

Nutrient Management for Improving Onion Productivity

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Abstract: In present study two onion varieties (Mansehra local and Swat-1) were evaluated against six treatments (T0=control, T1=NPK @120+60+60 Kg/ha, T2= 20 tons FYM+5 tons Poultry manure/ha, T3=40 tons FYM+5 tons Poultry manure/ha, T4= 60 tons FYM+5 tons Poultry manure/ha and T5=80 tons FYM+5 tons Poultry manure/ha) to select suitable concentration/combination of fertilizer to improve onion productivity. The experiment was laid out in Randomized Complete Block Design (RCBD) with split plot arrangement using three replications. Onion varieties were assigned to main plot whereas fertilizer treatments to sub plots. The data were recorded for different traits. Onion variety Mansehra local performed well as compared to Swat-1 in terms of many crop parameters under the agro-climatic conditions of the area. Mansehra local showed higher survival percentage (99.66%), better plant height (60.06 cm), higher number of leaves per plant (12.69 leaves/plant), higher water contents (85.04 %), higher bulb diameter (7.101), higher bulb weight (153.27 g) and higher bulb yield (41.01957 t/ha) than Swat 1. As far as fertilizer treatments are concerned T4 (60 tons FYM+5 tons Poultry manure/ha) was proved to be best fertilizer treatment for most of the agronomic traits. Keeping in view the results, variety Mansehra local and fertilizer treatment T4 were recommended for farming in Mansehra and other areas with similar climatic conditions to increase onion production. This will not only help to improve the economic return and revenue generation of the farmers but also lower the growing onion market prices in the country.

Key words: Swat-1 • Onion • Fertilizer • Bulb • Organic and treatment

INTRODUCTION

Allium is one of the 57 genera of angiosperms that have more than 500 species. It is by far the largest genus in the Amaryllidaceae. Majority of *Allium* species are native to the Northern Hemisphere, mainly in Asia. *Allium cepa* has cylindrical to ovoid or rounded bulbs with coats papery, white to brownish or reddish [1].

Onion besides being used as food is also used as medicine for the treatment of various diseases in different parts of the world [2]. In South Asia especially Pakistan onion is used as important and essential ingredient of a large number of food recipes. Nutritionally onion contains a number of important nutrients and fair amount of energy. It contains 1.6 KJ/g energy, carbohydrates 10%, fats 0.1 %, protein 1%, water 89% and considerable amount on vitamins and minerals. According to FAO

during 2008 Pakistan ranked fourth in onion production. Total production of Pakistan was recorded 2,015,200 tons. China was ranked first with total production of 20,817,295 tons, India stood second with production of 8,178,300 tons and USA ranked third with 3,349,170 tons.

In Pakistan per hectare yield of onion is low (15-17 ton per ha) as compared to the rest of onion producing countries. Major causes of low production are (i) poor varietal selection, (ii) fertilizer mismanagement and (iii) ignoring the area as potential high yield area. Farmers usually depend upon inorganic fertilizers to improve onion yield because modern agricultural practices encourage the use of inorganic fertilizers to boost the crop yield but, it has deleterious effects on soil physiochemistry as well as they are highly expensive. On the other hand organic material like farmyard manure (FYM) enhances plant growth, development and

ultimately yield. Because FYM improve the soil physical, chemical and biological properties along-with the provision of macro and micro nutrients [3].

FYM consists of rotted straw of plants, urine and feces, it enhances water holding capacity, erosion stability and gas exchange of the soil. Conventional FYM contains about 0.73% N, 0.18% P and 0.71% K. In Pakistan, farm yard manure is the most important organic manure. It is estimated that about 1.5 million tones of nutrients are available from farmyard. Moreover the poultry litter is relatively inexpensive source of both macro nutrients (N, P, K, Ca, Mg, S) and micronutrients (Cu, Fe, Mn, B). It also increase soil carbon, Nitrogen content, soil porosity and enhance soil microbiology. As poultry manure have high concentration of nutrients, so addition of proper amount of poultry manure can overcome the crop nutrients requirement [4]. Keeping this in view present study was designed to evaluate the effect of organic and inorganic fertilizer on onion production and to device a proper and balanced combination and scheme of fertilizers to maximize the yield of onion as well as to provide the information and awareness about the yield potential of the area.

MATERIALS AND METHODS

A field experiment was conducted at Agriculture Research Station Baffa, Mansehra during September 2011 to June 2012 in order to find out the effect of inorganic and organic fertilizer on the growth and yield of two onion varieties (Swat 1 and Mansehra Local). The experiment was laid out in Randomized Complete Block Design (RCBD) with split plot arrangement using three replications. Onion varieties were assigned to main plot whereas fertilizer treatments to sub plots. In the present study two onion varieties (Mansehra local and Swat-1) were evaluated against six treatments (T0=control, T1=NPK @120+60+60 Kg/ha, T2= 20 tons FYM+5 tons Poultry manure/ha, T3=40 tons FYM+5 tons Poultry manure/ha, T4= 60 tons FYM+5 tons Poultry manure/ha and T5=80 tons FYM+5 tons Poultry manure/ha).

For nitrogen (N) phosphorus (P) and potassium (K) urea (46% N), single super (20%) phosphate and sulphate of potash (50%) were used as source fertilizer respectively.

Parameters Studied

Survival Percentage: Survival percentage was calculated by dividing the number of plants survived by total number of plants transplanted and then multiplying this with 100.

$$\text{Survival percentage} = \frac{\text{Number of successfully established transplants} \times 100}{\text{Total number of transplants}}$$

Number of Leaves per Plant: Number of leaves was counted when the plants stopped producing further buds. Ten plants were sampled from each replication randomly. As there were three replications for each treatment so a total of 30 samples were recorded and then average values were calculated for each replication.

Plant Height: It was measured from the base of the stem to the top of shoot in centimeters. Ten plants were sampled from each treatment per replication and then averaged.

Days to Maturity: This was taken by using:

$$\text{Days to maturity} = \text{Date of harvest} - \text{date of transplant}$$

Bulb Weight: It was measured in grams and milligrams. Ten plants were sampled from each treatment per replication and then averaged.

Bulb Diameter: This was taken in centimeters with the help of venires caliper. Ten plants were sampled from each treatment per replication and then averaged.

Dry Matter Accumulation: To measure dry mater accumulation an appropriate sample from the bulb was taken and weighed, this was taken as wet weight, then said sample was oven dried at 65°C for 72 hours. Finally dry weight accumulation was measured by:

$$\text{Dry weight accumulation} = \frac{\text{weight of the oven dried sample} \times 100}{\text{Weight of fresh sample}}$$

Total Yield (tons/ha): To calculate total yield the mature crop was harvested and weight of each replication plot was measured. Average weight per plot for each treatment and variety was calculated. Per hector yield was calculated by dividing yield of each plot by plot size and multiplying with 10000.

It was calculated by

$$\text{Total yield per hector in tons} = \text{yield of the plot} \times 10000/8.6$$

Data were recorded by selecting the plants randomly from each treatment plot. The average was calculated for the statistical analysis of different parameters.

Harvesting: The mature bulbs were harvested and collected in June 2012.

Statistical Analysis: Statistical program of IBM Corporation named Statistical Product and Service Solution (SPSS) version 12.0.1 was used for analysis of data.

RESULTS

Survival Percentage: Data presented in the Table 1 showed non-significant differences between two varieties (p 0.09) though, Mansehra local showed better survival percentage 99.66. However, fertilizer regimes were differed significantly at 0.05 level of significance (p<0.000). Table 1 shows that fertilizer treatments T1 and T2 have non-significant difference from each other and T0. While fertilizer treatments T3, T4 and T5 have significant differences from T0 (control). T4 and T5 do not have statistically significant difference. The best results (99.66 %) were produced by T5 followed by T4 (99.58 %). As far as varieties are concerned Mansehra local produced better results with survival percentage value of 99.01%. Moreover, there exists no interaction between variety and fertilizer existed (P 0.574).

Number of Leaves per Plant: The maximum number of leaves (12.06) was recorded with T4 followed by T5 which produced 11.85 leaves per plant. Furthermore there exists no significant difference among all other treatments except control (p 0.043). Significant difference is there between varieties and Mansehra local is the superior variety with average 12.69 leaves/plant. No interaction was observed between two factors (Table 1)

Plant Height: Statistical analysis revealed that there exists significant difference among different fertilizer applications. All other fertilizer treatments differ significantly over control. T1 differed non significantly from T2 which itself showed non-significant difference with T3. T3 was observed to non significantly different with T4 which has the same relation with T5. Significant differences were observed between T1 and T3, T2 and T4. In all 66.78 cm was the maximum height produced with T5 followed by 56.56cm produced under T4. Furthermore it was observed that there was not any significant differences between two varieties (P 0.164). Mansehra local was observed to be the better variety with average plant height of 60.06 cm. No interaction was observed two factors (P 0.185 (Table 1).

Table 1: Survival %age, Number of leaves per Plant, Plant Height, Days to maturity, Dry matter accumulation, Bulb Diameter, Bulb weight and Total yield

		Treatments						
		T0	T1	T2	T3	T4	T5	Mean
Survival % age	Swat 1	98.03	98.1	98.3	98.93	99.6	99.43	98.73 a
	Mansehra local	98.1	98.93	98.76	98.8	99.73	99.73	99.01 a
	Mean	98.06 a	98.51 ab	98.53 ab	98.86 b	99.58 c	99.73	NS
Number of leaves per Plant	Swat 1	08.96	10.43	10.43	10.46	11.13	10.90	10.38 a
	Mansehra local	11.06	12.56	12.60	12.73	13.00	12.80	12.69 b
	Mean	10.016 a	11.50 b	11.51 b	11.60 b	12.06 b	11.85 b	P 0.000
Plant Height	Swat 1	46.20	54.93	59.60	60.70	63.66	69.73	58.15 a
	Mansehra local	41.70	55.33	59.16	67.00	67.46	66.78	60.06
	Mean	43.95 a	55.13 b	59.38 bc	63.85 cd	65.56 d	68.25 d	NSP.164
Days to maturity	Swat 1	184	184	182	180	180	179	181.55 a
	Mansehra local	181	180	178	175	175	174	177.38 b
	Mean	182 a	182 a	180 b	177.83 c	177.83 c	176.66 c	P 0.000
Dry matter accumulation	Swat 1	16.87	18.097	16.979	17.381	17.392	16.368	17.182 a
	Mansehra local	15.587	16.626	14.029	12.974	14.737	15.819	14.962 b
	Mean	16.231 a	17.361 a	15.504 a	15.177 a	16.065 a	16.093 a	NS
Bulb Diameter	Swat 1	5.403	5.700	6.593	6.690	7.053	7.300	6.457
	Mansehra local	5.953	6.706	7.050	7.173	7.376	8.343	7.101
	Mean	5.678 a	6.203 a	6.822 b	6.932 b	7.215 bc	7.822 c	P 0.001
Bulb weight	Swat 1	74.793	84.693	124.350	131.073	156.058	181.116	125.347a
	Mansehra local	92.180	129.873	154.996	159.856	163.256	219.463	153.27 b
	Mean	083.49 a	107.28 ab	139.67 bc	145.46 c	159.66 c	200.29 d	P=0.005
Total yield	Swat 1	11.627825	15.891423	26.356593	29.844966	36.039853	36.0398	25.966 a
	Mansehra local	15.89148	29.84497	41.07862	48.06203	57.36436	53.8758	41.019 b
	Mean	13.7597 a	22.8682 b	33.7176 c	38.9535cd	46.7021 d	44.957d	P =. 000

Values followed by same letter are not different significantly

Days to Maturity: The results indicated significant differences among different fertilizer regimes as well as between two varieties used. While, there existed no significant interaction between two factors. Mansehra local was proved to be better variety as it matured earlier (177 days) perhaps due to efficient utilization of nutrients. Furthermore, it was found that plant matured earlier as the fertilizer application was increased. Best time (176.66 days) was taken by crop treated with T5 followed by (177 days) T4 and T3. There was no difference between T0 (Control) and T1, all other treatments differ from them significantly. T2 has significant difference with all other treatments. T3, T4 and T5 did not have significant difference (Table 1).

Percent and Total Dry Matter Accumulation: Analysis reflects no significant differences among different fertilizer treatment (P 0.469). While significant differences between two varieties (p. 002) and there is no interaction between two factors (P 0.56). The maximum dry matter 17.36 % was obtained under T1 followed by T0 (Control) which produced 16.23 % dry matter. Swat 1 was proved to be superior variety and gave 17.182% dry matter (Table 1).

Bulb Diameter: Data in Table 1 showed significant differences between two varieties and non significant differences among different regimes of fertilizer but there is no any significant interaction between two factors. Mansehra local was superior variety as far as average bulb is concerned. It produced 7.101 cm bulb diameter. Maximum average bulb diameter (7.822 cm) was achieved under T5 followed by T4 which gave bulb diameter of 7.215 cm. The differences between these two applications are not significant at alpha level 0.05. T1 produced bulb diameter 6.203 cm which are statistically similar to control 5.678 cm. All organic regimes produced bulb diameters both numerically and statistically different from control and inorganic regimes. Furthermore statistical results show that there is no any significant interaction between two factors (p 0.752)

Bulb Weight: Results indicated significant differences between two varieties at alpha level. 05 and. 01 (P= 0.005). Variety Mansehra local is superior in context of bulb weight. It produced bulb with average weight of 153.27g compared to Swat 1, having bulbs with average weight of 125.347 grams. As far as fertilizers are concerned inorganic fertilizer application T1 has non-significant difference from control, while all organic doses produced bulb weights significantly different from control. The maximum average bulb weight 200.29g was produced with organic fertilizer

T5, followed by T4 which produced bulbs with an average weight of 159.66 grams. There exists significant differences between these two fertilizer applications (Table 1).

Total Yield: Statistical analysis showed that two varieties have significant differences in yield at alpha levels 0.05 and 0.01. Moreover, Mansehra Local is proved to superior variety which gave an average yield of 41.01957 tons / ha as compared to Swat 1, which gave average yield of 25.96675 tons / ha. Furthermore, there exists significant differences between different fertilizer treatments. All fertilizer applications differed significantly from control group. The maximum yield 46.7021 ton / ha was achieved under organic regime T4, followed by 44.9579 tons /ha which was obtained with T5 which clearly indicated that further increase in organic fertilizer application negatively affects the total yield. Further fertilizer application in Swat 1 has no effect on yield while, on Mansehra local it decreases the yield. No interaction exists between fertilizer and variety. The least average yield was achieved with T0 (control) group in which no fertilizer was applied (Table 1).

DISCUSSION

Results and statistical analysis of present work reveal that application of inorganic fertilizer NPK and organic fertilizers i.e. poultry manure+FYM increased the survival percentage significantly at alpha level 0.05. Moreover increase in fertilizer has linear positive effect on transplantation survival and best results 99.66 % were achieved with T5. These results are in conformity with Ghafoor *et al.*, [5] who reported that increase in fertilizer rate linearly increase the survival percentage. Moreover, it was found that the two varieties has non-significant difference on survival percentage after transplantation though, Mansehra local was found to be better variety with 99.01 % survival rate. This was in conformity with the findings of Sajid *et al.*, [6], who concluded that onion cultivars have insignificant effect on survival percentage.

Fertilizer application has significant effect on number of leaves. The maximum number of leaves 12.06 was recorded under T4 followed by T5 which produced 11.85 leaves per plant. All fertilizer treatments significantly differed from control, but there wasn't any significant difference among other treatments at 0.05 level of significance. These results were differed from Ghafoor *et al.*, [5] and Bangali *et al.*, [7] who deduced that number of leaves has linear significant difference with increasing

fertilizer treatment. Mansehra local was proved to be statistically superior variety over Swat 1, with 12.69 leaves per plant. These results are at par with Ghafoor *et al.*, [5] who reported significant differences among three onion varieties though Shah Alam gave maximum number of leaves.

Plant height was significantly affected by fertilizer application; the maximum average plant height (66.78 cm) was observed under T5 followed by T4. These results are also at par with the findings of Bangali *et al.*, [7]. Moreover there was no significant difference between two varieties at 0.05 level of significance although Mansehra local produced better numerical results. These findings deviate from Islam *et al.*, [8] who found significant difference between different varieties and recorded best result with Pussa red. Results also deviated from the findings of Ghafoor *et al.*, [5] who reported significant difference among different onion varieties and found Phulkara being superior. These deviations are probably due to the difference in climatic conditions and the varieties used. As far as days to maturity are concerned results indicate significant differences among different fertilizer regimes as well as between two varieties used. Mansehra Local was proved to be superior variety as it took less time i.e. 177 days till maturity. Furthermore, it was noted that increasing fertilizer rate has linear inverse effect on time take to maturity i.e. crop under increased fertilizer regimes matures because of better nutrient utilization.

Dry matter accumulation in bulb was not significantly affected by organic fertilizer, although numerically percent dry matter accumulation decreased with increasing levels of organic fertilizer. Results of this study indicated that there exists significant differences between two varieties (p 0.002) and there is no interaction between two factors (P 0.56). The maximum dry matter 17.36 % was obtained under T1 followed by T0 (Control), which produced 16.23 % dry matter. One thing must be made clear here that percent dry matter does not reflect nutrient uptake which is reflected by total dry matter per area of land. In terms of total dry matter there is a linear increase with increasing rate of fertilizer and Mansehra local is a far more superior variety. Swat 1 was proved to be superior variety and gave 17.182% dry matter. Apparently these findings reflect deviation from rest of the parameters but in fact percentage dry matter is not the absolute amount of dry matter rather amount of dry matter in relation to moisture contents of the bulb. Dry matter percent decreased non-significantly with increasing fertilizer. These are in accordance with the findings of Abdelrazzaq [9] who

reported that maximum dry matter 17.6 % was recorded with control. The minimum dry matter 15.6 % was reported with sheep manure. These results are also in conformity with Magdi *et al.*, [10].

There was a linear effect of fertilizer treatment on bulb diameter. Maximum average bulb diameter (7.822 cm) was achieved under T5 followed by T4 which gave bulb diameter of 7.215 cm. The differences between these two applications are not significant at alpha level 0.05. The minimum bulb diameter 5.678 cm was produced under control treatment which was not significantly different from average bulb size produced under T1 inorganic regime. These findings are in conformity with Boyhan and Hill, [11] who reported that there is a linear increase in plant diameter within creasing poultry litter. Similar results he concluded chicken manure to be the best fertilizer treatment for bulb diameter Magdi *et al.*, [10]. On the other hand there exists no significant difference between organic and inorganic fertilizers as reported by Yoldas *et al.*, [12]. Mansehra local was proved to be superior variety as far as average bulb is concerned. It produced 7.101 cm bulb diameter.

Bulb weight data indicate that there is a significant difference between two varieties at alpha level. 05 and. 01 ($P < 0.005$). Variety Mansehra local is superior variety with average bulb weight 125.347 g compared to Swat 1, which produced bulbs with average weight of 92.18 grams. Inorganic fertilizer treatment has no significant difference with control treatment while organic treatments show significant increase over control. The maximum bulb weight was produced with T5 followed by T4. Similar results were given by Magdi *et al.*, [10] who concluded organic manures to be superior over inorganic in bulb weight production. Bengali *et al.* also reported an increase in bulb weight with different organic fertilizers. Our findings showed that organic fertilizer should be preferred for better sized bulbs.

Data analysis regarding total yield reveals a significant differences among two varieties at alpha level 0.05 and 0.01. Mansehra Local was superior as it produced average yield of 41.01957 tons / ha compared to Swat 1, which gave average yield of 25.96675 tons / ha. All fertilizer applications were differed significantly compared to control group. The maximum yield 46.7021 ton / ha was achieved under organic regime T4 (60 tons FYM+5 tons Poultry manure/ha), followed by 44.9579 tons /ha which was obtained with T5 (80 tons FYM+5 tons Poultry manure/ha). These findings are in line with those obtained by Yoldas *et al.*, [12] who reported that with the increase in dose of nitrogen up to 120 kg N ha⁻¹ the yield t ha⁻¹

was increased, but below this level the total yield $t\ h^{-1}$ begins to decrease. The maximum yield (20.11 t/ha) was produced in 120 $kg\ N\ ha^{-1}$ closely followed by 160 and 200 $kg\ N\ ha^{-1}$ with 19.55 and 18.27 $t\ ha^{-1}$, respectively.

Our findings revealed that Mansehra Local is better and suitable variety for Mansehra and other areas with similar climatic conditions to increase onion production. This will not only help to improve the economic return and revenue generation of the farmers but also lower the growing onion market prices in the country. Fertilizer treatment T4 showed best results for most of the parameters and it is a best substitute for chemical fertilizer. It is advisable to use organic fertilizer in this proportion to get maximum yield, to conserve energy, save foreign exchange, uplift the livelihood of farmers and to improve soil structure and texture and its sustainable use.

REFERENCES

1. Huxley, A., M. Griffiths and M. Levy, 1992. The New Royal Horticultural Society Dictionary of Gardening. The Macmillan Press, Limited: London. The Stockton Press: New York.
2. Shaheen, A.M., M.M. Abdel-Mouty, A.H. Ali and F.A. Rizk, 2007. Natural and Chemical Phosphorus Fertilizers as Affected Onion Plant Growth, Bulbs Yield and its Some Physical and Chemical Properties. Australian Journal of Basic and Applied Sciences, 1(4): 519-524.
3. Augusti, K., 1996. Therapeutic values of onion and garlic. Ind. J. Exp. Bio, 34(7): 634-640.
4. Ghosh, P.K., P. Ramesh, K.K. Bandyopadhyay, A.K. Tripathi, K.M. Hati, A.K. Misra and C.L. Acharya, 2004. Comparative effectiveness of cattle manure, poultry manure, phosphocompost and fertilizer-NPK on three cropping systems in vertisols of semi-arid tropics. Indian Institute of Soil Science. Bhopal. India. Bio.Resource. Tech., 95: 77-83.
5. Ghafoor, A., M.S. Jilani, G. Khaliq and K. Waseem, 2003. Effect of different NPK levels on the growth and yield of three onion (*Allium cepa* L.) cultivars. Asian J. Plant Sci., 2(3): 342-346.
6. Sajid, M., A. Rub, S.T. Shah, I. Jan, I. huq, B. Haleema, M. Zamin, R. Alam and H. Zada, 2012. humic acids effect on bulb production of onion cultivars. Afr. Jr. Microbiol, Res., 6(28): 5769-5776.
7. Bangali, A.N., H.B. Pati, V.P. Chimmad and P.L. Patil, 2012. Effect of inorganics and organics on growth and yield of onion (*Allium cepa*L.). Karnataka J. Agric. Sci., 25(1): 112-115.
8. Islam, M.K., M.F. Alam and A.K.M.R. Islam, 2007. Growth and Yield Response of Onion (*Allium Cepa* L.). Genotypes to Different Levels of Fertilizers. Bangladesh J. Bot., 36(1): 33-38.
9. Abdelrazzaq, A., 2002. Effect of Chicken Manure, Sheep Manure and Inorganic Fertilizer on the Yield and Nutrient Uptake By Onion. Pak. J. Bio. Sci., 5(3): 266-268.
10. Magdi, A., A. Mousa and M.F. Mohamed, 2009. Enhanced yield and quality of onion (*Allium cepa* L C.V Giza 6) produced using organic fertilization. Assuit. Univ. Bull. Environ. Res., 12(1): 9-18.
11. Boyhan, G.E. and C.R. Hill, 2008. Organic Fertility Sources for the Production of Short-day Organic Onion Transplants. Horttechnology, 18(2): 227-231.
12. Yoldas, F., S. Ceylan, N. Mordogan and B.C. Esetlili, 2011. Effect of organic and inorganic fertilizers on yield and mineral content of onion (*Allium cepa* L.). Afr. J. Biotechnology, 10(55): 11488-11492.