Effect of farm yard manure and nitrogen treatments upon the quality and quantity of potato (*Solanum tuberosum* var. Agria)

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Received: 15. November 2014  /  Accepted: 22. December 2014  /  Available online: 01. June 2016  /  Printed: June 2016

Abstract. To investigate the effects of Farm Yard Manure (FYM) and nitrogen fertilizer on the characteristics of potato crop, an experiment was performed as a split plots based on randomized complete block design (RCBD) during the crop year 2012-13 in three replications. The experiment was laid out in Dasht-e-Mir Farm located 20 kilometers far from Khodabandehe, Iran. The FYM used at three levels (control, 20 and 40 t/ha) and nitrogen fertilizer derived from urea applied at four levels (control, 100, 200 and 300 kg/ha). The obtained results revealed that the treatment of 40 t/ha of FYM showed the highest effect on the leaf dry weight (107.7 g) (P<0.05), average yield (34040 kg/ha) and Crude protein content (8.393%) (P<0.01). FYM treatments effects on crude ash and dry matter content were no significant. The treatment of 300 kg/ha of nitrogen fertilizer on the leaf dry weight (103.9 g), crude protein content (8.330%) and dry matter content (23.81%) were significant (P<0.01). The investigation of the interaction effects of FYM and nitrogen fertilizer showed that highest average yield per plant (616.7 g) and average yield (40080 kg/ha) obtained in 40 t/ha of FYM and 200 kg/ha nitrogen fertilizer. Highest dry matter content (23.92 %) obtained in 40 t/ha of FYM and 300 kg/ha nitrogen fertilizer. The interaction effect of 40 t/ha of FYM and 300 kg/ha nitrogen fertilizer showed the highest effect on crude protein content (8.94%) and crude ash (6.75%) (P<0.01). The results show that for obtaining the optimum yield with better quality is indispensable application of FYM with chemical fertilizer.

Key words: percent dry matter, farm yard manure (FYM), protein raw percent and nitrogen fertilizer.

Introduction

Potato (*Solanum tuberosum* var. Agria) is a combination of Quarta and Selula originated from Germany. It is one of the glandular products and has the fifth nutritious significant in rank after wheat, rice, maize and barley. It plays an important role in nourishing the global population (Khajepoor 1997).

The low cost of chemical fertilizers, its availability and ease of preparation are considered as the main reasons to ignore the soil fertility increase and its preservation and control processes for a long term. This happens because the conventional agriculture aims to maximize production and income at the same time without considering its environmental effects (Nasiri-Mohallati et al. 2001, Vanaei et al. 2008).

Nitrogen deficiency in potato production causes more restrictions on the operation. On the other hand, the plant needs this element and it is consumed more from the viewpoint of application frequency and its amount (Sparrow & Chapman 2003). Abbasi (2007) and Saeidi (2008) announced that application of nitrogen fertilizer increases the average weight, the number and the operation of the tuber in potato, and these traits decrease will be decreased if the optimum nitrogen rate exceeds.

Malakuti (2000) reported that the nitrate limitation allowance for the human is 5 mg/kg of body weight daily. It would be threatening for human health if the nitrate limit is exceeded in the food in the long term. Many factors involve the nitrate accumulation in a variety of vegetables, onions and potatoes including the amount and type of nitrate fertilizer, frequency of crop variety, light intensity of sunlight, and the harvest period. The consumption of potato in Iran is 100 grams for each person daily. Due to close connection between the amount of nitrogen fertilizer and nitrate accumulation in plants which their tubers, bulbs and stems are directly used, it must be taken into consideration to consume nitrogen fertilizers as less as possible so that it can be mainly used for the production of amino acids and protein.

Consumption of nitrogenous fertilizers is a key factor in fertility management. As its wide application leads to delay maturity and reduces distribution of dry matter to the tubers (Shekari et al. 2007). Nitrogen increases the tuber weight follow increase the tubers number (Shahbazi 2005, Saeidi 2008).

Application of manure to improve the soil physical, chemical and biological properties has been used and effects of manure on soil properties leads to increasing in crop yield. Manure is the major source for organic nutrients (Tadesse et al. 2013). Much of the impact of manure on soil and crop yield due to its humus content. As play as a slow release source of nutrients acts (Khalil & Jan 2002).

Hasandokht (1997) reported by increasing the amount of FYM from zero to 20 and 30 t/ha, the application of potato yields increased respectively to 30% and 47%. Sharma (1991) also surveyed and reported the effect of 5 t/ha FYM and P various treatments on potato and announced an increase in potato tuber by using FYM.

Materials and methods

The research was carried out in Dasht-e-Mir Farm sited 20 kilometers far from Khodabandeh, a city with longitude of 36.03 and latitude of 49.22 during the crop year 2011-12. It was conducted in the split plot randomized complete block design in three replications. The main plots contained three levels of Farm Yard Manure (FYM) (0, 20, and 40 t/ha), and the subplots contained nitrogen fertilizer originated from urea in four levels (0, 100, 200 and 300 kg/ha). Land preparation was done in the usual way. Nitrogen fertilizer was added to the plant in three different periods (planting, tuber developing and 15 days after creating tuber). Each subplot consisted of six rows with 75 × 20 cm spacing and the distance between the main plots determined 1.5 m. The planting date was 20 May. The weeds were managed by Sencor herbicide application. The tubes were disinfected by spraying carbendazim before planting. The tubers were harvested in late Oc-
Results

The results of this experiment have been in Tables 1, 2 and 3. Effects of FYM and nitrogen fertilizer on potato characteristics have been explained separately.

**Effects of FYM on potato characteristics**

The results showed no significant effect of manure on the number of branches. The largest numbers of branches (9.02) was obtained in 40 t/ha manure treatment. Effect of manure on leaf dry weight was significant (p<0.05). The highest and lowest leaf dry weight (107.70 and 86.72 g) was obtained in 40 and 20 t/ha manures treatments respectively. Effect of manure on yield per plant was not significant, but was significant on the average yield (p<0.01). The highest average yield per plant (523.7 g) was achieved in 40 t/ha FYM.

**Table 1.** Means comparison for effects of FYM levels on different traits in potato (Solanum tuberosum var. Agria).

<table>
<thead>
<tr>
<th>FYM (t/ha)</th>
<th>Number of branches per plant</th>
<th>leaf dry weight (g)</th>
<th>Yield per plant (kg/ha)</th>
<th>Crude protein content (%)</th>
<th>Dry matter content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>6.07 b</td>
<td>63.02 b</td>
<td>257.2 c</td>
<td>7.95 b</td>
<td>21.77 a</td>
</tr>
<tr>
<td>20</td>
<td>7.05 ab</td>
<td>86.72 ab</td>
<td>25720 b</td>
<td>8.01 b</td>
<td>21.70 a</td>
</tr>
<tr>
<td>40</td>
<td>9.02a</td>
<td>107.7 a</td>
<td>34040 a</td>
<td>8.39 a</td>
<td>20.76 a</td>
</tr>
</tbody>
</table>

Duncan ns ** ns ns ns ns

Comparison with the Duncan test (P<0.05). ns: no significant * and **: Significant at 5% and 1% levels. Means with the same letter are not significantly different from each other.

**Table 2.** Means comparison for effects of nitrogen levels on different traits in potato (Solanum tuberosum var. Agria).

<table>
<thead>
<tr>
<th>Nitrogen (kg/ha)</th>
<th>Number of branches per plant</th>
<th>leaf dry weight (g)</th>
<th>Yield per plant (kg/ha)</th>
<th>Crude protein content (%)</th>
<th>Crude ash (%)</th>
<th>Dry matter content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>5.81 c</td>
<td>63.10 c</td>
<td>285.2 b</td>
<td>8.02 b</td>
<td>6.18</td>
<td>19.83 d</td>
</tr>
<tr>
<td>100</td>
<td>7.36 b</td>
<td>78.96 bc</td>
<td>394.7 a</td>
<td>7.94 b</td>
<td>6.24</td>
<td>20.66 c</td>
</tr>
<tr>
<td>200</td>
<td>8.92 a</td>
<td>94.68 ab</td>
<td>475.2 a</td>
<td>8.18 a</td>
<td>6.49</td>
<td>21.33 b</td>
</tr>
<tr>
<td>300</td>
<td>7.44 b</td>
<td>103.9 a</td>
<td>413.9 a</td>
<td>8.33 a</td>
<td>5.45 a</td>
<td>23.81 a</td>
</tr>
</tbody>
</table>

Duncan ns ** ns ns ** ns

Comparison with the Duncan test (P<0.05). ns: no significant * and **: Significant at 5% and 1% levels. Means with the same letter are not significantly different from each other.

**Table 3.** Compared average to the interaction of (FYM) and nitrogen fertilizer on different traits in potato var. Agria.

<table>
<thead>
<tr>
<th>Interaction of (FYM) and nitrogen</th>
<th>Number of branches per plant</th>
<th>leaf dry weight (g)</th>
<th>Yield per plant (kg/ha)</th>
<th>Crude protein content (%)</th>
<th>Dry matter content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 × 0</td>
<td>4.99 e</td>
<td>44.08 e</td>
<td>161.9 g</td>
<td>7.60 f</td>
<td>20.30 cd</td>
</tr>
<tr>
<td>100 × 0</td>
<td>5.88 e</td>
<td>53.33 de</td>
<td>234.2 fg</td>
<td>7.71 ef</td>
<td>6.37 bcd</td>
</tr>
<tr>
<td>200 × 0</td>
<td>7.21 bcd</td>
<td>68.33 cde</td>
<td>330.3 def</td>
<td>8.58 b</td>
<td>6.64 a</td>
</tr>
<tr>
<td>300 × 0</td>
<td>6.22 de</td>
<td>78.33 cd</td>
<td>302.5 efg</td>
<td>7.92 de</td>
<td>6.28 d</td>
</tr>
<tr>
<td>0 × 20</td>
<td>5.88 e</td>
<td>65.55 cde</td>
<td>303.9 efg</td>
<td>7.91 de</td>
<td>6.24 d</td>
</tr>
<tr>
<td>100 × 20</td>
<td>6.66 cde</td>
<td>75.00 cd</td>
<td>389.6 cdef</td>
<td>8.31 c</td>
<td>6.55 ab</td>
</tr>
<tr>
<td>200 × 20</td>
<td>8.77 abcd</td>
<td>96.33 abc</td>
<td>478.6 abcd</td>
<td>7.70 ef</td>
<td>6.29 cd</td>
</tr>
<tr>
<td>300 × 20</td>
<td>6.88 bcd</td>
<td>110.00 a</td>
<td>410.7 bcd</td>
<td>8.12 cd</td>
<td>6.34 bcd</td>
</tr>
<tr>
<td>0 × 40</td>
<td>6.55 cde</td>
<td>79.67 bcd</td>
<td>389.7 cdef</td>
<td>8.56 b</td>
<td>6.37 bcd</td>
</tr>
<tr>
<td>100 × 40</td>
<td>9.35 ab</td>
<td>108.50 ab</td>
<td>560.2 abf</td>
<td>7.80 ef</td>
<td>5.82 e</td>
</tr>
<tr>
<td>200 × 40</td>
<td>10.78 a</td>
<td>119.04 a</td>
<td>616.7 a</td>
<td>8.26 c</td>
<td>6.53 abc</td>
</tr>
<tr>
<td>300 × 40</td>
<td>9.22 abc</td>
<td>123.30 a</td>
<td>528.4 abc</td>
<td>8.94 a</td>
<td>6.75 a</td>
</tr>
</tbody>
</table>

Duncan ns ns ns ns ns

Comparison with the Duncan test (P<0.05). ns: no significant * and **: Significant at 5% and 1% levels. Means with the same letter are not significantly different from each other.
The highest (34040 kg/ha) and lowest (16720 kg/ha) average yield was obtained in 40 t/ha manure and control respectively.

The effect of manure on crude protein content was significant (p<0.001). The highest crude protein content was obtained in 40 t/ha FYM treatment (8.392%). However this treatment has not significant differences with other FYM treatments. Then all FYM treatments located in the same group.

The maximum dry matter content (21.77%) was observed with the control treatment. There were not significant differences among all FYM treatments for this trait (Table 1).

The results of the mean comparison showed that effects of different levels of nitrogen fertilizer on number of branches and leaf dry weight were significant (p<0.01).

Effects of nitrogen fertilizer on potato characteristics
The highest number of branches was obtained in treated with 200 kg/ha N (8.92). The maximum amount of leaf dry weigh (103.90 g) was achieved by 300 kg/ha N treatments. The minimum number of branches (5.81) and leaf dry weight (63.10 g) was obtained in the control. Effect of nitrogen fertilizer on yield per plant was not significant. The highest plant yield was observed in 200 kg/ha N treatment (475.2 g). This level has not significant differences with 100 and 300 kg/ha N treatments. The highest average yield was achieved in 200 kg/ha of nitrogen fertilizer treatments (30890 kg/ha). This treatment has not statistically different with 100 and 300 kg/ha N treatments that showed 25650 and 26900 kg/ha yields respectively (Table 2). Effect of nitrogen fertilizer on the crude protein and crude ash content was significant (p<0.001). The highest crude protein content was obtained in 300 kg/ha treatment. The lowest dry matter content (19.83%) was observed in the control (Table 2).

Effects of FYM and nitrogen interaction on potato characteristics
Mean comparison of the interaction of manure and nitrogen fertilizer on number of branches in potato (Agria cultivar) were not significant. However, the maximum leaf number was obtained in 40 tons of manure and 200 kg/ha N (10.78 values). Effect of manure and nitrogen fertilizer on leaf dry weight and yield per plant was not significant.

The highest leaf dry weight (119.4) and average plant yield (616.7 g) was belong to 40 tons FYM and 200 kg/ha N. However the lowest leaf dry weight (44.08) and average plant yield (161.9 g) was belong to control. The highest yield average (40080 kg/ha) was belong to 40 tons FYM and 200 kg/ha N. However the lowest (10520 kg/ha) was belong to control.

The interaction effects of manure and nitrogen fertilizer on crude protein content was not significant. The highest percent of crude protein (8.947%) was showed in 40 tons FYM and 300 kg/ha N. However the lowest (7.063%) was belong to control (Fig. 1).

Interaction effects of manure and nitrogen fertilizer on the percentage of crude ash content was significant (p<0.001). The highest percent of crude ash content (6.75 %) was showed in 40 tons FYM and 300 kg/ha N. However the lowest (5.93 %) was belong to control (Fig. 1).

Effect of manure and nitrogen fertilizer on dry matter content wasn’t also significant. The maximum percent of crude ash content (23.92%) was demonstrated in 40 tons FYM and 300 kg/ha N. However, this treatment didn’t show and differences with 20 tons FYM and 300 kg/ha N (23.32) and without FYM and 300 kg/ha N (23.19%). Then these three treatments assigned in a same group (Table 3).

Discussion
Researchers have shown that the main bottlenecks in agricultural production especially in arid and semi-arid areas are water and nitrogen. In these areas nitrogen is the first element that its deficiency is considerable. Because in these areas, the amount of soil organic matter that considered as the major source of nitrogen, is low. This deficiency in soil organic matter is related to several parameters such as low
rainfall, unsuitable crop rotation, poor green vegetation and not application of manure and green fertilizers. Therefore the need to use animal manure is feeling more. As the animal manure has high soil water storage capacity, especially at high water requiring crops like potatoes. Application of manure and chemical fertilizers can show a high yield.

Basir et al. (2008) experiment was done on chickpea (Cicer arietinum L.) by application of 0, 15, 25 and 35 t/ha of manure. His results showed that application of 15 tons of manure per hectare of manure showed no significant difference with other treatments. However the greatest biomass and straw yield was obtained is plots that have been treated by 15 t/ha FYM.

The highest average seed yield per plant was achieved in the control group. Sharma (1991) investigated the effect of 5 t/ha manure with different treatments of phosphorus on potato. He reported that manure application increased the yield of potato tubers. Kashi & Hasandokht (1999) reported that if manure increased from 0 to 20 and 30 tons per hectare, tuber weight will be increased from 55.9 to 72.2 g.

The highest and lowest average yield was obtained in 40 t/ha manure and control respectively.

Panahi et al. (2011) highlighted the effect of treatments on yield was significant. The highest yield of 29.33 t/ha of manure treatment was achieved.

Belde et al. (2000) stated that organic fertilizers caused a significant increase in soil organic matter and increase the uptake of zinc, copper, iron, phosphorus, potassium and nitrogen in soil.

Results showed that effect of nitrogen fertilizer on yield per plant was not significant. The highest plant yield was observed in 200 kg/ha N treatment that has not significant differences with other nitrogen treatments.

Prosba (1993) has been reported the average tuber weight increased with increasing nitrogen levels.

The interaction effects of manure and nitrogen fertilizer on percent of crude protein was not significant. The highest percent of crude protein was showed in 40 tons FYM and 300 kg/ha N. However the lowest was belonging to control. The data in Fig. 1 showed that crude protein content is increased by rapidly increasing amounts of manure and nitrogen fertilizer.

Acknowledgements. Our thanks to the authorities of Payman-noor University for providing the financial support for performing this research project. We would also like to appreciate the owner of Dasht-e-Mir Farm, Mr. Mir-aboliathi for this permission and providing necessary facilities for implementing this scientific research project. Thanks to Zagros Bioidea Co. in Razi University Incubator for all supports.

References


