gürbüz, F., (1987). *Research and Experimental Methods.* A.U. Agricultural Fac. Pub. No: 1021, Practice Guide: 295, 381.

Dok, M. (2005). Researches on Productivity and Various Related Elements of Some Maize Varieties in Planting Preliminary and 2nd Product Maize on Harran Plain. GAP IV.Agriculture Congress, 21-23 September, Urfa, 861-866.

Ertek, T. (2011). Exercises for Microeconomics Theory. Beta Publication Ýstanbul.

FAO, 2013. Statistics. http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor. (05.11.2014).

Hallauer, A. R. and Miranda, J. B., (1987). Quantitative Genetics in Maize Breeding. Iowa State University Press, Ames, Iowa, USA.

Hutchinson, R. L., Sharpe, T. R. and Slaughter, R. T., (1989). Corn Plant Population and N Rate Study. Lousiana Agric. Exp. Station. 116-117.

Idikut, L. and Kara, S.N., (2013). The Determination of Some Productivity Elements and Grain Cornstarch Rates of 2nd Product Maize Grown for Grain. *KS University Journal of naturel Sciences* **16**(1).

Inal, Ý. (2002). Researches on The Effects of Various Winter Intermediate Products in Planting Time Systems in Watery Fields of the Çukurova Region on Grain Productivity and Some Agricultural Characteristics of Maize *(Zea mays* L.). PhD. Thesis. CukurovaUniversity Field Crops Adana, Turkey

Jovanovic, Z. (1999). Effects of Some Agro Technical Practices on Pop-corn Yields. Institut Za Kukuruz “Zemun Polye” Beograd Zemun Agronomski Fakultet. 83-89.

Keskin, B., Yýlmaz Ý.H. and Arvas, O., (2005). Determination of Some Yield Characteristics of Grain Corn in Eastern Anatolia Region of Turkey. *Pak. Journal of Agronomy* **4**(1): 14-17.

Klein, M. (2014). *Mathematical Methods for Economics*, 2nd ed., Pearson, Essex-GB.

Krugman, P. and Wells, R., (2012). *Microeconomics.* (Translate from 2. press; ed. Sayým Iþýk, Murat Aslan, Ayþegül Ateþ, Cem Diþbudak, Kemal Türkcan), Palme Publication, Ankara.

Mardin Meteorology Directorate, (2014). Annual Climate Data. Meteorology Bulletin of Mardin.

Marschner, H. (1986). Mineral Nutrition in Higher Plants. Academic Press, Orlando, FL.23-28.

Nimje, P. M., and Seth, J., (1988). Effect of Nitrogen on Growth, Yield and Quality of Winter Maize. *Indian J. of Argon,* **33**(2): 209-211.

Öktem, A., Ülger A.C. and Kirtok, Y., (2001). The Effects of Various Nitrogen Doses and Row Distances on Grain Productivity and Some Agronomic Features of Pop-corn *(Zea mays everta Sturt). Journal of Çukurova University Agricultural Faculty, Adana.* **16**(2): 83-92.

Öz, A. and Kapar, H., (2001). The Determination of Production and Productivity Elements of Some One Hybrid Maize Grown in Samsun. The Fourth Field Crops Congress, 17-21 September Tekirdag, 221-225.

Özkan, B. (1997). The Economic Analysis of Nitrogen Fertilising in 2nd Product Maize. Anadolu, J of AARI 7(1), 135-145.

Özkan, A. and Ülger, A.C., (2011). The Effects of Various Nitrogen Dose Applications on Grain Productivity and Some Agricultural Features of Two Kinds of Pop-corn *(Zea mays L. everta Sturt)* in Ecological Conditions of Çukurova. *YYU J Agr. Sci.*, **21**(3): 198-208.

Padmaja, M, Sreelatha D. and Rao, K.L., (1999). Effect of Nitrogen on Nutrient Uptake in Maize (*Zea mays* L.) Types. *Journal of Research. Angrau* **27**(4): 112-114.

Paradkar, V.K. and Sharma, R.K., (1993). Effect of Nitrogen Fertilization on Maize (*Zea mays* L) Varieties under Rain Fed Conditions. *Indian Journal of Agronomy,* **38**(2): 303-304.

Pissaia A, Possamai J.C., and Daros, E., (1996). The Effect of Nitrogen Rate on Grain Yield in a Variety of Pop-corn (*Zea mays,* L.). *Revista do Setor de Ciencias Agrarias* **15**(2): 223-227.

Ram, S., Dhuckia, R. S., Kanwar, S. and Singh, K., (1993). Effect of Residual Phosphorus Applied to Forages and Nitrogen on Maize Yield. *Crop Research Hisar* **6**(3): 362-369.

Roy, R.K., Singh, K.S.P. (1986). Response of Pop-corn (*Zea mays L. Everta Sturt*) to Plant Population and Nitrogen, *Indian Journal of Agronomy* 31(1). 89-92.

Saruhan, V., Gül, I. and Akinci, C. (2007). A Study of Adaptation of Some Corn Cultivars As Grown as Second Crop. *Asian Journal of Plant Sciences,* **6**(2): 326-31.

Sekhon, N. K. and Aggarwal, G. C. (1994). Changes Induced in Maize Leaf Growth and Development by Organic Amendments and N Fertilizers in a Calcareous Ustochrept Soil Northwestern India. *Arid-Soil-Research and Rehabilitation,* **8**(3): 261-268.

Seyidoðlu, H. (2002). Law of Diminishing Returns, Ekonomics word; 3.press, Güzem Can Publications, No: 18, Ýstanbul. Sezer, Ý. and Gülümser, A. (1999). A Research on Determination of Maize Varieties *(Zea mays L.)* as Preliminary Product in Çarºamba Plain. The Third Field Crops Congress, 15-18 November, Adana, 275-280.

Sezer, I. and Yanbeyi, S. (1997). The Effect of Plant Frequency and Nitrogenous Fertilizer on Grain Productivity, Production Components, and Some Vegetable Characteristics of Pop-corn *(Zea mays L. everta Sturt)* in Çarºamba Plain. The Second Field Crops Congress, 22-25 September, Samsun, 128-133.

Siniksaran, E., Aktükün, A. and Akay, A. (2011). *Mathematics for Economists.* Türkmen Puplications, Istanbul, 2011

Sönmez, F. (2001). The Effect of Nitrogen on Grain Productivity and Production Components of Maize Varieties. GOP University Journal of Agricultural Faculty 18(1): 107-112.

Sözüdoðru, S., Karaca, A. and Haktanir, K. (1996). The Effect of Chicken Fertilizer on Nitrogen Mineralisation and Urease Activity. Agriculture Faculty of Ankara University Publications, Publications No: 1445, Ankara, 798.

O'Sullivan, A. Sheffrin and Perez, S. (2014). Microeconomics; Principles, Applications, and Tools, 8th ed., Paerson, Essex-GB.

Tosun, S. (2005). The Effects of Preliminary Plant and Various Nitrogen Doses on Some Vegetable and Agricultural Characteristics of 2nd Maize Product Msc. Thesis. KS University Field Crops Kahramanmaras, Turkey.

Tüfekçi A. and Karaaltin, S. (2001). The Effects of Various Nitrogen Doses in Preliminary Product Maize (*Zea mays* L.) on Production and Productivity Elements of 2nd Product. The Fourth Field Crops Congress, 17-21 September 2001 Tekirdag, 219-295.

Türkay, M. A., Cerit, I., Sarihan, I. H., Sen, H. M., Çinar, S. and Ülger, A. C. (2002). A Research on the Effects of Various Nitrogen Doses on the Grain Productivity and Some Agricultural Characteristics of Horse Teeth Hybrid Maize Varieties. Eastern Mediterranean Agricultural Research Institute, Adana, 63-67.