

The Effects of Intra-Row Spacing and N Fertilizer on the Yield of Two Foreign Potato Cultivars in Iran

A. RAHEMI¹, A. HASANPOUR, B. MANSOORI[†], A. ZAKERIN[‡] AND T. S. TAGHAVI[¶]

Department of Horticulture, Ministry of Agriculture, Tehran, Iran

[†]Fars Agriculture Research Center, Zarghan, Iran

[‡]Azad University, Jahrom, Iran

[¶]Department of Horticulture, Faculty of Agriculture, University of Tehran, Iran

¹Corresponding author's e-mail: a_rahemi@yahoo.com

ABSTRACT

The Intra-row spacing and N fertilizer are considered as major factors affecting potato yield. In this study the yield of a newly introduced potato cultivar named Marfona was compared with a relatively old variety named Diamant for two successive years. The experiment was conducted as split-split plot design. Potato cultivars were kept in the main plot and, intra-row and N fertilizer as sub plot and sub-sub plot respectively. The yield was recorded at the end of the growing season and statistical analyses were performed for two successive years separately. Potato cultivar, intra-row spacing and N fertilizer affected yield significantly. The cultivar Marfona showed 28.71% increase in yield over Diamant. Combined analysis revealed that twenty centimeter spacing resulted in 23.31% increases in yield over thirty centimeter spacing. Higher N fertilizer rate 225 kg ha⁻¹, resulted in 7.5% increase in yield over the lower rate 175 kg ha⁻¹. The analysis indicated that the effect of year and, year×cultivar×N fertilizer interaction was significant for yield. However, other interactions were not found to affect the yields significantly.

Key Words: Fertilizer; Marfona; Diamant; Seed spacing; Potato

INTRODUCTION

Potato is a plant native to South America and has been introduced to Iran 200 years ago. One of the challenges with white potato production, is the efficient management of nitrogen (N) fertilizer. Excessive N fertilizer applied at or before tuberization can extend the vegetative growth period and delay tuber development, resulting in a lower tuber yield. However, too much N applied later in the season can delay maturity of the tubers, reducing yield and adversely affecting tuber quality and skin set. Conversely, low-application of N at any point in the season also can result in lower tuber yields and reduces profits. Environmental considerations must also be taken into account in N fertilizer management. Nitrogen is a mobile nutrient in the soil and its excess can lead to losses via leaching or surface run off. These factors make the appropriate N rate critical for successful white potato production (Gathungu *et al.*, 2000; Phillips *et al.*, 2004).

Many scientists have studied the effect of N fertilizer rate and seed spacing on yield of potato cultivars. Singh (1995) applied different N treatments on potatoes cv. Kufri Badshah and found that the best N fertilizer rate is 200 kg N ha⁻¹ and produced highest yield. Jaiswal (1994) also observed that the best amount of N fertilizer is 180 kg N ha⁻¹. Iqbal *et al.* (1995) in a farm experiment obtained the highest yield with 250 kg N ha⁻¹. Jekic and Stojanor (1992) in a research on some cultivars including Diamant obtained the

highest yield with applying 90 kg N ha⁻¹ and the Diamant showed the highest yield among other cultivars. Barakat *et al.* (1994) also found that Diamant cultivar produced highest yield and dry matter with 285 kg N ha⁻¹. Kandeel *et al.* (1991) by using 0, 120, 240 kg N ha⁻¹ and observed that Diamant cultivar produced highest yield with 120 kg N ha⁻¹.

Gronowicz *et al.* (1990) studied the effect of seed spacing on rows and N fertilizer rate (70-100 kg N ha⁻¹) on Duet cultivar. They concluded that yield increased with choosing lesser seed spacing and higher N fertilizer rates. Rajadurai (1994) had established an experiment to compare intra-rows spacing on yield of Desiree cultivar. He concluded that increasing the seed spacing from 20 to 50 cm decreased the yield and highest yield obtained with 20 cm seed spacing. Negi *et al.* (1995) also showed that highest yield obtained with 20 cm spacing on rows in Kufri Jyoti cultivar. Khan (1993) had studied the effect of seed spacing on rows from 10 to 20 cm in Diamant cultivar. He concluded that the yield decreased with increasing the seed spacing. The objective of this study was to compare the effects of nitrogen rates and intra-row spacing on yield of Marfona compared to standard variety, Diamant.

An exotic potato cultivar 'Marfona' has been recently introduced to Darion in Fars province in south of Iran. The cooking quality of Marfona is better than Diamant. The dry matter of Marfona is low, its texture is firm and its color will not change after cooking. In Diamant cultivar, the dry matter of tubers is high and after cooking it is more prone to

Table I. The results of soil analysis of the field in Darion

Soil Structure	Ec (mScm ⁻¹)	pH paste	of Organic carbon (%)	Total N (%)	P (ppm)	K (ppm)
Clay loam	2.05	8.01	0.79	0.08	19.2	592

Table II. The effect of two potato cultivars on yield (t ha⁻¹)

Year	Cultivar	
	Diamant	Marfona
First year	43.61 b	57.08 a
Second year	26.80 b	41.76 a
Two years analysis	35.21 b	49.39 a

Means given different letters differ from each other by Duncan's test at $\alpha=0.01$.

Table III. The effect of plant spacing on yield of potatoes (t ha⁻¹)

Year	Plant spacing on rows	
	20 cm	30 cm
First year	53.59 a	47.04 b
Second year	42.18 a	26.39 b
Two years analysis	47.88 a	36.72 b

Means given different letters differ from each other by Duncan's test at $\alpha=0.01$.

Table IV. Effect of nitrogen fertilizer on yield (t/ha)

Year	Nitrogen fertilizer	
	175 kg N ha ⁻¹	225 kg N ha ⁻¹
First year	49.88 a	50.75 a
Second year	31.42 b	37.15 a
Two years analysis	40.65 b	43.95 a

Means given different letters differ from each other by Duncan's test at $\alpha=0.05$.

color change. Farmers are interesting in using this new cultivar, but they have insufficient information about N application and intra-row seed spacing. In this study compared this cultivar with a relatively old commonly grown cultivar Diamant. Marfona is a semi precocious cultivar, which in tuber size and yield is higher than Diamant.

MATERIALS AND METHODS

This research was done in Darion one of the most important cultivation areas in Fars province of Iran. The soil of the field was analyzed (Table I). This experiment was a split split plot design and had four replications. Two potato cultivars (Diamant & Marfona) were spread in the main plot, Intra-row spacing (20 & 30 cm) as sub plot and urea fertilizer (175-225 kg N ha⁻¹) as sub-sub-plot. The potatoes were cultivated in spring in a furrow system in 3 lines with 5 m long and 70 cm between rows in each experimental plot. The seeds were from fundamental type (E) and an average

35-55 mm in diameter and 75 g in weight.

Half of the N fertilizer was spread in rows with 5 centimeter far from tubers and beneath them. The other part of the N fertilizer was spread at two intervals, after germination and 4 weeks after germination. For recording the yield, one meter of the first and the end of each row was eliminated and the yield of other 3 m was measured. The yield of every plot and every treatment was measured as tons per hectare. The data was analyzed and simple analysis for each year and a combined analysis for 2 years were done.

RESULTS

In this study, the yield of potatoes was affected by cultivars significantly ($p \leq 0.01$). The 'Marfona' had a yield increase equal to 30.9 and 55.8% over Diamant in the first and second year, respectively. The increase of yield in a combined analysis for 2 years was 40.3% (Table II). Means were compared by, Duncan multiple range test.

The effect of intra-row spacing was significant on yield of potatoes ($p \leq 0.01$). The 20 cm spacing on rows (66.6x10³ plants per hectare) in comparison with 30 cm spacing showed 13.9, 59.8 and 30.39% increase in yield in the first year, second year and combined analysis for two years, respectively (Table III).

Increasing the N fertilizer was effective significantly on yield in second year ($p \leq 0.05$). The yield increased 18.2% with application of 225 kg N ha⁻¹ instead of 175 kg N ha⁻¹. In this experiment increasing the N fertilizer in a combined analysis for two years was significant too ($p \leq 0.05$) and application of 225kg N ha⁻¹ had increased the yield equal to 8.1% in comparison to 175 kg N ha⁻¹ (Table IV).

The effect of year on yield was significant ($p \leq 0.01$). The yield in the first year was 46.8% more than the second year (Fig. 1). The interaction of the year, cultivar and N fertilizer was significant on yield at $p \leq 0.05$ (Table V). The highest yield in Marfona cultivar obtained in the first year with 175 or 225 kg N ha⁻¹. In the second year Marfona produced higher yield with application of 225 kg N ha⁻¹. In the first year, Diamant cultivar produced higher yield with using 225 kg N ha⁻¹. There is no significant difference in yield in the second year between 175 and 225 kg N ha⁻¹.

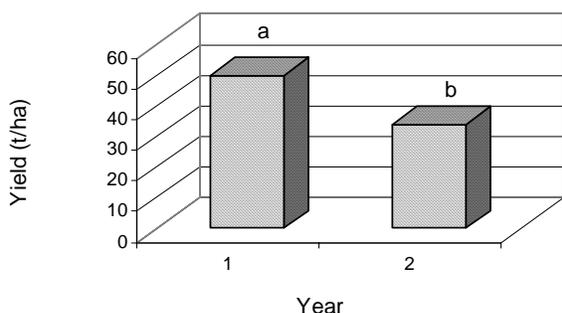
DISCUSSION

The yield of potatoes, as many crops, is dependent on many factors like the amount of minerals in the soil, plant spacing, cultivars etc. The intra-row spacing had a marked effect on yield. Increasing the density can increase the yield in three ways. First, the green leaves will cover the soil earlier and will absorb more sunlight and lead to more assimilation. Second, few lateral shoots will grow and the third is that the growth of tubers will start earlier (Beukema & Vanderzaag, 1990). The results of soil analysis showed that the amount of organic carbon, which can supply part of

Table V. The interaction of year×cultivar×nitrogen on yield (t ha⁻¹)

Year	Cultivar	N Fertilizer	
		175 kg N ha ⁻¹	225 kg N ha ⁻¹
First year	Marfona	57.92 a	56.12 a
Second year	Marfona	36.83 c	46.69 b
First year	Diamant	41.85 bc	45.38 b
Second year	Diamant	26.00 d	27.60 d

Means given different letters differ from each other by Duncan's test at $\alpha=0.05$.

Fig. 1. The effect of year on yield of two potato cultivars. Means given different letters differ from each other by Duncan's test at $\alpha=0.05$ 

the N required by the plant is low, therefore the crop showed a good response to nitrogen fertilizer and with increasing fertilizer, the yield increased too (Markovic *et al.*, 1992; Galeev, 1993; Zavalin & Gremitskikh, 1994). The yield decreased in the second year due to increases of temperature and reduction of net assimilation by the plant (Beukema & Vanderzaag, 1990).

The interaction between year, cultivar and nitrogen also showed that the yield in the second year is less than the first year. It also showed that increasing the N fertilizer increased the yield Lahky (1990) also believed that, the effect of N fertilization on yield is dependent on soil condition and year.

The percentage of tubers with medium weight (50-175 g) is higher in Marfona than Diamant cultivar (data not presented). As the environmental condition for both cultivars are equal, it reflects the genetical variations between cultivars. The shapes of tubers are also different. The ratio of length to width of Marfona (1/20) is higher than Diamant (1/11). Longer tubers of Marfona cultivar is more desirable by customers. The cooking quality of Marfona is also superior to Diamant. The higher yield, the longer and bigger tubers of Marfona and its superior quality, made it more suitable cultivar and are good reasons to replace this cultivar with Diamant. Marfona also produced higher yield than Diamant.

Based on the results of this experiment farmers can grow Marfona varitey with 20 centimeter intra-row sapcing and 225 kg N ha⁻¹ to achieve higher yield in Darion.

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(Received 20 January 2005; Accepted 20 June 2005)