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CHANGES IN YIELD AND YIELD COMPONENTS OF POTATO (*SOLANUM TUBEROSUM*) UNDER APPLICATION OF DIFFERENT NPK FERTILIZERS

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ABSTRACT

Excessive applications of chemical fertilizers are threat in human life and today application of proportional rates of NPK fertilizers find more important. This experiment was conducted in order to evaluate of the effects of different NPK fertilizers on yield and yield components of potato. The experiment was laid out in a split-plot arrangement based of RCBD with three replications. Table 1 shows some of the soil characteristics in experimental site: Treatments were three cultivars of potato such as Spirit, Banbaa and Sante in main plots and NPK fertilizers in four levels of 0-0-0, 20-20-20, 12-12-36 and 10-52-10 that consist of nitrogen%, phosphor% and potassium% respectively in each combined fertilizers in sub plots. The results showed that there is represented the effects of NPK fertilization on yield and yield components of potato. Furthermore cultivar×NPK interaction was significant on all traits excepting biomass. In all traits such as plant height, number of branches per plant, number of tuber per plant, tuber and biomass yield and harvest index the Spirit cultivar had the highest of them and Banbaa had the lowest. Lowest tuber yield was founded at Banbaa cultivar without application of any of NPK fertilizer rates. In final the results of the present study reviled that for achieve to highest tuber yield we can use Spirit cultivar and applied 20-20-20 NPK fertilizer treatment

Key words: Cultivar, NPK and potato

INTRODUCTION

Potato (*Solanum tuberosum*) is one of the main and strategic products and stands in fourth position after wheat, rice and corn .It has also a special role in feeding people of under developed Countries (Ranjbar et al, 2012). The potato is a member of the nightshade family (*Solanaceae*) and is a major world food crop and by far the most important vegetable crop in terms of quantities produced and consumed worldwide (FAO, 2005). Potato is exceeded only by wheat (*Triticum aestivum* L.), rice (*Oryza sativa* L.), and maize (*Zea mays* L.) in world production for human consumption (Bowen, 2003). Potato tubers give an exceptionally high yield per acre and are used in a wide variety of table, processed, livestock feed, and industrial uses (Feustel, 1987; Talburt, 1987). Potato provides nutritious food in a diversity of environments. Potato can be an important food for the increasing world population, and has the potential for increased vitamin C and protein content. Potato originated from tropical areas of high altitude in the Andes. The crop is grown throughout the world but is of particular importance in temperate climates. Present world production is 329 106 Mg fresh tubers from 19.1 million ha (FAO, 2005). The major world producers, in order of production, are China, Russian Federation, India, United States, Ukraine, Poland, Germany, Belarus, Netherlands, United Kingdom, Canada, Turkey, and Romania (FAO, 2005).

Increasing and extending the role of NPK fertilizers can reduce the need for plant requirement. Chemical fertilizers on the other hand, pose a health hazard and microbial population problem in soil besides the high cost of their application (Mahfouz and Sharaf-Eldin, 2007; Hasaneen et al., 2009). El-Habbasha and Abd El-Salam (2010) illustrated that increasing chemical nitrogen fertilization significantly decreased the oil content in canola seeds but increased grain yield of it. The excessive use of NPK fertilizer has generated several environmental problems.

It is important to develop suitable and integrated fertilization strategies for crop production that enhance the competitive ability of the crop, minimize weed competition, and reduce the risk of nonpoint source pollution from nitrogen. Moreover, it seems that there is little investigation on combined effects of organic and inorganic nitrogen fertilization under different rates of environmental factors in some crops such as potato. Excessive chemical nitrogen

fertilization of some crops such as sunflower not only generates that environmental risk, it may also affect the grain quality, decreasing its oil content and reduce yield through an increase of plant lodging (Scheiner et al., 2002). Greef (1994) reported that high values of the reduced N fraction (protein fraction) were found in photosynthetic active leaf tissue. However, this is true especially under conditions of favorable nitrate supply. Some of these problems can be tackled by use of proportional rate of NPK, which are naturally beneficial and ecologically friendly.

Hence, considering the above facts, the present study was undertaken to study the effects of different NPK fertilizers on yield and yield components of potato.

MATERIALS AND METHODS

A field experiment was conducted at Islamic Azad University, Boroujerd branch, Iran, during 2014 growing season. This experiment was conducted in order to evaluate of the effects of different NPK fertilizers on yield and yield components of potato. The experiment was laid out in a split-plot arrangements based of RCBD with three replications. Table 1 shows some of the soil characteristics in experimental site:

Table 1: Soil parameters of the experimental field.

Silt (%)	Sand (%)	Clay (%)	Organic C. (%)	PH	K(ppm)	P(ppm)	Tissues	Deeps(cm)
38	47.2	14.8	0.76	7.99	142	1.75	Loam	0-30

Treatments were three cultivars of potato such as Spirit, Banbaa and Sante in main plots and NPK fertilizers in four levels of 0-0-0, 20-20-20, 12-12-36 and 10-52-10 that consist of nitrogen%, phosphor% and potassium% respectively in each combined fertilizers in sub plots. 50% of that fertilizers used at planting time and other of that used in order to top dressing after starting of tubering and adding of soil on plant stems. Furrow and heel planting method was used. Each plot was planted in a 5 m long, 6-row. Row to row on top of heels and plant - plant distance was maintained at 75 and 20 cm, respectively. In growing season weeds were control y suitable herbicides. At crop maturity traits such as plant height, number of branches per plant, number of tubers per plant and tuber yield were measured.

The biomass production was measured on 1 square meter from each treatment at maturity stage. The harvest index was accounted for with the following:

HI = (economical yield / biological yield)

The statistical analysis to determine the individual and interactive effects of NPK on

potato cultivar were conducted using JMP 5.0.1.2 (Statistical analyses system Institute incorporated , 2002). Statistical significance was declared at $P \leq 0.05$ and $P \leq 0.01$. Treatment effects from the two runs of experiments followed a similar trend, and thus the data from the two independent runs were combined in the analysis.

RESULTS AND DISCUSSION

Days to tubering: The results showed that the effect of cultivar, NPK fertilizer and interaction between them on days to tubering was significant (table2). The comparison means showed that the highest days to tubering was founded for Spirit cultivar (45.2 days) and the minimum days to tubering was founded for Banbaa cultivar (35 days) (table3). For fertilizers treatment the highest days to tubering was founded for 20-20-20 NPK (44.7 days) and the minimum days to tubering was founded for 10-52-10 NPK (36 days) (table3). For interaction effect between them the highest days to tubering was founded for Spirit cultivar under application of 12-12-36 NPK (46.2 days) and the minimum days to tubering was founded for Banbaa cultivar under application of 0-0-0 NPK (37 days) (table4).

Table 2: Analysis of variance (mean squares) for yield and yield components of potato cultivars under application of different NPK fertilizers

S.O.V	df	days to tubering	plant height	number of branches per plant	number of tuber per plant	tuber yield	biomass yield	harvest index
R	2	9.72	515	5.8	0.08	0.44	1.25	7.08
Cultivar	4	21.9**	47.28*	20**	182**	14**	421**	625**
Error (a)	8	28	782	8.5	605	0.7	45	14
NPK	4	6**	151*	2.88*	0.88*	0.78*	7.8*	22**
Cultivar*NPK	16	4**	48*	4.45*	0.57*	0.52*	2.2	2.9*
Error (b)	40	28.5	564	6.45	422	6	27	11
Total	74	12.1	68	8.4	1.54	1.42	8.5	2.5
CV(%)		2.2	5.7	4.08	0.85	4	4.8	2.4

*** and **: Non significant and significant at the 0.05 and 0.01 level of probability, respectively.**

Plant height: The results showed that the effect of cultivar, NPK fertilizer and interaction between them on plant height was significant (table2). The comparison means showed that the highest plant height was founded for Spirit cultivar (148cm) and the minimum plant height was founded for Banbaa cultivar (13cm) (table3). For fertilizers treatment the highest plant height was founded for 20-20-20 NPK (150cm) and the minimum plant height was founded for 0-0-0 NPK (120cm) (table3). For interaction effect between them the highest plant height was founded for Spirit cultivar under application of 12-12-36 NPK (150cm) and the minimum plant height was founded for

Banbaa cultivar under application of 0-0-0 NPK (115cm) (table4).

Number of branches per plant: The results showed that the effect of cultivar, NPK fertilizer and interaction between them on number of branches per plant was significant (table2). The comparison means showed that the highest number of branches per plant was founded for Spirit cultivar (8.6) and the minimum number of branches per plant was founded for Banbaa cultivar (6.9) (table3). For fertilizers treatment the highest number of branches per plant was founded for 20-20-20 NPK (7.9) and the minimum number of branches per plant was founded for 0-0-0 NPK (4.5) (table3). For interaction effect between them the highest number of branches per plant was founded for Spirit cultivar under application of 20-20-20 NPK (8.7) and the minimum number of branches per plant was founded for Banbaa cultivar under application of 0-0-0 NPK (6.4) (table4).

Number of tuber per plant: The results showed that the effect of cultivar, NPK fertilizer and interaction between them on number of tuber per plant was significant (table2). The comparison means showed that the highest number of tuber per plant was founded for Spirit cultivar (12.8) and the minimum number of tuber per plant was founded for Banbaa cultivar (7.9) (table3). For fertilizers treatment the highest number of tuber per plant was founded for 12-12-36 NPK (13.4) and the minimum number of tuber per plant was founded for 0-0-0 NPK (6.5) (table3). For interaction effect between them the highest number of tuber per plant was founded for Spirit cultivar under application of 20-20-20 NPK (13.8) and the minimum number of tuber per plant was founded for Banbaa cultivar under application of 0-0-0 NPK (8.5) (table4).

Table 3: Simple means comparison for yield and yield components of potato cultivars under application of different NPK fertilizers

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treatments	days to tubering	plant height(cm)	number of branches per plant	number of tuber per plant	tuber yield(ton/ha)	biomass yield(ton/ha)	harvest index(%)
cltivars							
Spirit	**45.2a**	**148.1a**	**8.6a**	**12.8a**	**35.21a**	**55.84a**	**54.7a**
Sante	**42.7b**	**140b**	**8.2b**	**12b**	**27.5b**	**50b**	**53b**
Banbaa	**35.5e**	**135c**	**6.9e**	**7.9e**	**20c**	**45c**	**52c**
NPK 0-0-0 (control)	**38.5c**	**120d**	**4.5d**	**6.5c**	**18.52d**	**30d**	**48d**

10-52-10	**36.3e**	**130c**	**5.5c**	**10d**	**25c**	**40c**	**52c**
12-12-36	**42.1b**	**140b**	**6.5b**	**13.4a**	**30.5b**	**50b**	**57b**
20-20-20	**44.7a**	**150.4a**	**7.9a**	**11b**	**37.19a**	**58.23a**	**60.01a**

The same letters at each column indicate the insignificant difference at the 0.05 level of probability. (LSD test).

Tuber yield: The results showed that the effect of cultivar, NPK fertilizer and interaction between them on tuber yield was significant (table2). The comparison means showed that the highest tuber yield was founded for Spirit cultivar (35.2 ton/ha) and the minimum tuber yield was founded for Banbaa cultivar (20 ton/ha) (table3). For fertilizers treatment the highest tuber yield was founded for 12-12-36 NPK (37.19 ton/ha) and the minimum tuber yield was founded for 0-0-0 NPK (18.5 ton/ha) (table3). For interaction effect between them the highest tuber yield was founded for Spirit cultivar under application of 20-20-20 NPK (38 ton/ha) and the minimum tuber yield was founded for Banbaa cultivar under application of 0-0-0 NPK (15 ton/ha) (table4).

Biomass yield: The results showed that the effect of cultivar NPK fertilizer on biomass yield was significant (table2). The comparison means showed that the highest biomass yield was founded for Spirit cultivar (55.8 ton/ha) and the minimum biomass yield was founded for Banbaa cultivar (45 ton/ha) (table3). For fertilizers treatment the highest biomass yield was founded for 20-20-20 NPK (58.2 ton/ha) and the minimum biomass yield was founded for 0-0-0 NPK (20 ton/ha) (table3).

Harvest index: The results showed that the effect of cultivar, NPK fertilizer and interaction between them on harvest index was significant (table2). The comparison means showed that the highest harvest index was founded for Spirit cultivar (54.7%) and the minimum harvest index was founded for Banbaa cultivar (52%) (table3). For fertilizers treatment the highest harvest index was founded for 20-20-20 NPK (60%) and the minimum harvest index was founded for 0-0-0 NPK (48%) (table3). For interaction effect between them the highest harvest index was founded for Sante cultivar under application of 20-20-20 NPK (61%) and the minimum harvest index was founded for Banbaa cultivar under application of 0-0-0 NPK (48%) (table4).

Table 4: Means comparison for yield and yield components of potato cultivars under application of different NPK fertilizers

cltivars	NPK	days to tubering	plant height(cm)	number of branches per plant	number of tuber per plant	tuber yield(ton/ha)	harvest index(%)
Spirit	0-0-0 (control)	38d	125d	7.9d	10.5d	19d	50d
	10-52-10	42c	135c	8.2c	11.5c	28c	52c
	12-12-36	46.3a	150a	8.4b	12.5b	34b	56b
	20-20-20	45b	142b	8.7a	13.8a	38.02a	58a
Sante	0-0-0 (control)	40.3d	120d	7.7d	9.5d	17d	52d
	10-52-10	41.5c	125c	8c	10.5c	25c	56c
	12-12-36	44.2a	135a	8.3b	11.5b	31b	58b
	20-20-20	41.8b	130b	8.5a	12.5a	35a	61.25a
Banbaa	0-0-0 (control)	37.1c	115d	6.4d	8.5d	15d	48d
	10-52-10	34.1e	120c	6.7c	9.5c	20c	50c
	12-12-36	40.2a	125b	8b	10.5b	27a	52b
	20-20-20	38.5b	128a	8.3a	11.5a	25b	56a

The same letters at each column indicate the insignificant difference at the 0.05 level of probability

There is represented the effects of NPK fertilization on yield and yield components of potato. The results indicated that cultivar and NPK fertilizers had significant effect on all of the studied traits. Furthermore cultivar×NPK interaction was significant on all traits excepting biomass. It is important to develop integrated NPK fertilization strategies for crop production that enhance the competitive ability of the crop sand reduce the risk of non-point source pollution from nitrogen.

The results of the present study showed that application of NPK fertilizers on all potato cultivars increased the yield and yield components significantly over the treatments. This could be possible increased because of more availability of nutrients and their uptake. Similar findings were also reported by Tiwari and Parihar (1992), Ramesh et al. (1999), Gorttappeh et al. (2000), Saeed et al. (2002), who stated that synthetic fertilizers significantly increased grain and biological yield against control. Another study on the effect of N fertilization on growth and yield components showed increase in canola seed yield (Ahmadi and Bahrani, 2009)

In all treats Spirit cultivar had the highest of them and Banbaa had the lowest of them. Spirit cultivar is suitable and useful for cultivation in the planting region. Also, the application of NPK specially 20-20-20 NPK treatment was more useful for achieve to highest tuber and biomass yield that containing proportional beneficial nutrients and showed a promoting effect on the tuber

and biological yield. Also Greef (1994) reported that high values of the reduced N fraction were found in photosynthetic active leaf tissue. This is true especially under conditions of favorable nitrate supply. Application of NPK fertilizer significantly increased the plant height and number of branches per plant over the untreated control in Spirit, Sante and Banbaa cultivars (Table 4). These results are in accordance with those obtained by Chela et al. (1993), Sharma and Namdeo (1999). Plant height was increased in response to fertilizer application to soybean (Sharma and Namdeo, 1999).

Tuber yield is the most important trait that we want to achieve to that. Lowest tuber yield was founded at Banbaa cultivar without application of any of NPK fertilizer rates. The results of the present study reviled that for achieve to highest tuber yield we can use Spirit cultivar and applied 20-20-20 NPK fertilizer treatment (table4).

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