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Effect of inorganic NP fertilizers and vermicompost on growth, seed yield and yield components of onion (*Allium cepa* L.) at Maitsebri, northern Ethiopia

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The NP fertilizer or organic resources alone may not provide sufficient amounts or may be unsuitable for alleviating specific constraints to crop production. Therefore, a field experiment was conducted at Maitsebri Research Station of Shire-Maitsebri Agricultural Research Center (SMARC) to study the effect of inorganic NP fertilizers and vermicompost on growth, seed yield and yield components of red onion (*Allium cepa* L.) variety during 2016/17 dry season under irrigation. The treatments consisted of five NP fertilizer rates {0, 25, 50, 75 and 100% of recommended NP rates (69 kg N and 92 kg P_2O_5 ha^{-1})} and four rates of vermicompost (0, 2.5, 5.0, 7.5 t ha^{-1}). The experiment was laid out in a factorial arrangement using randomized complete block design (RCBD) with three replications. Results of the analysis revealed that the interaction effects on inorganic NP fertilizer and vermicompost significantly ($P<0.05$) affected plant height. Days to bolting, days to 50% flowering, flower stalk diameter and days to maturity were significantly ($P<0.05$) affected by the main effect of NP fertilizer rates and vermicompost. Similarly, numbers of umbels per plant, umbel diameter, number of seeds per umbel and seed weight per umbel were significantly affected by the main effect of NP fertilizer rates and vermicompost. The highest seed yield per hectare (1462.5 kg ha^{-1}) was obtained from the plants grown at 75% of RDF with vermicompost at 2.5 t ha^{-1} which was about 263% higher than seed yield from unfertilized control plot. It can, thus, be concluded that the combined application of 75% of RDF with vermicompost at 2.5 t ha^{-1}can improve growth, seed yield and yield components of Bombay red onion variety in the study area.

Key words: Growth, onion, NP fertilizers, parameters, seed yield, vermicompost.

INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important vegetable crops commercially grown in the world. Seed production is a vital part in onion growing and is highly specialized business. About 9,745.36 tons of onion seed was produced in the world (FAO, 2013). In Asian Vegetable Research and Development Center (AVRDC)

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Africa Regional Program a yield of onion seed 0.5 to 0.6 t ha^{-1} is considered as average. However under favorable conditions, yields up to 2.0 t ha^{-1} are achieved (Chadha et al., 1997). In Ethiopia onion seed yield of average 1.0 to 1.3 t ha^{-1} (Lemma et al., 2006) and also 1.3 - 2.0 t ha^{-1} has been reported (Nikus and Fikre, 2010).

The nutrient management paradigm acknowledges the need for both inorganic NP and organic inputs to sustain soil health and crop production due to positive interactions and complementarities between them (Sanchez and Jama, 2001; Vanlauwe et al*.,* 2002). It is a strategy that incorporates both inorganic NP and organic inputs plant nutrients to attain higher crop productivity, prevent soil degradation, and thereby helps meet future food supply needs (Vanlauwe et al., 2002; Place et al., 2003). This is due to practical reasons as fertilizer or organic resources alone may not provide sufficient amounts or may be unsuitable for alleviating specific constraints to crop production (Sanchez and Jama, 2001). Especially, vermicompost with inorganic NP fertilizers is one of the promising techniques for improving soil fertility and increasing vegetables production (Kachapur et al., 2001; Linus and Irungu, 2004).

Despite increase of area of coverage, the productivity of onion in Ethiopia is much lower than the expected production level. The bottleneck problem for high production and productivity is lack of adaptable high yielding varieties, lack of proper soil fertility management practice and other agronomic practices, diseases and insects etc. The problem of farmers throughout the country is that they have little knowledge on the optimum amount of NP fertilization and advantage of incorporating organic fertilizer, especially vermicompost, with inorganic fertilizer for the production of bulb, as well as seed of onion (Zende et al*.,* 1998; Nikus and Fikre, 2010). Farmers in Tigray, particularly in Northwestern Zone of Tigray also faced problems similar to other farmers in the country. Therefore, the aim of this research was to study the effect of inorganic NP fertilizers and vermicompost on growth, seed yield and yield components of onion under irrigation at Maitsebri, Northern Ethiopia.

MATERIALS AND METHODS

Description of the study area

The field experiment was conducted at the Research Station of Shire-Maitsebri Agricultural Research Center during the dry season of 2016/2017. The experimental site is located 85 km from Shire along the way Shire to Gondar and lies at 13°05'N and 38°08'E and at an elevation of 1,304 m above sea level. The mean annual temperature ranges between a minimum of 15.7°C (November-January) and a maximum of 36.6°C (February-May). It is a low altitude area with an average 5 years annual rainfall of 1,296.5 mm.

Description of the experimental materials

'Bombay Red' onion variety was used for the study. This variety can grow at an altitude of 700-2000 m.a.s.l. and it takes 110-120 days for seed production by bulb-to-seed method (Rahim et al., 1982; EIAR, 2012). Bombay Red is one of the most commonly and widely used variety in Tigray region. The sources of the NP fertilizers were urea (46% N) and Triple Super Phosphate (TSP) (46% P_2O_5) for supplying nitrogen and phosphorus, respectively. The vermicompost was obtained from Shire Soil Research Center.

The treatments comprised of 4 × 5 factorial combinations of vermicompost (0, 2.5, 5.0 and 7.5 t ha^{-1}) and NP fertilizers {0, 25, 50, 75 and 100% of recommended NP rates (69 kg N and 92 kg P_2O_5 ha^{-1})}. The treatments were replicated three times and laid out in a randomized complete block design. Onion bulbs were planted in double rows; the spacing between furrows was kept at 50 cm, between the double rows 30 cm and between plants 20 cm (EARO, 2004).

Experimental procedure and field management

The planting materials collected from Kobo-Alamata were medium sized bulbs of uniform diameter (4-5 cm), which were free from insect, disease and mechanical injuries, twins or split and very large bulbs were discarded. Before planting, the biological material was kept in storage house on wooden shelves for 15 days. For final planting, only the bulbs which were free from diseases, non-early sprouts and non-splitter were selected during the 15 days storage period. Also, prior to planting, one fourth of the bulb tops were sliced off to promote sprouting (Sukprakarn et al., 2005).

The selected bulbs were planted on 10 October 2016, planting time for bulb to seed method most commonly used in Ethiopia. All of the phosphorus fertilizer rates in the form of triple superphosphate (TSP) and vermicompost were applied once along the rows at planting. Urea as nitrogen source was applied in split application where half rate was applied at planting and the other half a month after emergence placed in rows along the onion plants at five centimeters away from the plants and covering with a five centimeters thick soil.

A 2.5 m × 2.8 m (7.0 m^2) gross plot size was used for each experimental unit. There were five double rows per plot and 28 plants in single double row. The blocks were separated by 1.5 m width whereas the space between each plot within a block was 1.0 m. The plots were irrigated as per the recommendation for the area, that is, at the interval of three days during the first phase of active growth of the plant. Later, the irrigation gap was increased to seven days interval (Lemma and Shimelis, 2003). Hoeing was done manually and the field was kept free of weeds throughout the growing period. For the control of diseases, such as purple blotch (*Alternaria porri*) and downy mildew (*Perenospora destractor*), Ridomil Gold 68WP at 2.5 kg ha^{-1} and Thilt 250 EC at 400 ml ha^{-1} were applied. For control of thrips (*Thrips tabaci*), Dimethoate spray at 20 ml 15 L^{-1} water was used (Nikus and Fikre, 2010).

Harvesting was started when over 50% of black seeds were exposed on an umbel and was done by hand three times, as all umbels per plant do not mature at one time due to difference in the stalks flowering. The umbels were dried on canvas and threshed by hand. The seeds were separated from stalks and other debris by winnowing and the chaff seeds were separated from well filled seeds by soaking seeds in water filled in buckets. The floating seeds were discarded as chaffy seeds because they were hollow and unable to sink in water while the sinking ones were considered as well filled and viable. The sinking seeds were dried under shade to 8% moisture content, weighted and recorded as seed weight per plot (Nikus and Fikre, 2010).

Data collection

Data were collected from the entire four double rows excluding the two extreme single rows on both sides. From each double row, two stalks and per plot also eight stalks were randomly taken for data collection. Growth, seed yield and yield components of onion seed were collected from 8 randomly selected and pre-tagged plants from the four central double rows of each plot:

Days to bolting: This was recorded as the number of days from date of planting up to when 50% of the plants in a plot produced flower stalk.

Days to 50% flowering: This was recorded as the number of days from date of planting up to when 50% of the flower stalks in each plot produced flowers.

Days to maturity: This was recorded as the number of days from date of planting up to when 50% of the plants in each plot matured or ready for harvest (when the seed colour changed to black or the capsule turned brown and started splitting).

Plant height (cm): This refers to the mean height of 8 randomly selected plants from the central rows from each plot. It was measured from the soil surface to the tip of the plant after development of umbels of the plant.

Flower stalk diameter (cm): This was measured for 8 randomly selected plants from the central rows from each plot at flowering stage and the average was calculated to record the parameter.

Number of flower stalks per plant: Numbers of flower stalks of the 8 randomly selected plants per plot from 4 double central rows was counted and the average calculated and recorded as the number of flower stalks per plant.

Number of umbels per plant: Numbers of umbels from the 8 randomly sampled plants was counted and the average calculated and expressed as the number of umbels per plant.

Umbel diameter (cm): This refers to the mean umbel diameter of the 8 randomly sampled plants in each plot. The diameter was measured using a ruler or a caliper two times measuring in two opposite direction (north-south and east to west).

Number of seeds per umbel: Five umbels were randomly taken from the 8 randomly sampled plants in each plot, dried, threshed and then counted to obtain number of seeds per umbel.

Seed weight per umbel (g): Five randomly sample umbels were harvested, dried, threshed to determine seeds weight per umbel and adjusted to a moisture content of 8%; the average weight of seed per umbel was calculated by dividing the total weight of seeds to number of the umbels.

Seed yield (kg ha^{-1}): The yield was estimated from seed yield per plot.

Statistical analysis: All collected data in this study were subjected to analysis of variance (ANOVA) following a procedure appropriate to a randomized complete block design using Gen Stat 14th edition statistical software according to Gomez and Gomez (1984). Mean comparison was done using least significant difference (LSD) at 5% probability level.
The statistical model used for analysis of the data collected from the experimental field is given by:

$$Y_{ijk} = \mu + A_i + B_j + \varepsilon_{ijk}$$

Where:

Y_{ijk} = the response variable
μ = Overall mean
A_i = Effect of factor A (NP fertilizer),
B_j= Effect of factor B (Vermicompost),
ε_{ijk} = Treatment error of factor A (NP fertilizer) and factor B (Vermicompost) and replication as block K.

RESULTS AND DISCUSSION

Days to bolting

Days to bolting was significantly ($P<0.05$) affected by the main effect of NP fertilizer rates and by vermicompost. Bombay Red onion variety bolted early (about 5 to 8 days earlier) when it was grown at NP fertilizer rate of 50% of RDF compared to the control plots that did not receive NP fertilizer rate (70 days). There was no significant difference among plants treated with 50, 70 and 100% RDF NP fertilizer rates (Table 1).

Similarly, increasing the rate of vermicompost from nil to 5.0 t ha^{-1} was decreasing days to bolt three days (Table 1). Vermicompost can be described as a complex mixture of earthworm feces, which when added to the soil or plant growing media accelerates the development of vegetable crops (Lazcanoa and Dominguez, 2011). It has a positive effect on vegetative growth, stimulating shoot and root development of potato and okra (Edwards et al., 2004; Yourtchi et al., 2013; Mal et al., 2013).

Days to 50% flowering

Days to 50% flowering were significantly ($P<0.05$) affected by the main effects of NP fertilizers and by vermicompost. The earlier days to 50% of flowering were attained in plants grown at 50, 75, 100 and 25% of RDF NP fertilizer rates with no significant difference among them while the delayed 50% days of flowering was in plants grown with no NP fertilizer application (Table 1).

In agreement with present result, Ali et al. (2007) and Law-Ogbomo and Egharevba (2009) reported that nitrogen and phosphorous fertilizers have enhanced days to 50% flowering. This might be due to metabolic and physiological activities that increase respiration and growth of the plant (Suthar, 2012).
Increasing the rate of vermicompost (VC) from nil to 7.5 t ha^{-1} decreased days to 50% flowering by three days compared to the control with no significant difference among the VC levels (Table 1).

Days to maturity

Days to maturity were other growth parameters of seed onion. The obtained results were shown to be highly and significantly ($P<0.01$) influenced by the main effects of NP fertilizer. Bombay Red onion variety seed maturity

Table 1. Phenology and growth parameters of onion seed as affected by NP fertilizers and vermicompost.

Inorganic NP fertilizer (% of RDF)	Days to Bolting	Days to 50% Flowering	Days to 50% maturity	Flower stalk diameter (cm)
0	70.42^{c}	90.08^{b}	127.7^{a}	1.233^{c}
25% of RDF	65.17^{b}	86.17^{a}	127.7^{a}	1.348^{b}
50% of RDF	62.50^{a}	83.58^{a}	127.2^{a}	1.463^{a}
75% of RDF	62.83^{a}	84.67^{a}	128.8^{a}	1.503^{a}
100% of RDF	62.75^{a}	84.67^{a}	133.3^{b}	1.473^{a}
LSD (5%)	1.847	2.498	1.970	0.0720
VC (t ha^{-1})				
0	66.07^{b}	87.93^{b}	128.9^{a}	1.290^{b}
2.5	64.60^{ab}	84.93^{a}	128.3^{a}	1.440^{a}
5.0	63.60^{a}	84.87^{a}	128.7^{a}	1.423^{a}
7.5	64.67^{ab}	85.60^{a}	130.1^{a}	1.463^{a}
LSD (5%)	1.652	2.234	NS	0.0644
CV (%)	3.5	3.5	1.8	6.2

Means followed by the same letter in the same columns are not significantly different at 5% probability level according to least significant difference (LSD (5%)). RDF = recommended dose of fertilizer, N = Nitrogen, P = Phosphorus, VC = Vermicompost, NS = non-significant.

Table 2. Plant height (cm) of onion seed as affected by NP fertilizers and vermicompost.

VC (t ha^{-1})	Inorganic NP fertilizer (% RDF)				
	0	25% RDF	50% RDF	75% RDF	100% RDF
0	68.27^{e}	75.53^{d}	74.27^{d}	75.43^{d}	75.40^{d}
2.5	75.73^{cd}	79.67^{bcd}	87.57^{a}	79.37^{bcd}	82.63^{ab}
5.0	74.30^{d}	81.40^{bc}	86.80^{a}	78.23^{bcd}	77.53^{bcd}
7.5	76.77^{cd}	75.50^{d}	77.43^{bcd}	78.40^{bcd}	80.00^{bcd}

LSD (5%) = 4.837; CV (%) = 3.8. Means with the same letter(s) in the table were not significantly different at 5% probability level according to least significant difference. LSD (5%) = least significant difference at P = 0.05, CV (%) = Coefficient of variation in percent, VC = vermicompost, N = Nitrogen, P = Phosphorus, RDF= Recommended Dose of Fertilizer.

was significantly delayed when grown at 100% of RDF NP fertilizer (133.3 days), a delay of 4 to 6 days compared to lower NP fertilizer rates and the control which did not show significant differences among them (Table 1). The delay in maturity at high rates of NP fertilizer application could be possibly due to the fact that those elements affect the supply of carbohydrate during the critical period of reproductive phase through reduction of sugar concentration in the leaves during the early ripening stage and inhibition of the translocation of assimilated products to the seed (Marschner, 1995).

Plant height (cm)

The interaction effect of NP fertilizer and vermicompost had significantly ($P<0.05$) influenced plant height. Application of 50% of RDF NP fertilizer with 2.5 and 5.0 t ha^{-1}vermicompost had recorded maximum plant height (87.57 and 86.80 cm), which were 27.1 and 28.3% respectively taller than plants that did not receive the NP fertilizer and vermicompost (Table 2). Gonzalez et al. (2001) reported that inorganic fertilizer and organic manure supplied all the essential nutrients at growth stage resulting in increase of measured variables like the plant height. Suthar (2012) concluded that the combination of vermicompost with chemical fertilizer increased the budget of essential soil micronutrients and promotes microbial population, which ultimately promotes the plant growth and production at sustainable basis.

Flower stalk diameter (cm)

Flower stalk diameter was highly and significantly ($P<0.01$) influenced by the main effect of NP fertilizers as well as vermicompost. Bombay Red onion variety flower stalk diameter was highest (1.503 cm) when grown at

Table 3. Yield components of onion seed as affected by NP fertilizers and vermicompost.

Inorganic NP fertilizer (% of RDF)	Number of flower stalks per plant	Number of umbels per plant	Umbel diameter (cm)
0	5.04[c]	5.04[c]	5.04[b]
25% of RDF	5.45[b]	5.45[b]	5.38[a]
50% of RDF	5.93[a]	5.93[a]	5.68[a]
75% of RDF	5.73[ab]	5.73[ab]	5.69[a]
100% of RDF	5.62[ab]	5.62[ab]	5.58[a]
LSD (5%)	0.349	0.349	0.321
VC (t ha^{-1})			
0	5.22[b]	5.22[b]	5.21[b]
2.5	5.63[a]	5.63[a]	5.48[ab]
5.0	5.73[a]	5.73[a]	5.63[a]
7.5	5.64[a]	5.64[a]	5.59[a]
LSD (5%)	0.313	0.313	0.288
CV (%)	7.6	7.6	7.1

Means followed by the same letter in the same columns are not significantly different at 5% probability level according to least significant difference (LSD (5%). N = Nitrogen, P = Phosphorus, RDF = Recommended Dose of Fertilizers, VC = Vermicompost.

75% of RDF NP fertilizer followed by plants grown at 50 and 100% of RDF NP fertilizer (1.463 and 1.473 cm) respectively, with no statistical difference among them. Plants in the control treatment recorded the least (1.233 cm), but the 25% of RDF NP fertilizer had 9.3% larger flower stalk diameter compared to the control (Table 1). Similar results is also reported by Getachew (2014) who found significantly more flower stalk diameter from NP fertilizer treated plants compared to control plants that did not receive NP fertilizer.

Similarly, vermicompost application at 2.5 to 7.5 t ha^{-1} resulted in 10.3 to 13.4% increment in flower stalk diameter compared to the lowest (1.290 cm) recorded from nil application of vermicompost (Table 1). Vermicompost applications 2.5, 5.0 and 7.5 t ha^{-1} had no significant difference among them on flower stalk diameter. According to Arancon et al. (2003), vermicomposts applied at very low rates 2.5 or 5.0 t ha^{-1} can significantly increase growth parameter of highly valuable vegetable crops such as plant height, flower stock diameter, yield etc due to attributed quality mineral nutrients.

Number of flower stalks and umbels per plant

Significant ($P<0.05$) differences were calculated in both number of flower stalks and number of umbels per plant due to the effect of NP fertilizers and vermicompost application rates. Increasing the application rates of NP fertilizer from 0 to 50% RDF NP fertilizer increased number of flower stack by 17.66%. Increasing the rate of NP fertilizer beyond 50% RDF NP fertilizer did not show any increase in number of flower stalk (Table 3).

Similarly, VC application at the rate of 5.0 t ha^{-1} gave significantly highest number of flower stalk (5.73) per plant compared with plots which did not receive VC, but gave the least number of flower stalks per plant (5.22). No significant differences were established in the number of flower stalk per plant among the VC application rates of 2.5, 5.0 and 7.5 t ha^{-1} (Table 3).

Results on the number of umbels per plant also followed similar trend to the number of flower stalk per plant. The application of NP fertilizer at 50, 75 and 100% RDF had significantly higher number of umbels per plant compared with the no NP application and 25% RDF. Increasing application rates of NP fertilizer from 0 to 50% RDF increased the number of umbels per plant by 17.66% (Table 3). In agreement with the present result, Tamrat (2006) and Rashid and Singh (2000) reported that increase in NP fertilization, increases number of umbels and flower stalks per plant. The finding of Nwadukwe and Chude (1995) show the interaction effects of applied NP fertilizer rates 50-100 N and 50 P_2O_5 kg ha^{-1}; also, an increased number of umbels and flower stalks per plant was noticed.

Similarly, increasing VC application rates from 0 to 5.0 t ha^{-1} gave 9.77% increase in the numbers of umbels per plant. No significant differences have been emphasized in the number of umbels per plant, among the various rates of VC except the nil application (Table 3).

Similar results were also reported that vermicompost stimulate plant flowering, increase the number and biomass of the flowers produced (Atiyeh et al., 2002; Arancon et al., 2008) as well as increase fruit yield (Atiyeh et al., 2000; Singh et al., 2008).

Table 4. Yield components of onion seed as affected by NP fertilizers and vermicompost.

Inorganic NP fertilizer (% of RDF)	Number of seeds per umbel	Seed weight per umbel (g)
0	675.0^{b}	2.28^{c}
25% of RDF	714.2^{b}	2.63^{b}
50% of RDF	825.3^{a}	2.80^{ab}
75% of RDF	897.0^{a}	3.02^{a}
100% of RDF	860.0^{a}	2.97^{a}
LSD (5%)	83.0	0.284
VC (t ha^{-1})		
0	724.7^{b}	2.51^{b}
2.5	792.4^{ab}	2.73^{ab}
5.0	831.2^{a}	2.86^{a}
7.5	829.0^{a}	2.85^{a}
LSD (5%)	74.3	0.249
CV (%)	12.6	12.3

Means followed by the same letter in the same column are not significantly different at 5% probability level according to LSD. N = Nitrogen, P = Phosphorus, RDF = Recommended Dose of Fertilizers, VC = Vermicompost.

Umbel diameter (cm)

Umbel diameter was significantly ($P<0.05$) affected by the main effect of NP fertilizer and by the vermicompost application rates. The highest umbel diameter (5.69 cm) was obtained with plots that received NP fertilizer at the rate of 75% RDF, which was significantly higher over the control (5.04 cm) but statistically at par with other rates of RDF NP fertilizer application rates. Applying NP fertilizer rates from nil to 75% RDF increased umbel diameter by 12.90% (Table 3).

Vermicompost at 5.0 t ha^{-1}gave significantly highest umbel diameter of 5.63 cm compared with nil application of VC (5.21 cm) and followed by VC rates at 7.5 t ha^{-1} (5.59 cm) and 2.5 t ha^{-1} (5.48 cm) which did not statistically vary among them. Application of 5.0 t ha^{-1} VC gave 8.06% increase in umbel diameter compared with the control (Table 3). This result is in line with that of Rashtbari et al. (2012) who reported that vermicompost significantly increased all the growth attributes such as plant height, umbel diameter, number of leaves, and leaf area index in response to applied municipal solid waste and vermicompost under well-watered, moderate and severe stress conditions.

Number of seeds per umbel

Main effect of NP fertilizer and vermicompost showed significant ($P<0.05$) differences on the number of seeds per umbel. The highest numbers of seeds per umbel were recorded in plots which received 50, 75 and 100% RDF NP fertilizer rates (825.3, 897 and 860 respectively) compared with unfertilized (675) and 25% RDF NP fertilized plots (714.2). There were no significant differences in the number of seeds per umbel among plots which received 50, 75 and 100% RDF NP fertilizer. The seeds per umbel obtained from 75% RDF NP fertilizer was 32.89% more compared with nil application of NP fertilizers, which was statistically at par with 25% RDF NP fertilizer application rates (Table 4).

This result was similar with the reports of Getachew (2014) who found that the highest number of seeds per umbel (914.6) was recorded from 115 N kg ha^{-1} and 114 P_2O_5 kg ha^{-1} and lowest from control with no significant difference from plants that received 85.5 N and 86.25 P_2O_5 kg ha^{-1}.

Vermicompost fertilized plots at the rate of 2.5, 5.0 and 7.5 t ha^{-1} gave significantly more number of seeds per umbel (792.4, 831.2 and 829 respectively) than VC unfertilized plots (724.7) (Table 4). No statistical differences in the number of seeds per umbel among the VC fertilized plots. The increment in seed per umbel was about 9.3 and 14.70% as VC application rate increased from nil to 2.5 and 5.0 t ha^{-1}, respectively. In agreement with the present result, vermicompost have been shown to increase the number and biomass of the flowers produced (Atiyeh et al., 2002; Arancon et al., 2008) and increase the number of fruits of vegetable crops such as tomato and strawberries (Atiyehn et al., 2000; Singh et al., 2008).

Seed weight per umbel (g)

Seed weight per umbel was significantly ($P<0.05$) affected by the main effect of NP fertilizer and vermicompost application. The highest significant seed

Table 5. Seed yield (kg) per hectare of onion as affected by NP fertilizer and vermicompost.

VC (t ha^{-1})	Inorganic NP fertilizer (% RDF)				
	0	25% RDF	50% RDF	75% RDF	100% RDF
0	402.8^{h}	454.7^{h}	527.8^{gh}	597.2^{gh}	743.1^{fg}
2.5	553.5^{gh}	865.2^{ef}	1192.3^{bcd}	1462.5^{a}	1189.7^{bcd}
5.0	948.1^{def}	869.3^{ef}	1448.6^{a}	1356.9^{abc}	1145.8^{bcd}
7.5	1050.9^{de}	958.8^{def}	1300.8^{abc}	1385.2^{ab}	1128.5^{cd}

LSD (5%) = 217.4; CV (%) = 13.4. Means in rows and columns with the same letter(s) in each treatment are not significantly different. LSD (5%) = least significant difference at P=0.05, CV (%) = Coefficient of variation in percent, VC = Vermicompost, N = Nitrogen, P = Phosphorus, RDF = Recommended Dose of Fertilizers.

weight per umbel was obtained from plants grown at 75% of RDF NP fertilizer (3.02 g) which was statistically at par with the application of 50% RDF (2.8 g) and 100% RDF (2.97 g) NP fertilizer rates. Significantly small seed weight (2.28 g) per umbel was recorded from nil application of NP and followed by 25% RDF NP fertilizer (2.63 g). The increase in the seed weight per umbel at 75% RDF NP fertilizer applied plots compared with unfertilized plots was about 32.46% (Table 4). The result are in agreement with the study of Getachew (2014) and Ali et al. (2008) who reported that seed weight per umbel was significantly increased by NP fertilizer 115 N kg ha^{-1} and 114 P_2O_5 kg ha^{-1} and 150 N and 80 P_2O_5 kg ha^{-1} application, respectively.

In the same way, plots which received vermicompost at 5.0 and 7.5 t ha^{-1} gave significantly highest seed weight of 2.86 and 2.85 g per umbel respectively, compared with nil vermicompost application (2.51 g) (Table 4).

The increase in seed weight from nil to 5.0 t ha^{-1}vermicompost application was by about 13.94%. No statistical differences have been recorded in seed weight per umbel, between nil and 2.5 t ha^{-1} vermicompost applications and 2.5 t ha^{-1}vermicompost with 5.0 and 7.5 t ha^{-1} vermicompost application rates. The increased seed weight per umbel could be due to the role of vermicompost which is known to contain micronutrients, apart from major nutrients and to contain several plant growth promoters, enzymes, beneficial bacteria and mycorrhizae (Gupta, 2005).

Seed yield per hectare

The interaction effect of 75% RDF NP fertilizer and 2.5 t ha^{-1}vermicompost showed the highest significant seed yield (1462.5 kg ha^{-1}), followed by 50% RDF NP × 5.0 t ha^{-1} and 75% RDF NP × 7.5 t ha^{-1} VC (1448.6 and 1385.2 kg ha^{-1} respectively) with no significant difference among them. The lowest seed yield per hectare was obtained from the plots with no NP fertilizer × no VC (402.8 kg ha^{-1}) followed by 25 to 75% RDF NP fertilizer without VC and no NP fertilizer with 2.5 t ha^{-1} VC, which did not vary significantly (Table 5). Application of 75% RDF NP × 2.5 t ha^{-1} gave 263% seed yield ha^{-1} increment compared with no NP fertilizers and no VC application rates.

The combination of vermicompost with chemical fertilizer increases the budget of essential soil micronutrients and promotes microbial population, which ultimately promotes the plant growth and production at sustainable basis (Suthar, 2012). The current result are in agreement with the work of Alemu et al. (2016) who found that application of N at a rate of 46 kg N ha^{-1}, 92 kg P_2O_5 ha^{-1} and vermicompost from 0 to 5.0 t ha^{-1} increased the total bulb yields of garlic by about 14.29, 20.61 and 9.57% as compared to the untreated control, respectively. In onion bulb production highest yield was obtained with 50% of nitrogen fertilizer with 5.0 t ha^{-1} vermicompost applications (Yohannes, 2015). Similarly, Daniel (2006) showed that highest total yield of potato tuber 29.59 t ha^{-1} were obtained with combination of 75% of RDF NP fertilizer combined with 8.0 t ha^{-1}vermicompost.

Conclusion

The field experiment was conducted to determine the effect of inorganic NP fertilizer and vermicompost on growth, seed yield and yield component of onion (*Allium cepa* L.) under irrigation at Maitsebri, northern Ethiopia. The statistical results revealed that most of the parameters considered were significantly ($P<0.05$) affected by the main effect of NP fertilizer rates and vermicompost. Besides, the interaction effect of NP fertilizer and vermicompost was significant ($P<0.05$) on plant height and seed yield per hectare. Thus, the maximum seed yield (1462.5 kg ha^{-1}) at 75% of RDF NP fertilizer with vermicompost at 2.5 t ha^{-1} produced 263% more seed yield. This might be due to the positive and synergetic effect of inorganic NP fertilizers and vermicompost owing to the balanced nutrition, increased yield attributes of onion seed. So, to get better yield and higher economic benefit from onion seed productions, farmers are suggested to use the combination rates of NP fertilizers at 75% RDF × VC at 2.5 t ha^{-1}.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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