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EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON ONION YIELD AND SOIL PROPERTIES IN SOYBEAN – ONION CROPPING SEQUENCE

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ABSTRACT

Study on "effect of Integrated nutrient management on yield of onion and soil properties in soybean-onion cropping sequence" was carried out during 2006-2007 and 2007-2008 for two successive years at All India Coordinated Research Project on Cropping Systems Farm, Mahatma Phule Krishi Vedyapeeth, Rahuri, District of Ahmednagar, Maharashtra State, India. The experimental field soil is sandy clay loam in texture, low in nitrogen, medium in phosphorus, fairly rich in potash, low in organic carbon content and slightly alkaline in reaction with pH 8.36. The experiment was laid out in Randomized Block Design (RBD) during both rabi seasons with eight treatments and four replications. Onion variety was used as Cv. N-2-4-1. The treatment details along with the symbols used are given below: T_1: 50% NPK recommended dose combined with 50% N through FYM + micronutrient as per soil test; T_2: 1/3 recommended N each through FYM, vermicompost and neem seed cake; T_3: T_2 + trap crop (sannhemp); T_4: T_2 + Agronomic practices the hand weeding and IPM technique for pest control; T_5: 50% N through FYM + Azotobacter + PSB; T_6: T_2 + Azotobacter + PSB; T_7: 100% NPK recommended dose and T_8: Control (no fertilizer application). The results showed that the production potential of soybean-onion cropping sequence was the maximum at 100 percent (302.8 q onion bulb ha^{-1}) recommended dose of fertilizer (100:50:50 kg ha^{-1} for onion). Similarly, the application of 100% organic nutrient source through FYM, vermicompost, neem seed cake, Azotobacter, PSB and trap crop gave the maximum yield of onion and also improved the fertility status of soil more than control and 100% NPK recommended dose.

INTRODUCTION

Onion, *Allium cepa*, is one of the leading vegetable crops worldwide, grown for its culinary purposes and medicinal values. In 2003, it was cultivated in more than 175 countries, on nearly 3 million ha, producing more than 50 million tonnes. India is the second largest producer of onion after China (Scholten and Van Bruggen 2007). In addition, onion, native of middle Asia or Mediterranean region, is one of the basic and most widely consumed bulb vegetables. Onion is especially a seasonal crop (*kharif* and *rabi*) belonging to the domestic market and is being commonly used for its pungency and flavour (Selvaraj 1976).

The compost is a more stable product since almost the entire nutrient fractions are in an organic form and the material is semi decomposed. Plants can uptake majority of nutrients in an inorganic form. Therefore, the nutrients in composted manure need to undergo biological breakdown (mineralization) in the soil before they are available to the plants. In essence, composted manure is a slow release fertilizer (Wiederholt *et al.* 2005)**.** Otherwise, organic farming systems, the use of temporally and spatially diverse crop rotations remains fundamental to the success of organic production systems; positive management of biological and ecological systems replaces inputs of synthetic pesticides and soluble NPK mineral fertilizers. While crop selection must, inevitably, be market driven to provide efficient economic production, a well balanced sequence of crops should be chosen that requires minimum external inputs, nutrients, machinery and energy to maintain soil fertility, and quality and yield of production (Jordan and Hutcheon 1996). Therefore, present investigation

on **"**effect of integrated nutrient management on yield of onion and soil properties in soybean-onion cropping sequence".

MATERIALS AND METHODS

The investigation on "Effect of inorganic and organic sources on yield of onion and soil properties in soybean-onion cropping sequence" was carried out during 2006-2007 and 2007-2008 for two successive years at All India Coordinated Research Project on Cropping Systems Farm, Mahatma Phule Krishi Vedyapeeth, Rahuri, District of Ahmednagar, Maharashtra State, India. The experimental field soil is sandy clay loam in texture, low in nitrogen, medium in phosphorus, fairly rich in potash, low in organic carbon content and slightly alkaline in reaction with pH 8.36. The experiment was laid out in Randomized Block Design (RBD) during both *rabi* seasons with eight treatments and four replications. Onion variety was used Cv. N-2-4-1. The gross and net plot sizes were 9.00 m x 4.50 m and 8.40 m x 3.30 m, respectively. These plot sizes were used for both the years of experimentation. The onion was planted at a spacing of 15 cm x 10 cm during both *rabi* seasons. The treatment details along with the symbols used are given below: T_1: 50% NPK recommended dose combined with 50% N through FYM + micronutrient as per soil test; T_2: 1/3 recommended N each through FYM, vermicompost and neem seed cake; T_3: T_2 + trap crop (sannhemp); T_4: T_2 + Agronomic practices the hand weeding and IPM technique for pest control; T_5: 50% N through FYM + *Azotobacter* + PSB; T_6: T_2 + *Azotobacter* + PSB; T_7: 100% NPK recommended dose and T_8: Control (no fertilizer application).

- Recommended dose for onion was 100: 50: 50 kg ha^{-1} (N: P_2O_5:K_2O)
- Zine sulphate was used one time with 20 kg ha^{-1} in first season of soybean crop.
- Sannhemp grown between two rows of soybean in treatment T_3 and it was incorporated in the soil at 40 days after sowing.

RESULTS AND DISCUSSION

1. Yield of onion

The results in Table 1 and 2 showed that the maximum height fresh weight of single bulb and bulb yield of onion in treatment T_7 of 100% NPK recommended dose was found significantly higher than other treatments followed by treatment T_1 of 50% NPK recommended dose combined with 50% N through FYM while the minimum theses parameters were reported in treatment control during both the years of the experiment. The per cent of pooled mean over control of onion bulb yield was the higher in T_7 with 97.1% and the other treatments of organic were also higher as compared with control and obtained 39.2 to 49.4 per cent (Table 1 and 2).

Table 1. Mean fresh weight of single onion bulb (g) as influenced by different treatments at harvest.

Treatments	2006-07 *Rabi*	2007-08 *Rabi*
T_1:50% NPK RDF + 50%N through FYM + micronutrient as per soil test (Zn)	69.7	74.8
T_2:1/3 N through each FYM, vermicompost and neem seed cake	58.7	62.2
T_3: T_2 + Trap crop (Sannhemp)	63.5	68.7
T_4: T_2 + Agronomic practices the hand weeding and IPM technique for pest control	62.2	67.6
T_5: 50%N through FYM + *Azotobacter* + PSB	60.1	62.1
T_6: T_2 + *Azotobacter* + PSB	63.6	66.7
T_7 : 100% NPK RDF	78.4	84.7
T_8: Control (no fertilizer application)	43.0	45.5
SE (m) ±	3.02	2.39
CD at 5%	8.95	7.07
General mean	62.4	66.5

Jayathilake *et al*. (2003) reported that the total bulb yield of onion and its components significantly increased with the application of biofertilizers in combination with organic nitrogen fertilizers. The kinds of organic fertilization applied in the experiment had a significant effect on the increase in the yields of onion as compared to without organic fertilization. The yields of onion increased respectively by 22.76-59.70 per cent and 17.30-48.65 per cent (Franczuk and Jablońska 2002). Bhujbal (1989) recorded that the effect of organic, inorganic and biofertilizer on growth, yield and storage quality of bulbs cv. N-2-4-1, reported that the highest plant height and number of leaves per plant were recorded by the treatment of 60 t FYM + 100:50:50 kg NPK ha^{-1}. In addition, Abbey and Kanton (2003) revealed from the application of farmyard manure (FYM), inorganic fertilizer (IF) or a combination of manure and inorganic fertilizer (FYM + IF) that the onion bulb weight was increased by FYM+IF in both the years. Similarly, Morarka (2006) reported that the application of dose of about 2500 kg of vermicast ha^{-1} to onion has been recommended as a substitute for chemical fertilizers. The use of farmyard manure also had been reduced to 50 percent level of chemical fertilizer.

Table 2. Mean bulb yield (q ha^{-1}) and the percentages of yield over control as influenced by different treatments.

Treatments	2006-2007 *Rabi*		2007-2008 *Rabi*		Pooled mean basis	
	Bulb yield (q ha^{-1})	Yield over control (%)	Bulb yield (q ha^{-1})	Yield over control (%)	Bulb yield (q ha^{-1})	Yield over control (%)
T_1:50% NPK RDF + 50%N through FYM + micronutrient as per soil test (Zn)	235.3	56.4	243.4	55.4	239.4	55.8
T_2:1/3 N through each FYM, vermicompost and neem seed cake	221.4	47.2	227.3	45.1	224.4	46.1
T_3: T_2 + Trap crop (Sannhemp)	222.3	47.8	229.9	46.8	226.1	47.2
T_4: T_2 + Agronomic practices the hand weeding and IPM technique for pest control	224.3	49.1	231.2	47.6	227.8	48.3
T_5: 50%N through FYM + *Rhizobium/ Azotobacter* + PSB	210.3	39.8	217.1	38.6	213.7	39.2
T_6: T_2 + *Rhizobium/ Azotobacter* + PSB	225.6	50.0	233.3	49.0	229.5	49.4
T_7 : 100% NPK RDF	298.3	98.2	307.2	96.2	302.8	97.1
T_8: Control (no fertilizer application)	150.4	-	156.6	-	153.5	-
SE (m) ±	3.68	-	3.24	-	2.52	
CD at 5%	12.16		9.61		7.46	
General mean	223.4		230.8		227.2	

2. Soil properties

2.1. pH: The analysis of soil from the permanent manorial plots revealed that continuous application of cattle manure for 84 years recorded higher values for all the physical properties evaluated (Vennila and Muthuvel 1999). The mean pH of soil registered as 8.39, 8.43 and 8.41 during the first year and during the second year and in pooled mean, respectively (Table 3). During both the years and in pooled mean, pH in the soil of all the treatments was not significant. The application of organic sources had not found to decrease pH of soil after first year and second year of the experimentation.

Table 3. pH of the soil as influenced by different treatments at harvest of *rabi* onion.

Treatments	2006-2007	2007-2008	Pooled mean
T_1:50% NPK RDF + 50%N through FYM + micronutrient as per soil test (Zn)	8.36	8.38	8.37
T_2:1/3 N through each FYM, vermicompost and neem seed cake	8.36	8.41	8.38
T_3: T_2 + Trap crop (Sannhemp)	8.40	8.44	8.42
T_4: T_2 + Agronomic practices hand weeding and IPM for pest control	8.41	8.42	8.41
T_5: 50%N through FYM + *Azotobacter* + PSB	8.40	8.49	8.44
T_6: T_2 + *Azotobacter* + PSB	8.39	8.43	8.41
T_7 : 100% NPK RDF	8.38	8.43	8.40
T_8: Control (no fertilizer application)	8.44	8.49	8.46
Initial	8.37	8.37	8.37
SE (m) ±	0.02	0.03	0.02
CD at 5%	ns	ns	ns
General mean	8.39	8.43	8.41

NS: not significant

2.2. EC: The mean EC of soil was measured 0.383 and 0.367 dSm^{-1} during the first year and the second year, respectively (Table 4). The EC in control (T_8) was highest while the EC the treatment T_3 registered lowest EC during both the years. The results showed that all the treatments, of organic sources as T_1, T_2, T_3, T_4, T_5 and T_6 were significantly the lowered these as compared with control during both the years. However, these organic sources were at par with treatment T_7 with 100% NPK recommended dose during both the years.

The field experiment on rotational system of *rabi* crops on medium black soil at Solapur (Maharashtra, India) indicated that crop rotation increased organic carbon where as soil pH and EC remained more or less same (Gaikwad *et al.* 1994). Maheswarappa *et al.* (1999) reported that FYM and vermicompost application alone decreased the bulk density, improved soil porosity, organic carbon, pH and maximum water holding capacity to a greater extent whereas under NPK alone and control there was no change in physico-chemical properties

Table 4. Electrical conductivity (EC dSm^{-1}) of the soil as influenced by different treatments at harvest *rabi* onion.

Treatments	2006-2007	2007-2008	Pooled mean
T_1:50% NPK RDF + 50%N through FYM + micronutrient as per soil test (Zn)	0.368	0.343	0.355
T_2:1/3 N through each FYM, vermicompost and neem seed cake	0.375	0.360	0.368
T_3: T_2 + Trap crop (Sannhemp)	0.365	0.340	0.353
T_4: T_2 + Agronomic practices hand weeding and IPM for pest control	0.385	0.363	0.374
T_5: 50%N through FYM + *Azotobacter* + PSB	0.378	0.350	0.364
T_6: T_2 + *Azotobacter* + PSB	0.378	0.373	0.375
T_7 : 100% NPK RDF	0.370	0.358	0.364
T_8: Control (no fertilizer application)	0.415	0.430	0.423

Treatments	2006-2007	2007-2008	Pooled mean
Initial	0.390	0.390	0.390
SE (m) ±	0.010	0.014	0.009
CD at 5%	0.028	0.042	0.027
General mean	0.383	0.367	0.374

2.3. Organic carbon

The mean organic carbon content was found 0.54 and 0.59 per cent at harvest of onion during the first and the second year, respectively (Table 5).

The results of organic carbon in the soil of the treatments, which was applied with organic sources as T_1, T_2, T_3, T_4, T_5 and T_6, were identical in organic carbon during both the years. However, they were not significant with treatment T_7 applied with 100% NPK recommended dose during the first year but these organic sources were registered significant as compared with treatment T_7 during the second year. While organic carbon content in control (T_8) was significantly lowest as compared with all the organic sources during both the years of the experiment.

Table 5. The organic carbon content (%) in the soil as influenced by different treatments at harvest of *rabi* onion.

Treatments	2006-2007	2007-2008	Pooled mean
T_1:50% NPK RDF + 50%N through FYM + micronutrient as per soil test (Zn)	0.55	0.63	0.60
T_2:1/3 N through each FYM, vermicompost and neem seed cake	0.57	0.61	0.58
T_3: T_2 + Trap crop (Sannhemp)	0.56	0.62	0.59
T_4: T_2 + Agronomic practices hand weeding and IPM for pest control	0.57	0.61	0.59
T_5: 50%N through FYM + *Azotobacter* + PSB	0.54	0.60	0.57
T_6: T_2 + *Azotobacter* + PSB	0.56	0.61	0.59
T_7 : 100% NPK RDF	0.51	0.53	0.54
T_8: Control (no fertilizer application)	0.49	0.48	0.49
Initial	0.51	0.51	0.51
SE (m) ±	0.02	0.01	0.01
CD at 5%	0.05	0.05	0.03
General mean	0.54	0.59	0.57

By incorporation of organic fertilizer and biofertilizer improved the soil fertility also decreased electrical conductivity and increased organic carbon content. Acharrya *et al.* (1988) reported that the treatment receiving FYM + 100 per cent of recommended N, P and K improved the organic carbon. Thind *et al.* (1993) studied effect of organic manures in maize-wheat rotation and observed that organic carbon markedly increased in FYM treatment. Santhy *et al.* (1999) revealed that the integrated use of organic manure (FYM) + inorganic fertilizer (NPK) slightly increased the EC (100% NPK + FYM). The pH remained unaltered by the treatments. Dux and Fink (2007) found that after 40 years without manure, soil organic matter-carbon (SOM-C) decreased approximately by 40 per cent, and increased by 27 per cent with the highest application rate.

2.4. Net nutrient balance

The maximum net nitrogen was registered as 13.0 kg ha^{-1} in treatment T_1 applied with 50% NPK

recommended combination with 50 % N through FYM while the minimum net nitrogen was found -14.4 kg ha^{-1} in treatment control (T_8). The treatment T_7 which was used with 100% NPK recommended dose obtained 12.2 kg N ha^{-1}. The other treatments with organic sources (T_2 to T_6) had more net nitrogen than treatment control (Fig. 1). The results could be concluded that application with organic sources increased nitrogen in the soil for past two years. The estimated mean values of the N fixation in soybean were 53 and 62 per cent by the ureide and isotope dilution methods respectively (Iwuafor *et al.* 2002).

The net phosphorus in treatment T_7 applied with 100 % NPK recommended dose had remained 2.5 kg ha^{-1} in the soil at the end of two years in soybean-onion cropping sequence while all the treatments of organic sources as T_1, T_2, T_3, T_4, T_5 and T_6, reached as 5.2 to 13 kg P ha^{-1}. The application with organic sources was increased more phosphorus than treatment with 100% NPK recommended and control (Fig. 2).

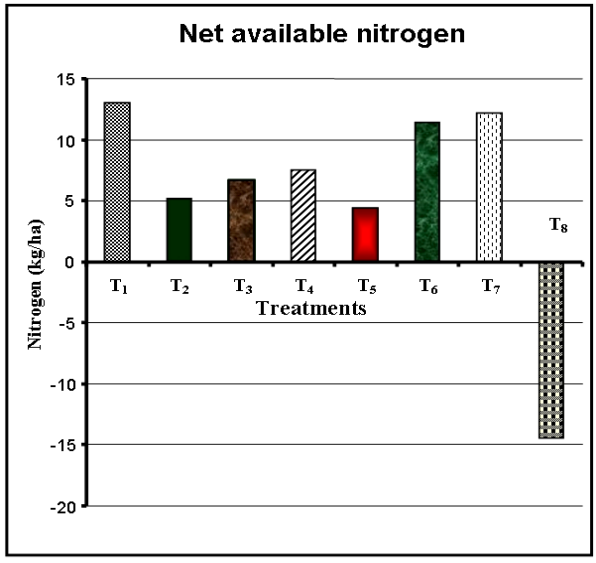

Figure 1. Net nitrogen balance as influenced by different treatments after two cycles of soybean-onion cropping sequence (fourth season)

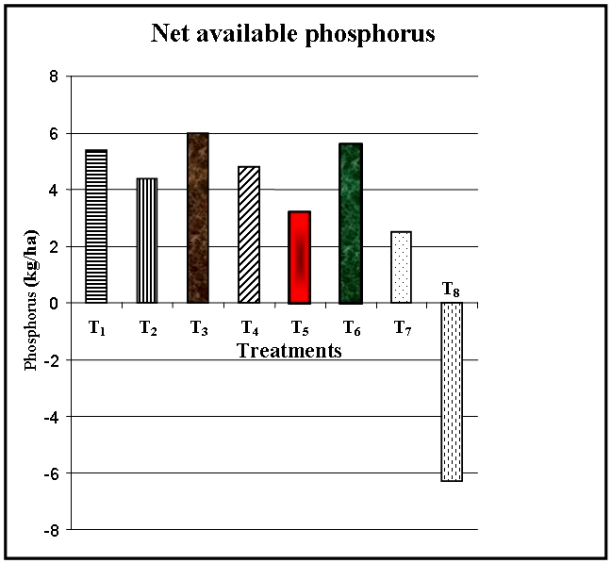

Figure 2. Net phosphorus balance as influenced by different treatments after two cycles of soybean-onion cropping sequence (fourth season).

The net potassium was positive in all the treatments, which applied with organic sources (from T_1 to T_6) while the treatment T_7 applied with 100% NPK recommended dose and treatment control were negative in the potassium at the end of two cycles of soybean-onion cropping sequence. The maximum net potassium was 38.1 kg ha^{-1} in treatment T_1 which was applied with 50 % NPK recommended dose + 50% N through FYM and the minimum net potassium was found -51.5 kg ha^{-1} in treatment control (T_8). The other treatments like T_2, T_3, T_4, T_5 and T_6 enhanced more net potassium than control and treatment T_7 (Fig 3).

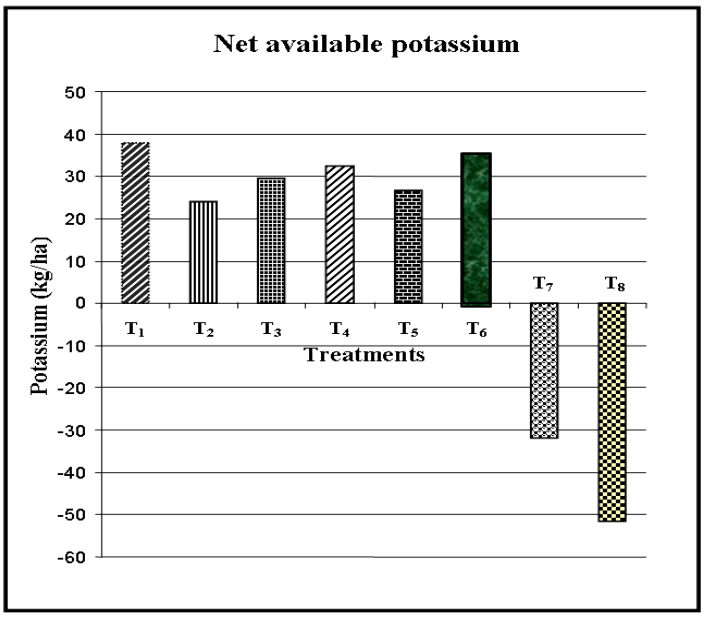

Figure 3. Net potassium balance as influenced by different treatments after two cycles of soybean-onion cropping sequence (fourth season).

Available P and K showed depletion due to cropping when compared to initial status (Gaikwad *et al.* 1994). In addition, Patil *et al.* (1995) reported that the legumes in the sequence or addition of organic matter to the crop improved the fertility status of available N in soil. They stated that P and K status in the soil was also maintained by these sequences.

The results of the net nutrient balance as shown above of soybean-onion cropping sequence of the experiment could be concluded that the application with organic sources was improved more than nutrients in the soil over control and using with 100% of chemical fertilizer. Malewar *et al,* (1999) indicated that each oilseed based crop sequence showed differential effect on the availability of N, P and K in soil. Ogoke *et al.* (2003) studied the cereal-based cropping system on its effects on soil N. The calculated N balance of the early and the medium varieties was −2.6 to −12.2 kg N ha^{-1} while the longer duration varieties had positive N balances ranging from 2 to 10.9 kg N ha^{-1}. The N accrual was negative when P was not applied and ranged from 2.4 to 5.2 kg N ha^{-1} with P application.

CONCLUSIONS

- The production potential of soybean-onion cropping sequence was maximum at 100 percent (302.8 q onion bulb ha^{-1}) recommended dose of fertilizer (100:50:50 kg ha^{-1} for onion).
- Application of 100% organic nutrient source through FYM, vermicompost, neem seed cake, *Azotobacter,* PSB and trap crop gave the maximum yield of onion and also improved the fertility status of soil more than control and 100% NPK recommended dose.

Future line of work

This experiment should be done continuous a long term for estimating effective organic sources on yield, quality, economic and soil health. In addition, to study soil microbiology factors and other soil physico-chemical properties.

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Ảnh hưởng của quản lý dinh dưỡng tổng hợp trên năng suất của hành củ và trên một số đặc tính đất của hệ thống luân canh đậu nành – hành củ

Nghiên cứu "ảnh hưởng của quản lý dinh dưỡng tổng hợp trên năng suất của hành củ và trên một số đặc tính đất của hệ thống luân canh đậu nành – hành củ" được thực hiện năm 2006-2007 và 2007-2008 tại Nông Trại của hệ thống Canh Tác, trường Đại học Nông Nghiệp Mahatma Phule (MPKV), Rahuri, huyện Ahmednagar, (MS) India. Thí nghiệm được bố trí theo khối hòan tòan ngẫu nhiên (RBD) trong suốt cả vụ hai vụ *rabi* (mùa đông) với 8 nghiệm thức và 4 lần lặp lại. Giống hành N-2-4-1được sử dụng cho thí nghiệm. Các nghiệm thức được bố trí như sau: T_1: 50% NPK kết hợp 50% N nhờ vào phân FYM + dinh dưỡng vi lượng qua kiểm tra đất (Zn: 20kg/ha); T_2: 1/3 N nhờ vào từng loại phân FYM, phân trùn đất và bã hạt neem; T_3: T_2 + cây phân xanh (sannhemp được trồng và vùi vào đất trong vụ đậu nành); T_4: T_2 + làm cỏ dại bằng tay và quản lý dịch hại IPM; T_5: 50% N nhờ vào FYM + *Azotobacter* + PSB; T_6: T_2 + *Azotobacter* + PSB; T_7: 100% NPK theo khuyến cáo và T_8: đối chứng (không bón phân). Kết quả thí nghiệm cho thấy năng suất tiềm năng cao nhất ở nghiệm thức 100% NPK theo khuyến cáo (100:50:50 kg ha^{-1}) với năng suất đạt 302.8 tạ củ hành ha^{-1}. Tương tự, áp dụng 100% dinh dưỡng nhờ vào nguồn phân hữu cơ như FYM, phân trùn đất, bã hạt neem, phân sinh học (*Azotobacter,* PSB) và cây phân xanh đã cho năng suất củ hành cao hơn đối chứng và cũng cho thấy có sự cải thiện độ phì của đất gia tăng hơn nghiệm thức đối chứng và nghiệm thức áp dụng 100% NPK theo khuyến cáo.