INFLUENCE OF DIFFERENT TYPES OF FERTILIZERS ON YIELD AND QUALITY OF ONION SEEDS (*Allium cepa* L.)

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INFLUENCE OF DIFFERENT TYPES OF FERTILIZERS ON YIELD AND QUALITY OF ONION SEEDS (*Allium cepa* L.)

A thesis presented by

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The thesis attached hereto, entitled "**Influence of Different Types of Fertilizers on Yield and Quality of Onion Seeds (*Allium cepa* L.)"** was prepared under the direction of the chairperson of the candidate's supervisory committee and has been approved by all members of that committee and board of examiners as a partial fulfillment of the requirements for the degree of **MASTER OF AGRICULTURAL SCIENCE (HORTICULTURE).**

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DECLARATION OF ORIGINALITY

This thesis represents the original works of the author, except where otherwise stated. It has not been submitted previously for a degree at any University.

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Date -

DEDICATED TO MY BELOVED PARENTS

U AUNG NGWE AND DAW MYINT KYI

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Influence of Different Types of Fertilizers on Yield and Quality of Onion seeds (*Allium cepa* L.)

Dr. Yi Yi Soe Khin Thwe Thwe Aung

ABSTRACT

This research was conducted at the Department of Horticulture, Yezin Agricultural University to study different types of fertilizers on yield and quality of onion seeds (*Allium cepa* L.). There were two experiments; field experiment was from October 2011 to April 2012 and pot experiment was from November 2012 to April 2013. The treatments were five different types of fertilizers: vermicompost (23000kgha^{-1}), poultry manure (9000kgha^{-1}), cow dung (8000kgha^{-1}), inorganic fertilizer (N: P: K at the rate of 125:200:100 kgha^{-1}) and control. Randomized Complete Block design was used with four replications. The data collected were plant height, number of leaves per plant, number of umbels per plant, days to inflorescence emergence, days to 50% flowering, seed yield, 1000 seed weight, germination percent and rate, fresh weight and dry weight of germinated seedlings and seedling vigor index.

Plant height of NPK- treated plants was significantly higher than other treatments in the field experiment. In the pot experiment, plant height was not significantly affected by different types of fertilizers. In both experiments, the plant growth parameters such as number of leaves per plant, number of umbels per plant, days to inflorescence emergence, and days to 50% flowering were not significantly affected by different types of fertilizers. In the field experiment significantly higher seed yield was observed in poultry manure and vermicompost-treated plants and the seeds from poultry manure-treated plants gave heavier seedling dry weight among all treatments. In the pot experiment, seed yield per plant was significantly higher in poultry manure and NPK-treated plants than others and 1000 seed weight was significantly higher in all the fertilizers-treated plants than control.

In comparing the effects of organic manures with those of chemical fertilizer, significantly higher seed yield was observed in organic manure treated plants than chemical fertilizer-treated ones in the field experiment while chemical fertilizer-treated plants gave higher seed yield than organic manure-treated ones in the pot experiment. Based on the results of this study, poultry manure should be used in the good quality onion seed production in Myanmar.

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CHAPTER I

INTRODUCTION

Onion (*Allium cepa*) belongs to the family Alliaceae. The origin of onion is in Central or West Asia perhaps from Palestine to India (Fritsch et al. 2010). It is a major bulbous crop among vegetables and is of global importance. Over centuries, people consumed onion because it is rich in nutrients and medicinal properties. Onion in diet may play a part in preventing heart disease and ailments including stomach cancer (Currah and Protor 1999). According to FAO studies, onion falls second only to tomato in terms of total annual world production (Ashrafuzzaman et al. 2009). In Myanmar, onion is particularly grown in Mandalay, Sagaing and Magway regions (DAP 1999). At present, it is grown not only for local consumption, but as an export vegetable giving large income for growers. In Myanmar, about 72, 000 ha of land were used for cultivation of this crop, with an average yield of 15.63 MT ha^{-1}. Onion production is 1, 131, 000 MT ha^{-1} seed rate is 4 kg ha^{-1} and seed requirement is 284.5 MT (DAP 2011).

Generally, there are two types of onion bulb production in Myanmar – green onion production in which onion sets are planted especially during rainy season, and dry bulb production in which onion seeds are sown at the end of the rainy season and growing the crop during winter and harvested at the beginning of summer. The latter is practiced in most of onion growing areas (FAO 1987).

To produce onion seeds, two methods are commonly used, namely, seed-to-seed method and bulb-to-seed method. The former has a low production cost in which onion seeds can be collected within one season. The timing of seed sowing should be adjusted to meet sufficient low temperature in order to encourage flower stalk production. Bulb to seed method requires two growing seasons: one for seed bulb raising and the other for seed production. The seed bulbs are stored till the next growing season.

In Myanmar, the price of onion seeds is very expensive in some years when low seed yields was obtained in the previous seasons. In onion bulb production, the growers also encounter more problems due to poor germination of seeds. As most of onion seed producers give less attention on bulb selection for seed purpose, seed yields were still low and performance of those seeds were also poor and consequently cause low bulb yields.

To improve yield and quality of onion seeds, not only the flowering behavior of onion cultivar intended to produce seeds but also importance of agronomic practices must be thoroughly understood (Bendegumbal 2007). Among the agronomic practices, nutrient management through organic sources is considered as an important factor for organic seed production. The high cost of chemical fertilizers is a problem. Therefore, use of integrated nutrient management such as organic manures like farmyard manures, vermicompost and poultry manure has become necessary.

Vermicompost provides major macronutrients (N, P, K, Ca, Mg, S) and micronutrients (Fe, Mo, Zn, Cu, etc.). N, P and K contents were 0.8, 1.1, 0.5% respectively (Giraddi et. al.1993). The cow dung manure supplies 0.5% N, 0.3% P and 0.5% K. The poultry manure contains 1.7% N, 1.4% P, 0.9% K (Sinha 2004). The physical properties of soil such as aggregation, aeration, permeability and water holding capacity were indirectly improved by vermicompost, poultry manure and cow dung manure (Chandramohan 2002). The poultry manure contains 60% N due to its rapid mineralization. Poultry manure is recognized as a valuable source of plant nutrients for all crops (Castellanos and Partt 1981). Among the animal manure, poultry manure has the largest nitrogen content which can promote seed production. (Bendegumbal 2007)

Furthermore, knowing the deleterious effect of using only chemical fertilizers on soil health, use of chemical fertilizer supplemented with organic waste and biofertilizer will be environmentally advantageous. Hence, it becomes necessary to know the impact of organic manures on plant growth, seed yield and quality in onion.

In Myanmar, there is still less information on proper fertilizer application in quality seed production in onion. Therefore, this study was carried out with the following objectives:

- To determine the effect of different organic manures on yield and quality of onion seeds
- To compare the effects of organic and inorganic fertilizers on yield and quality of onion seeds.

CHAPTER II

LITERATURE REVIEW

2.1 Life Cycle of Onion

The onion seed, which contains a small, coiled embryo and an endospermic food reserve, imbibes water when wetted in the soil. Then the embryo starts growth actively. From the growing point, the seedling develops a succession of leaves. Under proper temperature and day length, the leafy plant eventually ceases to form leaf blades, and instead, the apex begins to initiate a number of bladeless, concentric, thickened leaf sheaths. Together with the swollen lower leaf sheaths of the older leaves, they make up the fleshy part of onion bulb (Jones and Mann 1963; Currah and Proctor 1990).

Once on further leaf blades are being produced to support it from the inside, the onion's neck become hollow and collapse under the weight of the tops. The green blades gradually senesce and die and then the bulb mature and go into a resting period. At the end of the apparent external dormancy, the main and some lateral growing points on the upper surface of the base plate continue to grow slowly and form shoot initials consisting of bladed leaves and flower stalk primordial (Jones and Mann 1963). When the bulb is replanted, root start to grow from initials present in the base plate, and soon a number of leafy shoots emerge, followed by the floral scapes of stalks. Individual bulb can produce 1-12 or more flower stalks depending on cultivar, bulb size and its planting time. Number of flowers per umbel may also vary from 50 to 2000 depending on the cultivars, time of seed bulb planting and size of seed bulb (Shinohara 1977).

As each individual flower is protandrous, the onion is largely out-breeding. If pollination and fertilization are successful the ovules start to develop, and the seed capsules mature in a few weeks and split open to release the black, somewhat angular seeds (Currah 1970).

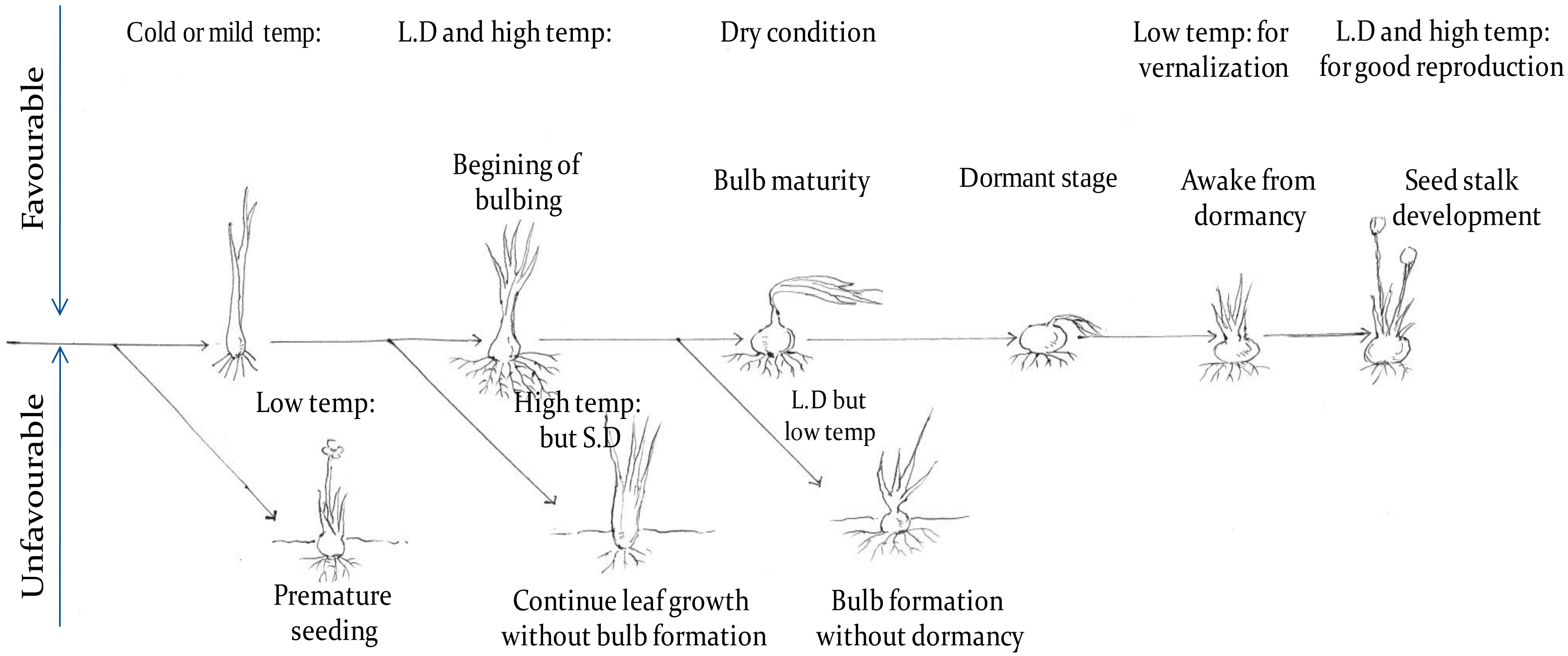

Figure 2.1. Illustration of life cycle of Onion (Shinohara, 1977)

2.2 Flowering Behavior of Onion

As onion belongs to green plant vernalized type, onion plant requires a certain amount of low temperature exposure for its flower induction. After the flowers have differentiated, the plant requires certain rate of long daylength exposure for its seed stalk development. Moreover, the vernalization response can be furnished after the plant has reached a certain stage. Cultivars developed in the higher altitudes or cooler places may have a requirement of longer period of low temperatures. (Shinohara 1977)

Much of the reports stated that 9˚C is the optimum temperature for the inflorescence initiation (Holdsworth and Heath 1950; Woodbury 1950; and Shishido and Saito 1975) although this probably varies with cultivar (Brewster 1983).

Van Kampen (1970), working with spring-sown bulb onions, delineated **three phases** in onion inflorescence development, namely: the **thermophase** during which inflorescence induction is temperature dependent; the **competition phase** during which inflorescence emergence can be suppressed by the factors favouring bulb growth; and the **completion phase** in which warm temperatures and long days are beneficial . Temperatures in the range of 9-15˚C have been found most favourable to inflorescence initiation (Aura 1963; Van Kampem 1970; and Brewster 1982). The duration and temperature of the thermophase must be sufficient to ensure that inflorescence is not suppressed by competition from bulb development when temperatures increase.

Onion plants must be larger than a certain size before they can initiate inflorescence. For an autumn sown cultivar, this is about 0.45gm shoot dry weight (Brewster 1985). In general, the larger plant size has been found to favor inflorescence initiation (Holdsworth and Health 1950). Many cold requiring plants of perennial and biennial types possess a juvenile phase in which they cannot be induced to initiate inflorescence (Brewster 1985).

To facilitate the improvement of onion cultivar, the factors affecting inflorescence and seed head development are required to be understood. Information on the factors that control inflorescence initiation and development will also be useful in devising technique to prevent bolting in bulb crops and to promote flowering for breeding work and seed production.

2.3 Climatic Requirement for Onion Seed Production

Onion seed production is influenced not only by genetic factor but also climatic factors such as temperature, daylength and rainfall.

2.3.1 Temperature

The ideal temperatures for mother bulb production are 18˚C - 24˚C day and 10 - 12˚C night temperature. For bulb production it can go higher beyond these ranges. However, it is the major factor for flower stalk development and seed set. Higher temperature can prevent flowering. After bulb develops, cool weather is required for flower stalk initiation. Then, drier conditions with good sunshine are required for seed maturity, harvesting and processing. It is also important to know specific requirement of the crop varieties. For instance, Bombay and Adama red can flower and produce higher seed yield under relatively lower chilling temperature while variety like Red Creole needs very low temperature and cannot produce sufficient seeds like the other varieties. High temperature during flowering also results in flower abortions and hence lower seed yield. So, selection of appropriate months in a given locality is crucial in onion seed production venture. Studies and experiences in Asellia, Ethiopia, showed that onion seed production is best if mother bulbs are planted in September and October for flowering to take place in the months of January and February- in cooler and drier months. This is the best period for getting higher and quality seed yields (Nikus and Mulugeta 2010).

For onion, optimum temperatures for bulbing are 8-12˚C and vernalization is definitely slower at 6˚C or less. The optimum temperature is about 5˚C for vernalization in most temperate vegetables (Wiebe 1990). However, the optimum temperature for vernalization of onion is higher than that of most temperate vegetables. The optimum temperature and the time required for onion may vary with cultivar-15-12˚C for West African cv. Bauk, 3-4˚C for northern Russian strains, 9˚C (20 days) for Japanese spring-sown cvs Sapporiki and Omai-wase and 9˚C (30 days) for autumn-sown cv Senshuki.

Temperatures of 28 - 31˚C applied to bulbs previously induced by low temperatures can reverse inflorescence induction, and this is termed "devernalization". The duration of 28 - 31˚C storage needed to prevent flowering increases the more advanced stage of inflorescence initiation. Aura (1963) also found that inflorescence initiation was more rapid in bulbs stored at 9 - 13˚C than those stored at 3 - 5˚C and it was more rapid in large bulbs than in small ones. Bulb or set storage at 28-30˚C also delays bulb initiation. As bulb development suppresses inflorescence elongation during the competition phase, a short period (one to two months) of storage at such a high temperature at the end of a long period of cool storage can, by delaying bulbing, result in increased bolting.

2.3.2 Daylength

The onion is classified as a long-day plant, i.e, a certain length of day must be attained before bulbing takes place. Garner and Allard (1920) have shown that length of day affected flowering and bulb formation in certain varieties of onions. They found that the Silver Skin variety grown from sets planted May 19 at Washington, D.C, developed normal bulbs and showed the first blossoms July 14 under the normal length of day. Under a 10 hour day, the plants remained green for 12 months and formed no bulbs and no flowers.

Inflorescence initiation in growing seedling is influenced by photoperiod, nitrogen nutrition and daily radiant exposure as well as by temperature. Long photoperiods increase the rate of inflorescence initiation but a low nitrogen status can largely replace the requirement for long photoperiods. Exposure of seedling to low light intensities prior to vernalization, resulting in a low concentration of non-structural carbohydrates in the plants, slows subsequent inflorescence initiation and increases the critical leaf number needed to reach the post-juvenile stage.

2.3.3 Interaction between daylenth and temperature

When an inflorescence initial has developed within a bulb, its subsequent rate of elongation depends on temperature and after the bulb has sprouted and started to grow, on daylength. Long photoperiods coupled with fairly cool temperature (10-15˚C) are optimal. A vegetative shoot apex normally develops axillary to the inflorescence and this can develop more rapidly than the inflorescence under a combination of warm temperatures (20˚C or higher) and long photoperiods (e.g. 16 h, although this probably depends on cultivar). This results in the swelling of the axillary bud to form bulb scales and the shriveling and degeneration of the young scape, hence the term competition phase coined by Kampen (1970) to describe the apparent competition between axillary bud and inflorescence .

Brewster (1982) pointed out that there is an interaction between daylength and temperature with respect to flowering of onions grown from sets. At temperatures high enough to favour bulbing, long day discouraged flowering. When the temperature was low enough to prevent or delay bulbing, long day accelerated the appearance of flower stalks.

Temperature of 12-16°C in combination with photoperiods of 16-17h have been found satisfactory for inflorescence emergence from induced bulbs and plants of intermediate day cultivars. Since the photoperiods and temperatures needed for bulbing vary with cultivar, it is almost certain that the photoperiods and temperatures needed to avoid suppression of developing inflorescence by competition from bulbing will depend on cultivar. The inflorescences of a short-day cultivar will be suppressed by a shorter day length than a long day cultivar. Also, plants raised from bulbs or set produce bulbs more rapidly than those raised from seeds, unless they have been heat treated at the end of storage. Therefore competition from bulbing probably suppressed inflorescences in bulb-raised plants at shorter photoperiods and lower temperatures than seed raised plants.

2.3.4 Rainfall

Excessive rainfall and very cool condition are undesirable as they lead to disease development and poor seed setting. Good sun shine at the time of full blooming stage will facilitate the activity of beneficial insects for higher rate of cross pollination and seed set. The relative humidity should be lower during seed development (Nikus and Mulugeta 2010).

2.4 Cultural Requirement for Onion Seed Production

2.4.1 Cultivar

Seed production potential also depends on cultivars. Some onion types with higher chilling requirement produce few flower stalks in tropical. So, producers should exercise seed production on adapted onion varieties. Likewise in selecting onion varieties for seed production, emphasis should be given to the most popular varieties under production (Nikus and Mulugeta 2010). For example, in Ethiopia, Bombay red is the most widely grown onion variety under irrigation in the country due to its higher bulb yield and earliness. But Bombay red is not suitable for production under rain fed as it easily rots in the field if encounters rain during maturity stage. Bulb yields up to 40000 MT for Bombay red were observed on farmer's fields in Central Rift Valley (CRV) areas, which is mainly due to its tolerance to higher plant population (can successfully produce good size bulbs at spacing as low as 4 cm between plants). On the other hand, Adama red can produce good size bulbs only at plant spacing greater than 6 cm. Unlike the former, Adama red can be produced under rain fed conditions as it tolerates rotting due to rain effects during maturity stage. Thus, when selecting a cultivar for its seed production the yield and area coverage of that variety should also be taken into account.

2.4.2 Soil

Light soil with good fertility and drainage and pH of 6.0 - 8.0 is preferred for onion production. Loam or clay loam soils are best suited for seed production (Nikus and Mulugeta 2010).

2.4.3 Fertilizer and Manure

2.4.3.1 Cow dung manure

The nutrient content of cow dung manure varies with different resources. The nutrient content of cowdung manure in a study conducted by Chatterjee et al. (1979) was found to be 0.64 per cent of N, 0.07 per cent P and 0.29 per cent K whereas Sharma and Mitra (1989) reported that cowdung contained 26.1 per cent of C, 1.71 per cent of N, 0.24 per cent of P and 2.04 per cent of K on dry weight basis. The cow dung used in the trials of Sriramachandrasekharan et al. (1996) had 1.2 per cent N, 0.21 per cent P, 1.96 per cent K, 26.90 per cent C with C: N ratio of 22.4:1.0. The cow dung manure seems to act directly for increasing the crop or seed yield either by accelerating the respiration process through cell permeability or by hormone growth action. It supplies nitrogen, phosphorus and sulphur in available forms to the plants through biological decomposition. Indirectly, it improves the physical properties of soil such as aggregation, aeration, permeability and water holding capacity (Chandramohan 2002).

Singh (1995) observed that the highest bulb yield (50.6 g per pot) was obtained from plants fertilized with cowdung (10 ton ha^{-1}) + 40 kg N per ha^{-1} + 60 kg P per ha^{-1}. Similarly, Warade et al. (1996) reported that the highest bulb yield (27.7 ton ha^{-1}) was obtained with 40 ton cowdung ha^{-1} + NPK (100, 50 and 50 kg ha^{-1}, respectively). The application of cowdung 72.0 q ha^{-1} along with ammonium sulphate 565 kg ha^{-1} was effective in increasing the growth and yield in onion (Gupta *et al.*, 1999). Rumpel (1998) reported that cowdung + NPK gave the highest bulb yields of onion and cowdung alone gave better results than NPK fertilizer.

2.4.3.2 Vermicompost

Kale et al. (1992) opined that vermicompost is like any other organic manure and depends on the nature of waste used as feed for worms and its nitrogen content varied from 0.5 to 2.0 per cent. Similar variations with respect to phosphorus and potassium content have also been observed. The complex organic residues are biodegraded by symbiotic association between earthworm and microbes and in the process where vermicompost is produced. The vermicompost, apart from increasing the density of microbes, also provides sufficient energy for them to remain active. Vermicompost can provide the required nutrients to the plants. It provides the vital macroelements such as N, P_2O_5, K_2O, Ca and Mg and micronutrients such as Fe, Mo, Zn, Cu, etc. The chemical analysis of vermicompost revealed that the per cent N, P_2O_5 and K_2O contents were 0.8, 1.1 and 0.5, respectively (Giraddi 1993). Vermicomposts have many outstanding biological properties. They are rich in bacteria including cellulose-degrading bacteria, actinomycetes and fungi (Edwards 1983; Tomati et al. 1987; Werner and Cuevas 1996). In addition, Tomati et al. (1983) also reported that earthworm castings, obtained after sludge digestion, were rich in microorganisms, especially bacteria. Nair et al (1997) compared the microorganisms associated with vermicomposts with those in traditional composts. He reported that the vermicomposts had much larger populations of bacteria (57 millions), fungi (224 thousand) and actinomycetes (177 millions) compared with those in conventional composts. The outstanding physico-chemical and biological properties of vermicomposts makes them excellent materials as additives to greenhouse container media, organic fertilizers or soil amendments for various horticultural field crops.

Vermicompost, besides being a rich source of micronutrients, also acts as a chelating agent and regulates the availability of metallic micronutrients to the plants and increase the plant growth and yield by providing nutrients in the available form. Thanunathan et al. (1997) conducted the pot experiment in which onions (*Allium cepa* var. aggregatum) were grown in 12 different combinations of soil, mine spoil, vermicompost. Bulb yield ranged from 2.72 g per plant in mine spoil alone to 38.05 g per plant in a 1:1:1 pot mixture of soil, mine spoil and coir vermicompost. Jayathilake et al. (2003) obtained highest onion bulb yield with the application of *Azospirillum* + vermicompost + chemical fertilizers. Reddy (2005) studied the effect of different levels of vermicompost (0, 10, 20 and 30 ton ha^{-1}) and nitrogen fertilizer (0, 50, 100, 150 and 200 kg ha^{-1}) on the growth and yield of onion (cv. N-53). Plant height, number of leaves per plant, leaf area, bulb length, diameter and weight and yield of onion increased significantly with increasing levels of vermicompost (from 10 – 30 $tonha^{-1}$) and nitrogen fertilizer (from 50 – 200 kg ha^{-1}).

2.4.3.3 Poultry manure

Poultry manure generally refers to excrement, as voided by the animal. Manure characteristics are influenced by animal species, age, diet, health, farm management and environment. The total N and P contents of poultry manures are among the highest of all animal manures (Somners and Sutton, 1980). Composting or the controlled biological decomposition of organic waste has been investigated as a method of stabilizing poultry litter and manure prior to land application. This process produced a material with several advantages with respect to handling by reducing volume, mass of dry matter, odors, fly attraction and weed seed viability (Sweeten 1980).

Castellanos and Pratt (1981) estimated that 60 per cent of the organic N in poultry manure was available. Due to its rapid mineralization, poultry manure was recognized as a valuable source of plant nutrients for crops. The nitrogen (60%) is present as uric acid, 30 per cent as more stable organic nitrogen and the balance as mineral nitrogen (Srivastava 1988). Pimpini *et al.* (1992) compared the effect of poultry manure and mineral fertilizer combinations (equivalent to 140 kg N + 140 kg P_2O_5 + 100 kg K_2O ha^{-1} and 210 kg N + 210 kg P_2O_5 + 150 kg K_2O ha^{-1}) were compared with a non-fertilized control. All the fertilizer treatments increased the larger-sized onion bulbs. Govindasamy et al. (1994) studied the optimal combinations of N in the form of urea and poultry manure and reported that use of poultry manure was more economical at high targeted yields.

Amanullah et al. (2010) reported that poultry manure contained all the essential plant nutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulphur (S), manganese (Mn), copper (Cu), zinc (Zn), chlorine (Cl), boron (B), iron (Fe) and molybdenum (Mo). The chemical composition of poultry manure depends on several factors including the source of manure, feed of animals, age and condition of animals, storage and handling of manure and litter used as well as the age and moisture content of the manure (Mariakulandai and Manickam 1975). In fresh excreta, uric acid or urate is the most abundant nitrogen compound (40 - 70%) while urea and ammonium are present in small quantities (Archer 1985).

Although poultry manure is a rich source of N, availability is subject to volatilization, denitrification, immobilization, mineralization, leaching and plant uptake. Wolf et al. (1988) found that 37% of the total N in surface applied poultry manure was volatilized in 11 days, followed by immobilization between 1-2 weeks resulting in the reduction in inorganic N content.

Espiritu et al. (1995) recorded that the crop yield improvement due to addition of poultry manure was attributed to the presence of both readily available and slow release nitrogen. Incorporation of organic substances could increase the micronutrient status in soil depending upon the supply of reducing and chelating substances. In this regard, Bijaysingh et al. (1988) observed that the higher concentrations of micronutrients were found in the soil tested with poultry manure and *Sesbania aculata*. The performance of poultry manure was better than FYM. The increase in plant height due to availability of soluble phosphorus in soil solution was higher when poultry manure was applied (Warncke and Siregar 1992).

2.4.3.4 Chemical fertilizers

Nitrogen, phosphorus and potassium are often referred to as the primary macronutrients because of the general probability of plants being deficient in these nutrients and because of the large quantities taken up from the soil relative to other essential nutrients (Marschner 1995). Onions are more susceptible than most crop plants in extracting nutrients, especially the immobile types, because of their shallow and unbranched root system; hence, they require and often respond well to additional fertilizers (Brewster 1994). Shallots are considered to have similar nutritional requirements to other Alliums (Currah & Proctor 1990; Brewster 1994; Zahara et al. 1994).

The effect of N and P chemical fertilizers alone on the plant rhizosphere, growth, seed yield and quality of some crops were studied by many investigators.(Abosdera 2005). Nitrogen is one of the major essential nutrient elements that contributes a lot for the production of crop. Imbalanced and poorly monitored nitrogen application limits yields and induces large losses of reactive nitrogen to the environment. (Cassman *et al.* 2002). Nitrogen increased the rates of leaf initiation and extension of garlic in early growth (Garcia 1980; Koltunov 1984). It improved bulb growth and development (Buwalda and Freeman 1987, Fritsch *et al.* 1990; Hossain, 1997; Garcia *et al.* 1994). Hedge (1988) showed that the dry matter production of bulb and bulb yield were increased due to nitrogen application.

Phosphorus (P) deficiency is one of the largest constraints to crop production in many tropical soils, owing to low native content and high P fixation capacity of the soil (Warren 1992; Barber 1995; Marschner 1995; Norman et al. 1995; Fairhust et al. 1999). In onions, P deficiencies reduce root and leaf growth, bulb size and yield and can also delay maturation (Ojala et al. 1983; Brewster 1994; Greenwood et al. 2001). In soils that are moderately low in P, onion growth and yield can be enhanced by P application. Depending on soil P status, cultivar and plant density, P application rates up to 200 kg ha^{-1} were found to maximize onion yields and bulb weights and reduce storage loss of bulbs (Haggag et al. 1986; Vachhani and Patel 1993; McPharlin and Robertson 1999; El-Rehim 2000; Singh and Singh 2000; Singh et al. 1998, Singh et al. 2000). Increased P levels are also known to improve bulb size and the number of marketable bulbs in shallots (Zahara et al. 1994; Nagaraju et al. 2000).

Potassium application stimulates nitrogenase activity and greater partitioning of above ground nitrogen to seeds and thereby increase seed yields (Thomas and Hungaria 1988). The K requirement of onion plants increases with yield and its functions are linked to photosynthesis (Marschner 1995; Greenwood and Stone 1998). If K is deficient or not supplied in adequate amounts, onion plants can be stunted, become susceptible to disease and have reduced yields (Develash and Sugha 1997; Rizk 1997; Singh and Verma 2001). Yield responses of onions to applied K would be less likely on soils with high cation exchange capacity such as certain types of clay soils (Marschner 1995), low soil moisture contents (Kuchenbuch et al. 1989; Al-Moshileh 2001) and low yielding cultivars (Boyhan and Hill 2001).

Nwadukwe and Chude (1995) tested the effect of five N rates (0, 50, 100, 150 and 200 kg ha^{-1}) and four P rates (0, 25, 50 and 75 kg Pha^{-1}) on the onion seed yield. The main effects of N and P and their interaction on number of umbels per bulb, seed weight per umbel and seed yield were significant but there were no significant effects on plant stand and 1000 seed weight. Islam (1999) reported that among the sources of potassium tested combinations, two split application of potassium sulphate resulted in the highest onion bulb yield (10.58 ton ha^{-1}) which was 44 per cent greater than the yield obtained from a single basal application of muriate of potash. Singh and Chaure (1999) reported that application of nitrogen (150 kg ha^{-1}) recorded higher leaf length, number of leaves per plant, bolting percentage, bulb weight and bulb yield. Jilani et al. (2004) investigated the effect of different levels of nitrogen (0, 80, 120, 160 and 180 kg N ha^{-1}) on three onion cultivars. The results revealed that total yield was highly significant in all three varieties and 120 kg N ha^{-1} proved to be the best for all the parameters studied. Singh et al. (2003) recorded the optimum level of nitrogen and potassium for obtaining the maximum growth and yield of onion crop with treatments receiving 0, 50, 100 and 150 kg N ha^{-1} and 0, 40, 80 and 120 kg K ha^{-1}. Plant height at harvest, leaf length, and fresh weight of leaves were highest in treatment with the highest nitrogen rate.

2.4.4 Irrigation

The yield of onion seeds is affected by the irrigation regime. In Israel, onion for seed production is grown under two different regimes; ***dryland cultivation***, whereby the onion plants grow, flower and produce seeds by utilizing only the water from the rainfall; and ***irrigated cultivation***, whereby irrigation was done when necessary, usually one to three times after planting in October and before the rains start. To obtain a high yield of onion seed it is important to start irrigation directly after planting. At about two weeks before harvesting water supply should be stopped to increase the quality of harvest (www.agridep.gov.lk/index.php/en/crop/-recommendation/1469). In the spring-summer, an additional four to six irrigations are given from the last effective rain until the harvest (Globerson et al 1972).

The field should be irrigated three days after planting to facilitate for easy germination of bulbs. Then irrigation should be continued every seven days until full flowering and then at every 10 days interval followed by 10-15 days interval near maturity depending on soil types (Nikus and Mulugeta 2010).

2.4.5 Pollination

Onion is a cross pollinated crop and efficient pollination depends largely on the presence of insects in the area and their activity at flowering time. It is essential to ensure that there is sufficient population of pollinating insects including honeybees to achieve the full potential of onion seed and consequent higher seed yield (Nikus and Mulugeta 2010).

2.4 Current Status of Seed Production in Myanmar

Nowadays, there are three main tasks of Ministry of Agriculture and Irrigation (MOAI) regarding with seed production in Myanmar

1. Seed Production
2. Training and Education
3. Research and Development

On site seed production pilot project in farmers' level (2010-2011) by Japan International Cooperation Agency (JICA) is collaborated with Department of Agricultural Rescarch (DAR) and Department of Agriculture (DOA), MOAI. DOA is responsible for further development of the seed industry in Myanmar. At present, seed production industry is leading role in governmental sector. But, it is not enough distribution for seed necessaries. This will be succeeded in cooperation with private companies. Now, government sector is encouraging to private companies to increase crops seed production. Recently, MOAI supported private seed production companies to participate in seed production industry.

In Myanmar, the quality seeds which are systemically distributed in seed market are certified seeds. Farmers are also using this certified seed and it can increase yield and quality of their products. South and South east Asia countries have being implemented for seed program since few years ago. Quality seed production industry was cooperated with contact farmers. Since onion is one of the most important vegetables in Myanmar a lot of onion seeds are still required in Myanmar. It is necessary to produce onion seeds from government and private sector.

CHAPTER III
MATERIALS AND METHODS

3.1 Field Experiment

3.1.1 Experimental site - The experiment was conducted at Department of Horticulture, Yezin Agricultural University, Naypyitaw (19˚ 15'N and 0˚ 7'E). The soil type is sandy loam with a pH value of 6.25.

3.1.2 Experimental period – Field experiment was conducted from November 2011 to April 2012.

3.1.3 Experimental design - The experiment was conducted using Randomized Complete Block design with four replications. There were five treatments in this experiment and the treatments were applications of different types of fertilizer as follows;

Vermicompost (23000 kg ha^{-1})

Poultry manure (9000 kg ha^{-1})

Cow dung manure (7000 kg ha^{-1})

N: P: K 125: 200: 100 kg ha^{-1} (Urea, T-super and Muriate of Potash fertilizer)

Control

3.1.4 Experimental procedure- The tested variety was Shwephalar and medium-sized bulbs (3.5 - 4.5cm in diameter) were selected. Bulb-to-seed method was used in this experiment for onion seed production. The spacing was 20cm x 30 cm and the size of each experimental plot was 1 x 2 m^2.

Just before planting the plots were leveled. Different types of fertilizers [urea (55 g), potash (21 g), potassium (42 g), vermicompost **(**4800 g), cow dung manure (6400 g), poultry manure (1800 g)] were applied to each experimental plot according to treatments as basal application before planting.

Before planting, the bulbs were cut open at about one-third from the top. Just after cutting, the bulbs were soaked in water mixed with Topsin (1.25g L^{-1}) for about 30 minutes. The bulbs were placed individually with their tops buried about 3cm deep in the soil. There were 10 bulbs in each row and 4 rows per plot. There were 40 bulbs in each plot. Overhead irrigation was managed daily. Watering was stopped 15 to 25 days before harvest. Hand weeding was carried out as necessary. The flower stalks were supported with bamboo sticks when the umbel was seed set. The umbels were harvested when about 15 – 20 % of the umbels exposed black seeds. After harvest, the umbels were sun dried for about 3 days and the seeds were extracted and threshed by hand. Germination test was carried out using 100 seeds for each treatment at 4 days after drying. Soil and organic manures were analyzed before the onion cultivation. It can be seen in Appendix Table 5 and Table 6.

3.1.5 Data collection

3.1.5.1 Collected data

The following data were collected as plant growth parameters at weekly intervals;

Plant height (cm)
Number of leaves/plant
Days to inflorescence emergence
Days to 50% flower opening
Number of umbels /seed bulb

After harvesting, the following data were recorded using the collection procedure mentioned below.

Seed yield per plant
1000 seed weight (g)
Seed germination %
Germination rate (days)
Shoot and root length of seedling (10 days after seedling emergence)
Seed vigor index (SVI = G % + (SL + RL))
Fresh weight of seedling (10 days after germination test)
Dry weight of seedling (15 days after germination test)

3.1.5.2 Collection procedure of experimental data

From each treatment, five plants were randomly selected and tagged for recording. The observations on growth, seed yield and quality parameters were made as mentioned below.

Plant growth parameters

Plant height (cm)

The height of the five plants was recorded in centimeter from ground level to tip of the longest leaf of each plant vertically and the average height was worked out.

Number of leaves per plant

Number of fully opened functional leaves was recorded in five plants at weekly interval and mean was worked out and expressed as number of leaves per plant.

Days to inflorescence emergence

In each treatment, one row was selected to record days to emergence of flowering. The number of days required to first flowering in the selected row in each treatment was recorded and expressed as days to inflorescence emergence.

Days to 50 % flowering

In each treatment, previously selected row was used to record days to 50 per cent flowering. The number of days taken for flowering of 50 per cent of plants in the selected row was recorded and expressed as days to 50 per cent flowering.

Yield parameter

Number of umbels per seed bulb

Number of umbels out of sample plant was counted at the time of harvest in each of the five earlier randomly selected plants and the average was worked out and expressed as the number of umbels per seed bulb.

Seed yield (g)

The seed separated from sample plants of each treatment were collected and total yield and seed yield per plant was recorded.

Thousand seed weight (g)

The 1000 seed weight was recorded and the average seed weight was expressed in gram.

Seed quality parameters

Germination % and Germination rate

One hundred onion seeds were placed on wetted cotton wool in the Petri dishes covered with caps. The germination and seedling growth were daily observed for 10 days. The number of seeds germinated in each Petri dish was counted and rate of germination was calculated.

$$GR = \frac{(n_1 \text{ x } t_1)+(n_2 \text{ x } t_2)+(n_3 \text{ x } t_3)+\text{------------}(n_i \text{ x } t_i)}{T}$$

GR= germination rate

n = number of days for each counting of germinated plants

t = number of germinated plants in each counting days

T = total number of germinated seeds

Shoot length (cm)

Ten randomly selected 10-day-old normal seedlings from germination test were used for measuring shoot length from collar region to the point of attachment of cotyledon and mean was worked out and expressed in centimeter.

Root length (cm)

Seedlings used for shoot measurement were also used for measuring root length. The length of root was measured from collar region to the tip of primary root and was expressed as mean root length in centimeter.

Fresh weight of seedling (g)

Ten randomly selected seedlings were taken in each treatment to determine the fresh weight of seedlings. Fresh weight of seedling was expressed in gram.

Dry weight of seedlings (g)

Ten randomly selected seedlings taken for fresh weight data were used to determine the dry weight of seedlings. The seedlings were dried in hot air oven at 76˚C - 80˚C. Dry weight per seedling was expressed in gram.

Seedling vigor index

The seedling vigor index was calculated by adopting the formula as suggested by Abdul-Baki and Anderson (1973) and expressed as a number.

Seedling vigor index (SVI) = Germination (%) + [Root length (cm) + Shoot length (cm)]

3.1.6 Statistical analysis

The collected data were analyzed statistically through ANOVA using SAS program and mean data were analyzed by using Least Significant Difference (LSD) test and single-paired comparison.

3.2 Pot Experiment

Pot experiment was conducted at Department of Horticulture (YAU) from November 2012 to April 2013. Randomized Complete Block design was used for five treatments applied as in the field experiment. In this experiment, four bags were used for each replication, totally 80 bags.

3.2.1 Experimental procedure - Black poly ethylene bags of 40 cm x 35 cm were used in the pot experiment. The diameters of each container were 40 cm and its volume was 0.0962 m^2. Four bulbs were separately planted in garden soil mixed with preset treatments in polyethylene bags. Other plant management practices were done as in the field experiment.

3.2.2 Data collection

Data collection of the pot experiment is the same as that used in the field experiment.

CHAPTER IV

RESULTS AND DISCUSSION

4.1 Field Experiment (2011-2012)

4.1.1 Plant growth parameters

Plant height

In this experiment, the onion plant height was affected by different fertilizer application (Figure 4.1). The heights of N:P:K-treated plants were significantly higher than those of other treatments at 6, 8 and 10 weeks after planting (WAP). At 6 WAP, the highest plant was observed in N:P:K-treated plants (44.76 cm) and the lowest plant was observed in cow dung manure-treated plants (32.75 cm). This finding was similar to that of Vachhani and Patel (1993) in which the highest plant was observed with the application of NPK fertilizer. It may be due to the effect of chemical fertilizers that show rapid response in increasing vegetative growth of onion.

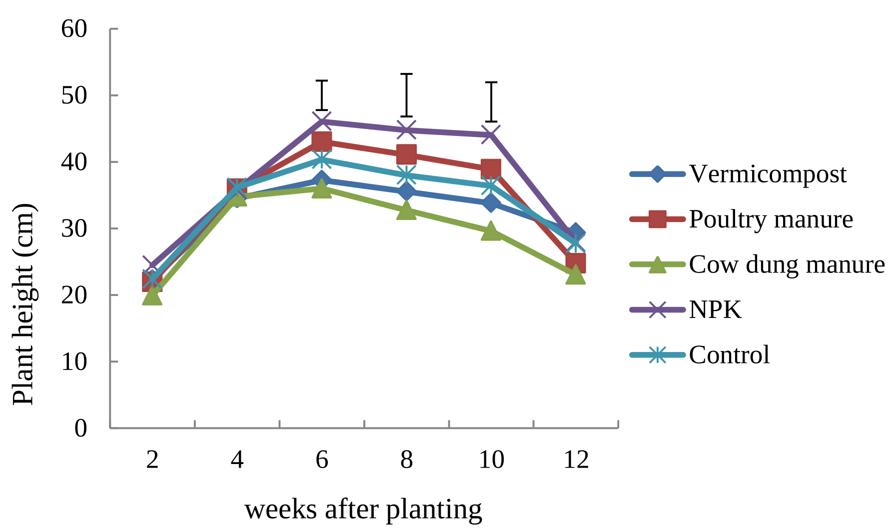

Figure 4.1 Onion plant height (cm) as affected by different types of fertilizer throughout the growing season (field experiment). Vertical bar (I) indicates LSD (P=0.05)

Number of leaves per plant

The results indicated that number of leaves per plant was not significantly affected by different types of fertilizers (Table 4.1). In terms of value, maximum number of leaves per plant (18.05) was observed in NPK-applied plants and minimum number of leaves per plant (14.05) was observed in vermicompost-treated ones at 6WAP. This result was similar to the findings of Rizk (1997) and Vachhani and Patel (1993) who observed that higher number of leaves per plant was produced with the application of NPK fertilizer. It can be assumed that chemical fertilizers have higher availability of nutrients to the plant roots than other organic fertilizers used in this experiment.

Table 4.1 Number of leaves per plant as affected by different types of fertilizer throughout the growing season in the field experiment

Treatments	Number of leaves per plant					
	2WAP	4WAP	6WAP	8WAP	10WAP	12WAP
Vermicompost	8.05	10.85	14.05	14.90	13.20	10.00
Poultry manure	8.85	15.10	17.95	17.65	13.30	6.85
Cow dung manure	9.65	14.25	17.45	18.45	15.35	10.00
NPK	7.80	15.40	18.05	16.55	13.70	7.50
Control	8.00	12.35	14.75	14.45	12.55	8.05
$LSD_{0.05}$	3.08	4.93	4.39	5.07	5.05	5.27
$Pr \geq F$	ns	ns	ns	ns	ns	ns
C.V (%)	23.65	23.59	17.33	20.08	24.79	40.38

WAP = weeks after planting, ns=no significant

Days to inflorescence emergence

The number of days to inflorescence emergence was not significantly affected by different fertilizer application (Figure 4.2). The earliest inflorescence emergence was observed in NPK-treated plants and the latest inflorescence emergence was recorded in control plants. It may be due to the rapidly releasing effect of chemical fertilizer more than organic manure.

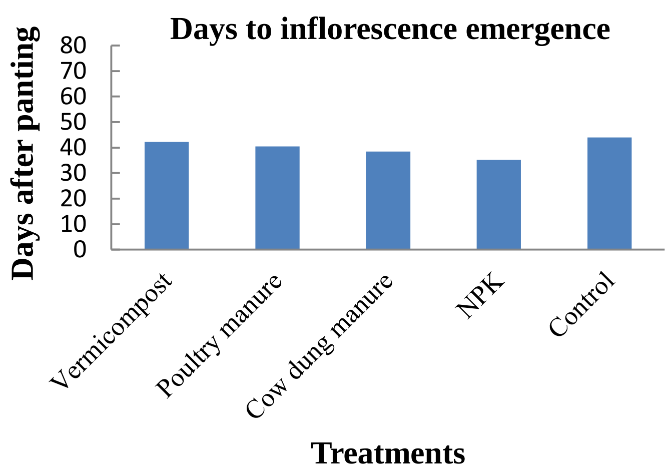

Figure 4.2 Days to inflorescence emergence of the onion plants as affected by different types of fertilizer in the field experiment

Days to 50% flowering

Different types of fertilizers did not significantly affect number of days to 50% flowering (Figure 4.3). The shortest days to 50% flowering was observed in control plants (68 days) and the longest (74 days) in vermicompost and poultry manure-applied plants. According to the result of soil and manure analysis in this study, different types of fertilizers contain different levels of available nitrogen contents that is more or less higher than in control plots. It is apparent that nitrogen can prolong vegetative growth stage leading to delayed 50% flowering in the plants treated with different types of fertilizer.

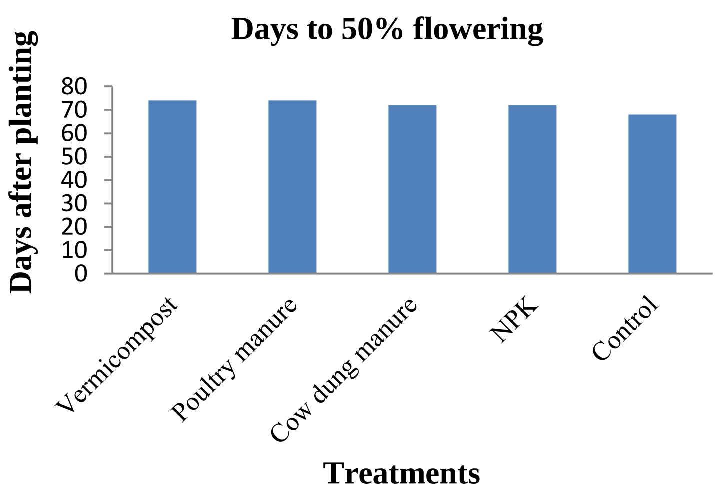

Figure 4.3 Days to 50% flowering of the onion plants as affected by different types of fertilizer in the field experiment

4.1.2 Seed yield parameters

Number of umbels per seed bulb

Number of umbels per seed bulb was not significantly affected by all treatments (Table 4.2). Generally, the number of umbels that can be produced by an onion bulb is largely influenced by genetic factor. In this experiment, only one variety, Shwephalar was used and the insignificant number of umbels per seed bulb was due to the characteristic of that variety. In terms of value maximum number of umbels per seed bulb (2.8) was recorded in poultry manure-treated plants and the minimum number of umbels per seed bulb (2.2) was recorded in vermicompost-treated plants. Castellanos and Pratt (1981) noted that poultry manure was recognized as a valuable source of plant nutrients for crops due to its rapid mineralization.

Seed yield per plant

Seed yield per plant was significantly different among different types of fertilizers (Table4. 2). Poultry manure-applied plants produced significantly highest seed yield (2.6g) that was not significantly different with the seed yield (2.4g) of vermicompost-treated plants while N:P:K-applied plants produced lowest seed yield (1.0g). The result in this study was in agreement with Allen and Farrah (2005) who observed the improvement of seed yield and quality in poultry manure applied onion plants. They also stated that poultry manure has a significant amount of nitrogen. which promotes healthy plant growth and adds long life to humus build up to the soil which encourages healthy microbial and earthworm activity. Therefore, poultry manure-applied plants produced significantly highest seed yield than other treatments. Similar effects were also observed in vermicompost which acts as chealating agent and regulates the availability of micronutrients to plants thereby increased growth and yield by providing nutrient in available form (Giraddi 1993).

Thousand Seed weight (g)

All treatments showed no significant difference in thousand seed weight (Table 4.2). The maximum thousand seed weight (3.6g) was observed in vermicompost-treated plants, N:P:K-treated plants and control plants while minimum thousand seed weight (3.5g) was observed in poultry manure-treated plants and cow dung manure-treated plants. The result contradicts with the finding of Channabasanagowda (2008) who reported that significantly higher seed yield in vermicompost treatment might be attributed to increased 1000 seed weight.

Table 4.2 Number of umbels per seed bulb, seed yield per plant and thousand seed weight as affected by different types of fertilizers in the field experiment

Treatment	No. of umbels per seed bulb	Seed yield per plant (g)	1000 seed weight(g)
Vermicompost	2.2	2.4a	3.6
Poultry manure	2.8	2.6a	3.5
Cow dung	2.5	1.3b	3.5
NPK	2.4	1.0b	3.6
Control	2.3	1.7b	3.6
$LSD_{0.05}$	0.9	0.6	0.13
Pr≥F	ns	*	ns
CV%	23.91	33.18	25.37

ns= no significant,*=significant

4.1.3 Seed quality parameters

Germination percent

There was no significant difference in seed germination percent among all treatments (Table 4.3). The highest seed germination (80.25%) was found in poultry manure-treated plants and the lowest seed germination (64.5%) was observed in control. It appears that the seeds produced by poultry manure-treated plants showed higher seed viability and this finding was in agreement with Wong et al. (1983) who reported that poultry manure application can enhance seed germination of onion in one of his experiments. Moreover, poultry manure acts as a good soil amendment or fertilizer (e.g. provides N, P and K) and can also increase the soil and leaf N, P, K Ca, and Mg concentrations (Duncan 2005; Agbede et al. 2008).

Germination rate

Different types of fertilizers did not affect significantly on germination rate of onion seeds (Table 4 3). The values of germination rate were ranging from 5.25 days in NPK-treated plants to 5.85 days in vermicompost-treated plants. It means that the seed vigor was almost the same in the seeds produced by onion plants applied with all different types of fertilizers in this study.

Fresh weight of seedling (g)

The effects of different types of fertilizers on fresh weight of seedling were not significantly different in this study (Table 4.3). The highest fresh weight (1.09g) of seedling was observed in the seeds produced by poultry manure-treated plants and the lowest fresh weight (0.76g) of seedling was found in those of control plants. It seems to be higher content of available P in poultry manure than vermicompost and cow dung manure used in this study. Highest fresh weight of seedling was observed in application of poultry manure (Giardini et al 1993). Abosdera (2005) also stated that the seed quality can be increased in some crops by applying P fertilizer to the plants. Therefore, Poultry manure- treated plant produced the higher fresh weight of seedling than cow dung manure and vermicompost-treated plants.

Dry weight of seedling (g)

In this experiment, dry weight of seedling was significantly affected by different types of fertilizers (Table 4.3). The maximum dry weight (0.3g) of seedling was observed in the seeds obtained from poultry manure-treated plants and the minimum value (0.15g), from control plants. Channabasanagowda et al. also evaluated the effect of different organic manures on the quality of onion seeds in 2008. In his experiment, the seeds produced by poultry manure applied plants showed the maximum seedling dry weight. Higher seedling dry weight is one of the indicators showing the good seed quality and it is apparent that the seed quality can be improved by using poultry manure in onion seed production. Furthermore, poultry manure is reported to be the richest and most concentrated manure which is particularly good for vegetable production (Olaitan and Lambin, 1988). Organic materials, such as poultry manure, supply chelating agents that aid in maintaining the solubility of micronutrients.

Seedling vigor index

All treatments showed no significant difference in seedling vigor index (Table 4.3). The value was in the range between 68.11 in control plants and 83.65 in cow dung manure-treated plants. Bendegumbal (2007) reported that the seedling vigour index did not varied significantly in onion. The similar findings were also observed by Patel and Patil (1988) and Bhatia and Pandey (1991) in onion.

Table 4.3 Germination percent, germination rate, seedling fresh weight, seedling dry weight and seedling vigor index of onion seed as affected by different types of fertilizer (field experiment)

Treatments	Germination %	Germination rate (days)	Seedling fresh weight (g)	Seedling dry weight (g)	Seedling vigor index
Vermicompost	73.25	5.87	0.08	0.20b	76.99
Poultry manure	80.25	5.52	1.09	0.30a	83.64
Cow dung manure	80.00	5.57	0.99	0.20b	83.65
NPK	79.00	5.25	1.03	0.17b	63.1
Control	64.50	5.62	0.76	0.15b	68.11
LSD	22.06	0.81	0.35	0.7	22.07
Pr≥ F	ns	ns	ns	*	ns
CV%	18.95	9.55	24.56	25.19	18.11

ns= no significant,*=significant

Comparison of seed yield between the application of different organic manures and inorganic fertilizers

The effect of organic manure on seed yield was compared with that of inorganic fertilizers using single-paired comparison and the result was shown in (Table 4.4). Seed yield per plant was significantly different between the onion plants treated with organic manures and inorganic fertilizers. Significantly higher seed yield was observed in the plants treated with different types of manure than those treated with inorganic fertilizer. Among different organic manures, seed yield of poultry manure- treated plants showed no significant difference from that of vermicompost and cow dung manure-treated plants.

It can be assumed that organic fertilizers may improve the physical and biological properties of soil serve as a source of mineral nutrients. So, higher seed yield was observed in the plants treated with different types of manure than chemical fertilizer applied plant.

Table 4.4 Analysis of variance for seed yield between different types of organic manures and chemical fertilizers (field experiment)

Contrast	DF	Mean Square	F Value	Pr > F
C1	1	4.02	9.49	0.0076
C2	1	1.60	3.78	0.0709

C1: Vermicompost, Poultry manure and Cow dung manure vs NPK

C2: Poultry manure vs Vermicompost and Cow dung manure

4.2 Pot Experiment

4.2.1 Plant growth parameters

Plant height

In this experiment, plant height was not significantly affected by different fertilizer application (Figure 4.4). The NPK-applied plants were recorded to have taller plant height (53.26 cm) while the shortest plant (50.01cm) was recorded in control plants. The result is similar to the finding of Vachhani and Patel (1993) who observed the highest plant when NPK fertilizers were applied in their experiment. It may be due to the fact that NPK fertilizers showed faster response in vegetative growth of onion plant than the other fertilizers, different types of organic manure.

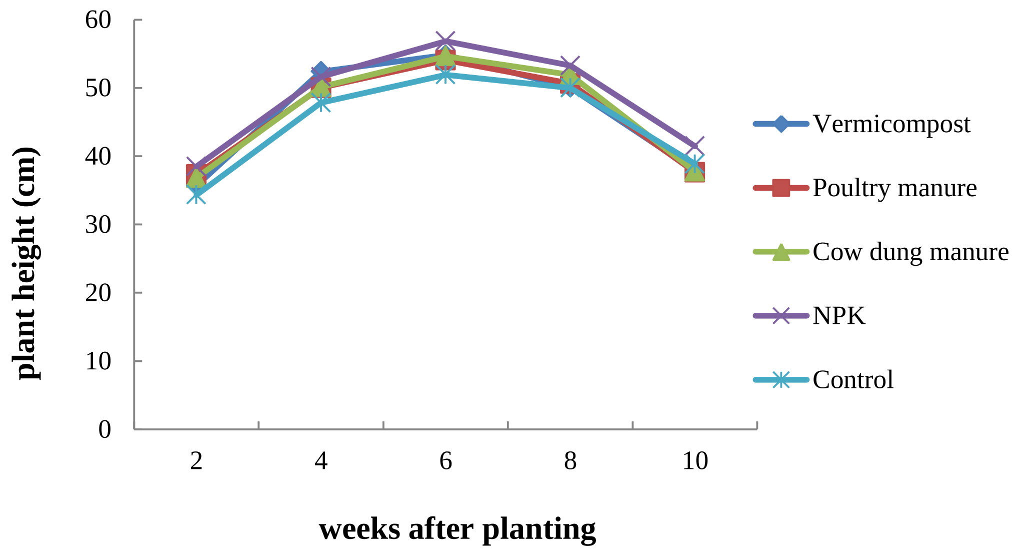

Figure 4.4 Onion plant height (cm) as affected by different types of fertilizers throughout the growing season (pot experiment)

Number of leaves per plant

The number of leaves per plant was not significantly different among different fertilizer applied to the onion plants (Table 4.5). The maximum number of leaves (29.15) per plant was produced from NPK-treated plants while the minimum (25.36), from cow dung manure-applied plants. Higher number of leaves per plant was recorded with the application of NPK fertilizer in onion (Vachhani and Patel 1993). It can be assumed that the use of chemical fertilizer can promote the vegetative growth of the plants such as plant height and number of leaves.

Table 4.5 Number of leaves per plants applied by different types of fertilizer throughout the growing season in the pot experiment

	Number of leaves per plant				
Treatments	2WAP	4WAP	6WAP	8WAP	10WAP
Vermicompost	19.50	26.65	28.25	23.50	13.13
Poultry manure	19.73	27.27	27.05	22.20	13.18
Cow dung manure	17.84	24.95	25.36	19.80	12.95
NPK	17.6 0	26.94	29.15	21.80	14.01
Control	18.78	25.48	26.64	20.65	13.36
$LSD_{0.05}$	3.14	4.21	4.87	3.04	2.61
Pr≥F	ns	ns	ns	ns	ns
CV%	10.9	10.42	11.59	9.16	12.71

WAP = weeks after planting, ns= no significant

Days to inflorescence emergence

Different types of fertilizers did not have significant difference in number of days to reach inflorescence emergence (Figure 4.5). However, in terms of value, the earliest days to inflorescence emergence was observed in cow dung manure-treated plants (14.25) days and the latest days to inflorescence emergence was recorded in NPK-applied plants (18.25) days. From this result, the nature of vegetative-reproductive balance in onion plants can be seen clearly. If the plants get lower vegetative growth, they change to reproductive phase faster than those with higher vegetative growth. It was shown by NPK-treated plants having higher numbers of leaves reached reproductive growth about 4 days later than cow dung manure treated plants which have lower numbers of leaves. Therefore, the application of cow dung manure seemed to be effective in faster inflorescence emergence in onion seed production.

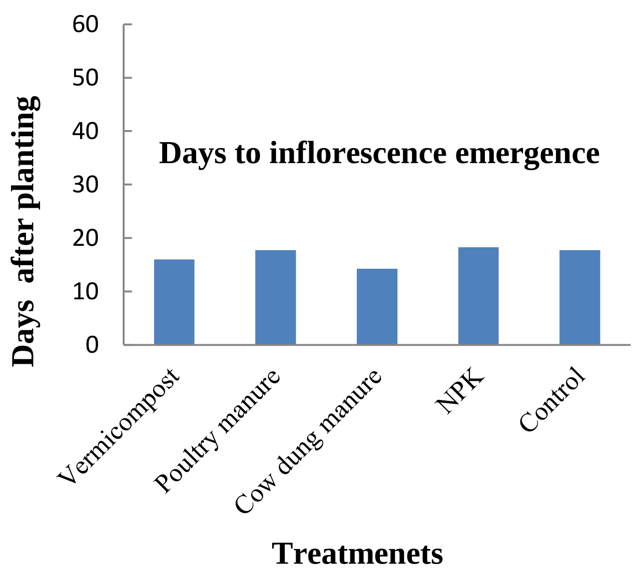

Figure 4.5 Days to inflorescence emergence of the onion plants applied by different type of fertilizer in the pot experiment

Days to 50% flowering

The number of days to 50% flowering was not significantly affected by different fertilizer applications (Figure 4.6). The time required to reach 50% flowering are not much variable, ranging from 35.5days to in vermicompost treatment to 40.37 days in NPK-treated plants. In contrast to this finding, Bendegumbal (2007) noted that the onion plants applied with vermicompost reached 50%flowering much earlier than other fertilizers-treated plants. It was due to the high content of available nutrients such as nitrates, phosphates, exchangeable calcium and soluble potassium (Atiyeh et al., 2002; Arancon et al., 2004).

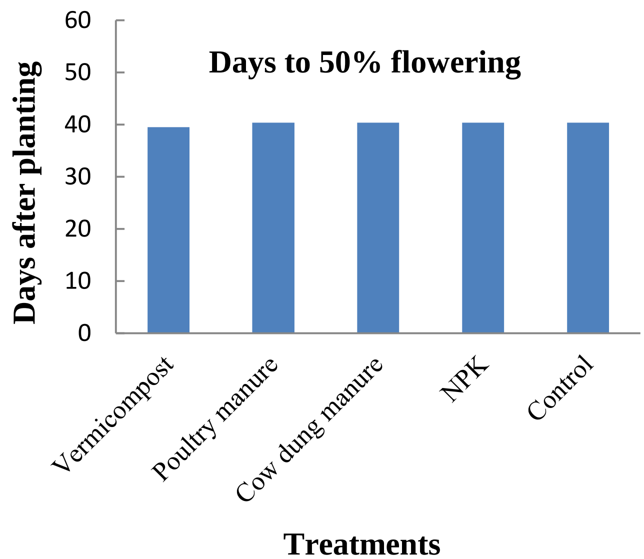

Figure 4.6 Days to 50% flowering of the onion plants applied by different type of fertilizer in the pot experiment

4.2.2 Seed yield parameters

Number of umbels per seed bulb

There was highly significant difference in number of umbels per seed bulb among different types of fertilizer (Table 4.6). The highest number of umbels (3.92) per seed bulb was observed in poultry manure applied plants and the lowest number of umbels (2.92) per seed bulb was observed in cow dung manure-treated plants. Giardini et al (1993) also observed higher number of umbels per seed bulb in poultry manure applied onion plants. In fact, the number of umbels per seed bulb is mainly dependent on the type of cultivar used. However, in this study, there may be certain other factors that can influence on the number of umbels per seed bulb such as the condition of plant growth and the availability of nutrients of the soil.

Seed yield per plant

The effect of different types of fertilizer was highly significant on seed yield per plant in this study (Table 4.6). Significantly highest seed yield (1.5g) was observed when the plants were applied with the poultry manure although the value was not significantly different with NPK-treated plant while control plants produced lowest seed yield (0.38g) per plant. This finding concurred with that of Zamil et al (2004) who observed that poultry manure treated plants produced highest seed yield. Poultry manure is one of the main sources of organic plant nutrient and has a great potential for soil fertility maintenance, and equally important are its effects on the improvement of soil organic matter, soil structure and the biological life of the soil when applied in adequate quantities (Mathew and Karikari, 1995).

Thousand seed weight

Different types of fertilizer showed significantly different effect in thousand seed weight of the seeds produced by onion plants (Table 4.6). In this study, the plants treated with all different types of fertilizer produced significantly higher thousand seed weight than control plants. Applied organic materials promote biological activity in the soil, as well as a favorable nutrient exchange capacity, water balance, organic matter content and soil structure (Muse, 1993). Organic manure and chemical fertilizers provide nutrient for producing healthy and vigorous plant growth. It can lead to increasing nutrient availability of the plants thus become better dry matter accumulation in the seeds. It is obvious that dry matter accumulation became higher in reproductive organ of fertilizer-treated onion plants than non-treated plants.

Table 4.6 Number of umbels per seed bulb, seed yield per plant (g) and thousand seed weight (g) as affected by different types of fertilizer in the pot experiment

Treatment	No. of umbels per seed bulb	Seed yield per plant (g)	1000 seed weight (g)
Vermicompost	3.47b	0.72b	3.55a
Poultry manure	3.92a	1.50a	3.60a
Cow dung	2.92d	0.70b	3.55a
NPK	3.12cd	1.38a	3.52a
Control	3.32bc	0.38b	3.32b
$LSD_{0.05}$	0.28	0.41	0.10
Pr≥F	**	**	*
CV%	5.49	28.89	3.13

**=highly significant,*= significant

4.2.3 Seed quality parameters

Seed germination %

Seed germination percent was not significantly affected by different types of fertilizer (Table 4.7). The maximum seed germination (69.25 %) was observed in vermicompost-treated plants and the minimum seed germination (63.25 %) was observed in poultry manure-applied plants. The non-significant effect of different organic manure on seed germination percent was also recognized by Bendegumbal (2007). The possible reason may be due to the ability to show the response of the crops to the different types of fertilizers applied and as a general rule, organic manure cannot show the significant response in only one growing season. Its effect will be more prominent in next growing season due to its slow releasing nature and its ability to improve physical properties of the soil.

Germination rate

There was no significant difference in germination rate among all treatments (Table 4.7). The fast germination rate (4.27 days) was observed in poultry manure-treated plants and the slowest germination rate (4.95 days) was observed in control plants. The similar findings were recorded by Patel and Patil (1988) and Bhatia and Pandey (1991) in which the use of different types of organic manures showed no influence on seed quality parameters in onion seeds.

Seedling vigor index

Seedling vigor index was not significantly affected by application of different types of fertilizer (Table 4.7). This result was in accord with Bendegumbal (2007) who found that different types of organic manure and their combination showed no significant effect on seedling vigour index. The value of seedling vigor index was calculated using the value of germination percent, shoot length and root length of the seedlings in this study. Therefore, the different types of fertilizers seemed to have the positive effect only on yield parameter such as seed yield per plant and thousand seed weight but this effect cannot be carried to the seed quality parameters.

Table 4.7 Germination percent, germination rate and seedling vigor index of onion seed as affected by different types of fertilizer in pot experiment

Treatment	Germination percent	Germination rate (days)	Seedling vigor index
Vermicompost	69.25	4.82	76.68
Poultry manure	63.25	4.27	73.34
Cow dung	66.00	4.75	71.85
NPK	64.25	5.35	72.12
Control	64.50	4.95	72.63
$LSD_{0.05}$	5.73	0.98	6.25
Pr≥F	ns	ns	ns
CV%	2.68	13.01	5.50

ns = no significant

Comparison of seed yield between the effect of different organic manure and inorganic fertilizer

The effects of organic fertilizer and inorganic fertilizers on seed yield were compared using single-paired comparison and the result is shown in Table 4.8. Seed yield per plant was significantly different between the onion plants treated with different organic manures and inorganic fertilizer. In pot experiment, the plants treated with inorganic fertilizers produced higher seed yield than those treated with different organic manure. Among different organic manures, the seed yield of poultry manure treated plants was significantly higher than those of vermicompost and cow dung manure-treated ones.

It was obvious that the effect of NPK on seed yield showed much clearer in the pot experiment than that of field experiment. Similarly, significant increase in seed yield was recorded with the application of NPK fertilizer (Rashmi 2003). NPK responded positively to seed yield and seed yield components of plant.

Table 4.8 Analysis of variances for seed yield between different types of organic manures and inorganic fertilizers (pot experiment)

Contrast	DF	Mean Square	F Value	Pr > F
C1	1	0.48	7.70	0.0142
C2	1	1.68	26.69	0.001

C1: Vermicompost, Poultry manure and Cow dung manure vs NPK

C2: Poultry manure vs Vermicompost and Cow dung manure

CHAPTER V

CONCLUSION

The present study evaluated influence of nutrient management on yield and quality of onion seeds (*Allium cepa* L.) using different types of fertilizers in two growing seasons, from November 2011 to April 2012 and from November 2012 to April 2013.

In the field experiment, the growth parameters were not significantly affected by different types of fertilizers except plant height, in which NPK-treated plants were significantly higher than others. Significantly higher seed yield was observed in poultry manure- and vermicompost-treated plants and heavier seedling dry weight was noted in poultry manure treated plants than other treatments.

In the pot experiment, no significant difference was observed in all growth parameters, seed germination%, seedling fresh weight, seedling dry weight, seedling vigor index among different types of fertilizers. However, poultry manure-treated plants produced significantly higher seed yield than other treatments except NPK-treated plants. Thousand seed weight of the onion seeds produced by all fertilizer-treated plants was significantly higher than that of control plants.

In comparing the effect of organic manures with that of chemical fertilizer, significantly higher seed yield was observed in organic manure treated plants than chemical fertilizer-treated ones in the field experiment and NPK treated plants produced higher seed yield than organic manure-treated plant in the pot experiment.

The result of field experiment revealed that poultry manure and vermicompost should be used for higher onion seed yield. However, the effect of vermicompost seemed to be variable because of lower seed yield in vermicompost-treated plants in the pot experiment.

Based on the results of this study, poultry manure should be used to improve onion seed production in Myanmar. Moreover, it is also suggested that the effect of different organic manures and their combinations on the quality of onion seeds is needed to study. The optimum concentration of poultry manure should be further investigated in quality seed production of onion.

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Appendix Figure 1.Onion field at the department of Horticulture

Appendix Figure 2. Onion pot experiment at the department of Horticulture

Appendix figure 3. Onion inflorescence showing seed maturity

APPENDIX TABLES

Appendix Table 1 Onion plant height (cm) as affected by different types of fertilizer throughout the growing season in the field experiment

Treatment	Plant height (cm)										
	2WAP	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP	9WAP	10WAP	11WAP	12WAP
vermicompost	22.29	31.39	34.53	36.73	37.23c	38.94	35.52c	35.52c	33.8bc	33.27	29.34
poultry manure	21.96	31.50	35.93	37.38	35.92ab	44.25	41.05a	41.05a	38.87ab	38.03	24.75
cow dung manure	19.93	28.47	34.76	35.75	35.99c	36.53	32.75c	32.75c	29.62c	30.10	23.05
NPK	24.47	32.30	35.78	39.27	46.05a	45.72	44.76a	44.76a	44.02a	39.88	27.93
control	22.39	29.93	36.13	38.40	40.33bc	47.27	37.97bc	37.97bc	36.4b	34.03	27.73
LSD	3.75	6.07	7.54	6.70	4.42	7.40	6.39	6.39	5.93	5.32	0.04
Pr ≥ F	ns	ns	ns	ns	**	ns	*	*	**	ns	ns
CV%	10.96	12.84	13.82	11.53	7.08	11.59	10.8	10.8	10.54	9.86	17.19

Mean of the same latter within a column are not significantly different based on LSD at 5% level

ns = non significant, *= significant at 0.05% probability level,**= significant at 0.01 probability level, WAP= weeks after planting

Appendix Table 2 Number of leaves per plant as affected by different types of fertilizer throughout the growing season in the field experiment

Treatment	Number of leaves per plant										
	2WAP	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP	9WAP	10WAP	11WAP	12WAP
vermicompost	8.05	9.95	10.85	13.75	14.05	19.95	14.90	14.25	13.20	11.80	10.00
poultry manure	8.85	10.75	15.10	16.55	17.95	18.55	17.65	15.70	13.30	9.25	6.85
cow dung manure	9.65	12.40	14.25	17.10	17.45	19.40	18.45	18.10	15.35	13.30	10.00
NPK	7.80	7.80	15.40	16.10	18.05	16.55	16.55	15.65	13.70	11.10	7.50
control	8.00	10.00	12.35	14.25	14.75	14.45	14.45	13.60	12.55	10.95	8.05
LSD	3.08	5.88	4.93	4.75	4.39	6.29	5.07	5.08	5.05	6.41	5.27
Pr≥F	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
CV%	23.65	32.37	23.59	19.84	17.33	21.67	20.08	21.24	24.07	25.17	40.38

Mean of the same latter within a column are not significantly different based on LSD at 5% level

ns = non significant, *= significant at 0.05% probability level,**= significant at 0.01 probability level, WAP= weeks after planting

Appendix Table 3 Onion plant heights (cm) as affected by different types of fertilizes in pot experiment

Treatment	Plant height (cm)										
	1WAP	2WAP	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP	9WAP	10WAP	11WAP
vermicompost	24.59	35.70	43.16	52.40	50.40	54.80	53.43	50.04	52.33	37.89	19.47
poultry manure	24.78	37.32	44.46	50.02	52.17	54.05	53.62	50.63	49.05	37.65	15.67
cow dung manure	24.59	36.84	44.53	50.14	51.32	54.65	53.20	51.91	50.81	37.75	16.22
NPK	25.18	38.49	46.01	51.61	55.19	56.85	55.33	53.26	52.59	41.47	20.82
control	21.93	34.34	41.81	47.82	50.40	51.93	51.68	50.01	50.23	38.86	15.96
$LSD_{0.05}$	3.44	4.90	4.34	4.55	6.67	3.31	2.23	7.28	4.94	7.21	6.51
$Pr \geq F$	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
CV%	9.27	8.71	6.40	5.80	8.34	3.95	2.71	9.24	6.28	12.09	23.99

Mean of the same latter within a column are not significantly different based on LSD at 5% level

ns = non significant, WAP= weeks after planting

Appendix Table 4 Number of leaves per plants applied by different types of fertilizer throughout the growing season in the pot experiment

Treatment	Number of leaves per plant										
	1WAP	2WAP	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP	9WAP	10WAP	11WAP
vermicompost	14.34	19.50	24.84	26.65	28.05	28.25	25.93	23.5	21.46	13.13	6.81
poultry manure	14.15	19.73	22.84	27.27	29.56	27.05	24.2	22.2	20.36	13.18	7.02
cow dung manure	12.12	17.84	20.75	24.95	25.77	25.36	23.17	19.8	19.42	12.95	6.81
NPK	13.17	17.60	20.99	26.94	27.87	29.15	24.46	21.8	22.3	14.01	7.15
control	14.22	18.78	22.31	25.48	26.74	26.64	23.63	20.65	20.15	13.36	6.98
LSD	2.69	3.14	4.53	4.21	3.86	4.87	2.70	3.04	2.78	2.61	1.26
Pr≥F	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
CV%	12.86	10.90	13.16	10.42	9.09	11.59	7.23	9.16	8.69	12.71	11.80

Mean of the same latter within a column are not significantly different based on LSD at 5% level

ns = non significant, WAP = weeks after planting

Appendix Table 5 Analysis of available nutrient content of different organic manure used in the field experiment

no	Sample	Available (%) O.D.B*				Organic carbon%
		N	P	K	S	
1	Poultry manure	1.41	1.05	0.78	0.07	16.45
2	Cow dung manure	1.77	1.02	0.71	0.06	41.53
3	Vermicompost	0.53	0.09	1.32	0.01	7.93

Appendix Table 6 Analysis of available nutrient content of different organic manure used in the pot experiment

No	Sample	Available (%) O.D.B*				Organic carbon%
		N	P	K	S	
1	Poultry manure	1.35	0.45	0.28	0.15	14.2
2	Cow dung manure	1.68	2.59	0.32	0.3	14.5
3	Vermicompost	0.49	0.3	0.21	0.32	9.1

O.D.B*= Oven Dry Basis

Appendix Table 7 Rainfall and temperature data collected from meteorological station of Department of Agricultural Research (DAR), Yezin during experimental period (2011-2012)

Month	Temperature(°C)		Total rainfall (mm)
	Maximum	Minimum	
November	34.8	21.4	-
December	32.4	15.6	-
January	32.8	14.2	3.6
February	36.4	16.0	-
March	38.3	18.8	-

Appendix Table 8 Rainfall and temperature data collected from meteorological station of Department of Agricultural Research (DAR), Yezin during experimental period (2012-2013)

Month	Temperature(°C)		Total rainfall (mm)
	Maximum	Minimum	
November	34.8	21.5	-
December	32.4	15.7	-
January	32.0	14.7	3.7
February	36.5	17.7	-
March	38.4	18.4	-