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The effect of farm yard manure and nitrogen fertilizer on some characteristics of potato (*Solanum tuberosum* var. Agria)

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Abstract. To investigate the effects of Farm Yard Manure (FYM) and nitrogen fertilizer on the characteristics of potato crop, an experiment was carried out in split plots based on completely randomized blocks during the crop year 2012-13. The experiment was performed in three replications for each of FYM in three levels (control, 20 and 40 t/ha) and nitrogen fertilizer derived from urea in four levels (control, 100, 200 and 300 kg/ha). The results revealed that the treatment of 40 t/ha of FYM on the total dry weight (204.0 g), average tuber weight (92.58 g), average yield (34,040) respectively were significant ($P<0.01$). It is also proved that treatment effect of 300 kg of nitrogen fertilizer on plant height (59.55 cm), bulb diameter (6.168 cm), total dry weight (203.9 g) and the dry matter (23.81%). The investigation of the interaction effect of FYM and nitrogen fertilizer on potato proved to show no significant differences between the mentioned treatments and the measured characteristics. The 40 t/ha of FYM and 300 kg nitrogen fertilizer resulted in 23.92% of dry matter, 241.2 g of total dry weight, 6.830 cm of bulb diameter, and 70.11 cm of plant height. Furthermore, the 40 t/ha of FYM and 200 kg nitrogen fertilizer resulted in the highest average tuber weight (97.44 g), and the average yield (40080 kg). The results showed that is necessary and inevitable to use FYM in order to achieve the highest performance and to protect the soil from degradation.

Key words: Farm yard manure, nitrogen fertilizer, percent dry matter, potato.

Introduction

Potato (*Solanum tuberosum* var. Agria) is a combination of Quarta and Selula originated from Germany and an average to postmature kind. It is one of the glandular products and has the fifth nutritious significant in rank after wheat, rice, maize, barley. It plays and important role in nourishing the global population (Khajepoor 1997). The low cost of chemical fertilizers and its availability and ease of preparation are considered as the main reasons to ignore the soil fertility increase and its preservation and control processes in 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 2001). It has been common to use FYM for improving the physical, chemical, and biological characteristics of the soil. The effect of FYM on the soil traits lead to an increase in production (Kuepper 2000). The FYM is the most important organic sources of nutrients in Pakistan. Since FYM contains humus, its main effects are on soil and the application of product. It acts as a free source of phytonutrients (Khalil & Jan 2002). Hasandokht (1996) 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). Sharma 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. 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 tubes, 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.

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 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. This study is an attempt to investigate the effects of FYM and nitrogen fertilizer whose origin is from urea on the properties of Agria potato.

Materials and methods

The experiment was performed in Dasht-e-Mir Farm located 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/ha0. Nitrogen fertilizer was added to the plant in three different periods (planting, tuber developing and 15 days after creating tuber). Each subplot consisted of four rows with 75 cm space and the space between the main plots determined 15 m. The planting date was 20 May. The tubes were disinfected by spraying carbendazim before planting. The tubers were harvested in late October, and the following traits of the potato were evaluated by MSTAT-C software: number of leaves, plant height, tuber diameter, total dry weight, average tuber weight, average yield/ha and percentage of dry matter.

Results

The results of the experiments are shown in Tables 1 to 3. The results confirmed that the effect of FYM on leaf numbers

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

FYM (t/ha)	Number of leaves	Plant height (cm)	Tuber diameter (cm)	Total Dry weight (g)	Average tuber weight (g)	Average yield(kg/ha)	Percent dry matter (%)
control	60.36 b	46.91 b	4.850 a	121.3 c	56.66 c	16720 c	21.77 a
20	66.00 b	51.44 ab	4.965 a	170.2 b	78.14 b	25720 b	21.70 a
40	78.27 a	57.75 a	5.527 a	204.0 a	92.58 a	34040 a	20.76 a
Duncan	*	*	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).

Nitrogen (kg/ha)	Number of leaves	Plant height (cm)	Tuber diameter (cm)	Total Dry weight (g)	Average tuber weight (g)	Average yield(kg/ha)	Percent dry matter (%)
control	58.81 b	44.85 c	4.340 b	125.2 b	64.29 b	18540 b	19.83 d
100	67.41 b	49.59 bc	4.814 b	147.2 b	76.37 a	25650 a	20.66 c
200	68.25 b	54.15 b	5.133 b	184.3 a	82.90 a	30890 a	21.33 b
300	68.37 a	59.55 a	6.168 a	203.9 a	79.61 a	26900 a	23.81 a
Duncan	*	**	**	**	**	**	**

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.

(FYM) treatment (t/ha)	Number of leaves	Plant height (cm)	Tuber diameter (cm)	Total Dry weight (g)	Average tuber weight (g)	Average yield(kg/ha)	Percent dry matter (%)
0 * 0	53.55 c	42.67 d	4.250 b	91.22 f	42.75 f	10520 g	20.30 cd
100 * 0	59.44 bc	45.22 d	4.437 b	102.0 ef	54.44 ef	15220 fg	20.85 bcd
200 * 0	65.77 bc	49.55 bcd	5.023 ab	134.2 def	64.97 de	21470 def	21.72 b
300 * 0	62.66 bc	50.22 bcd	5.690 ab	157.7 cd	64.47 de	19670 efg	23.19 a
0 * 20	56.44 bc	44.00 d	4.403 b	131.8 def	66.89 de	19750 efg	20.37 cd
100 *20	63.66 bc	47.89 cd	4.707 b	146.2 cde	77.42 cd	25320 cdef	21.41 bc
200 * 20	75.44 abc	55.55 bc	4.767 b	190.0 bc	85.78 abc	31110 abcd	21.70 b
300 *20	68.44 bc	58.33 b	5.983 ab	212.7 ab	82.47 bc	26690 bcde	23.32 a
0 * 40	66.44 bc	47.89 cd	4.367 b	152.7 cd	83.24 bc	25330 cdef	18.83 e
100 * 40	79.11 ab	55.66 bc	5.300 ab	193.3 bc	97.24 a	36410 ab	19.72 de
200 * 40	93.55 a	57.33 b	5.610 ab	228.8 ab	97.94 a	40080 a	20.56 bcd
300 *40	74.00 abc	70.11 a	6.830 a	241.2 a	91.90 ab	34340 abc	23.92 a
Duncan	ns	ns	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.

and plant height was significant (P<0.05). The Maximum number of leaves (60.36 leaves) and plant height (46.91 cm) obtained in the 40 tons of FYM. The minimum number of leaves and plant height were obtained in the control treatment.

The effect of FYM on total dry weight, average weight and average tuber yield/ha was significant at (P<0.01). The highest total dry weight was achieved in 40 tons of FYM (204.0 g), and the minimum total dry weight (121.3 g) was obtained in the control (Table 1).

Results showed that the application of 15 t/ha of FYM reveals no significant difference with other treatments, but the highest total biomass and straw yield was obtained in treatments 15 t/ha. The highest average yield/ha and average tuber weight obtained in 40 tons of FYM treatments, respectively, with a value of 34040 kg and 92.58 g. The minimum average tuber weight (56.66 g) and average yield/ha (16720 kg) obtained in control treatments. The effect of FYM on tuber diameter and percent dry matter were not significant. The maximum diameter of the tuber was obtained from treatment of 40 t/ha FYM which had the same statistic value as the one with 20 tons of FYM and the control treatments with a value of 4.965 and 4.850 cm. The highest average product (29.33 t/ha) obtained from the application treatment of FYM.

The highest percent dry weight was obtained from controlled treatment with a value of 21.77% which located in the same statistics group was from 20 and 40 t/ha of FYM, respectively, with a value of 21.70 % and 20.76% (Table 1).

Results obtained from the comparison of different levels of nitrogen fertilizer on leaf number were significant (P<0.05). The maximum number of leaves treated with 300 kg of nitrogen fertilizer (68.37) originated from urea value was obtained. The minimum number of leaves of the control treatment was obtained with the value of 58.81 was the treatment of 100 and 200 kg/ha located in the same statistic groups. Nitrogen fertilizer on plant height and diameter of the tubers were significant at one percent level (P<0.01). The

maximum height of plants treated with 300 kg of nitrogen fertilizer (59.55 cm) and the minimum of (44.85 cm) were obtained with control treated. In addition, the maximum tuber diameter was obtained from 300 (kg) of nitrogen fertilizer treatment amounts to 6.168 (cm). The minimum diameter tuber was obtained from the control treated amount of 4.340 (cm) and from 100 and 200 kg nitrogen fertilizer treatment were located in the same statistic groups (Table 2).

The effects of nitrogen fertilizer on total dry weight were significant at one percent level (P<0.01). The results showed the highest total dry weight of 300 (kg) on nitrogen fertilizer treated was obtained from 203.9 (g), and it was located at the same statistic group. This group had similar statistics with nitrogen treat 200 kg/ha amounts to 184.3 (g). The lowest total dry weight was obtained from treatment control (125.2 g) and from treatment of 100 kg/ha nitrogen which had the same statistic values.

The effects of nitrogen fertilizer on average tuber weight and average yield/ha were significant (P<0.01). The results showed the highest average tuber weight of 300 kg nitrogen fertilizer treatments was obtained with a value of 79.61 g that with the 200 and 100 kg nitrogen fertilizer treatments respectively 82.90 and 76.37 g which could be located at the same group from statistical viewpoint. The highest average yield/ha was obtained of 200 kg of nitrogen fertilizer treatment with the value from 30890 (kg/ha). This treatment with treatments of 100 and 300 kg/ha respectively 25650 and 26900 kg/ha were located in the same group as the same statistical values. The effects of nitrogen fertilizer on percent dry matter was significant (P<0.01). The results showed the highest percent dry matter was obtained from the treatment of 300 kg/ha was 23.81%. The lowest percent dry matter was obtained of the control treatment (19.83 %) (Table 2).

The comparison between the average to the interaction of FYM and nitrogen fertilizer on potato var. Agria leaves was not significant. The highest number of leaves was obtained from 40 t/ha FYM and 200 kg/ha nitrogen fertilizer (93.55 leaves). The effect of different levels of FYM and nitrogen fertilizer on plant height and diameter of the tuber was not significant. The highest plant height and tuber diameter were obtained from of 40 tons of FYM and 300 kg of nitrogen fertilizer treatments, respectively, with values of 70.11 and 6.730 cm, and the lowest plant height and tuber diameter were obtained from control treatments, respectively, with values of 42.67 and 4.250 cm (Table 3).

The effect of different levels of FYM and nitrogen fertilizer on total dry weight was not significant. The highest total dry weight was obtained from 40 t/ha FYM and 300 kg/ha nitrogen fertilizer (241.2 g). The effect of different levels of FYM and nitrogen fertilizer on average tuber weight and average yield kg/ha was not significant. The highest average tuber weight was obtained from 40 t/ha FYM and 200 kg/ha nitrogen fertilizer (97.94 g) that with 40 t/ha (FYM) and 100 kg/ha nitrogen fertilizer on amount 97.24 (g) which had the same statistical values (Table 3).

The highest average yield/ha was obtained from 40 tons of FYM and 200 kg nitrogen fertilizer treatments with the value 40080 kg. The effect of different levels of FYM and nitrogen fertilizer on the percentage of dry matter was not significant. The highest percent of dry matter was obtained from 40 t/ha FYM, and 300 kg/ha nitrogen fertilizer (23.92%) that with 20 t/ha FYM and 300 kg/ha nitrogen fertilizer and zero FYM and 300 kg/ha nitrogen fertilizer treatments respectively 23.32 and 23.19 (%) were located in the similar group from statistical viewpoint (Fig. 1).

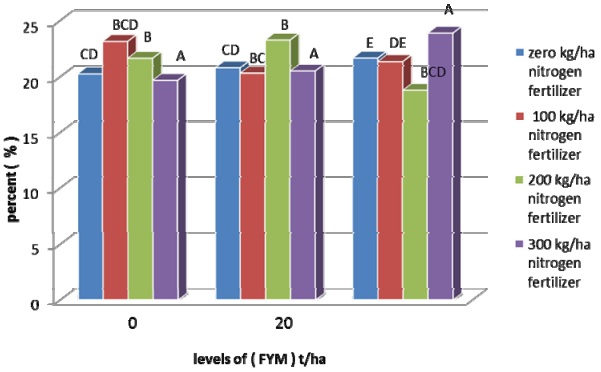

Figure 1. The interaction effect of different levels of (FYM) and nitrogen fertilizer on percent dry matter on potato var. Agria. Means with the same letter are not significantly different from each other.

According to the obtained results, it can be obviously stated that the effects of nitrogen fertilizer on percent dry matter is much more than FYM due to the contribution of them in making plant carbon hydrate and protein.

Discussion

The statistical analysis showed that the effect of FYM on leaf numbers, plant height, total dry weight, average weight and average tuber yield/ha was significant. Akparobi (2009) had a test in *Amaranthus cruentus* by applying 0, 15, 25 and 35 t/ha of FYM. He stated that the FYM application was significant on factors such as plant height, and the number of leaves (P<0.05). Hasandokht (1996) reported the application of tuber in potato increased 30% and 47% respectively when there was an increase in the amount of FYM ranging from 0 to 20 and 30 t/ha. Sharma (1991) also investigated on the effect of 5 tons of FYM with different phosphorus treatments on potato and reported that the application of FYM increased the potato tuber yield.

Abdul Basi (2008) carried out an experiment on *Cicer arietinum* L. by application levels, 0, 15, 25 and 35 t/ha (FYM). Kashi & Hasandokht (1999) reported that by an increase in FYM from 0 to 20 and 30 t/ha, the potato average tuber weight was increased from 55.9 to 72.2 g.

The greatest diameter of the tuber was achieved in 40 t/ha FYM which had the same statistic value as the one with 20 tons of FYM and the control treatments. Khodabakhsh et al (2010) stated that the effect of FYM treatments on yield was significant. The highest average product obtained from the application treatment of FYM.

The least diameter tuber was achieved in the control treatment. Jamaati et al (2009) reported that nitrogen was effective on tuber size and increased tuber weight, but excessive increase in nitrogen caused the reduction of tuber weight. Ankumah et al (2003) reported that the tuber size was effective on the growth period of potato, time tuber formation and nitrogen levels.

The statistical analysis showed the highest average tuber weight of 300 kg nitrogen fertilizer treatments was achieved. Prosba (1993) also reported an increase of tuber weight by increasing the application of nitrogen.

The various researches have proved that shown that nitrogen and water are the main concerns in agricultural production especially in arid and semi-arid areas where nitrogen is the first vital element whose lack is greatly felt. This is mainly due to the fact the amount of organic material of the soil which provides the source nitrogen is low. There are many reasons involved for the shortage of nitrogen including low rainfall, poor crop rotation, poor crop coverage, not applying farm yard manure and green manure. Consequently, it is strongly needed to use FYM which has the capacity of keeping the water for soil, especially for agricultural products like potato which requires a great deal of water. Applying of farm yard manure along with chemical fertilizer together can lead to successful result.

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