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Effects of chicken, pig and cow manures on growth and yield of Kalmegh (*Andrographis paniculata* Nees)

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Kalmegh (*Andrographis paniculata* Nees.) is a traditional medical herb. It is commonly used to cure a variety of diseases. The current study aimed at investigating the effect of chicken, pig and cow manure at rates 2.5, 5, 7.5, 10, 12.5 ton ha^{-1}on yield, leaf area index, stem, leaf and total dry weight of *Andrographis paniculata*. The results shown that chicken manure gave the highest leaf area index, total dry weight and dry weight yield followed by pig manure, while cow manure gave the lowest. In general the yield increased significantly with increased manure rates. The higher manure rate of 12.5 ton ha^{-1} gave a significantly higher plant height, stem and leaf, dry weight and dry weight yield than 2.5, 5, 7.5 ton ha^{-1} rate. There was no significant different between the types of organic manure and fertilizer application rates. However, application of 12.5 ton ha^{-1} of chicken manure result in a significantly higher performance of growth parameters, total dry weight and dry weight yield when compared to 2.5, 5, 7.5 and 10 ton ha^{-1}, respectively.

Keywords: organic manure, growth, yield, *Andrographis paniculata*

Introduction

Kalmegh (*Andrographis paniculata* Nees.) also known as king of bitters belonging to the family Acanthaceae is one of the most important medicinal plants that is recommended for cultivation in Thailand, as there is a great demand for the plant by the pharmaceutical industries mainly for using in the country and export. It is a source of several diterpenoids of which andrographolide is important (Arpana and Bagyaraj, 2007). The drug is being used for treating fever, liver disease, diabetes, snake bite, chronic malaria, jaundice and dysentery (Sanjutha *et al*., 2008). The leaf and the whole herb contain the medicinal properties.

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Organic manure was recommended by the United Nations Organizations. (Codex Alimentarius Commission, 2001). In addition, organic manuring have beneficial impacts on soil properties and produce safe plants with good, neat source of better availability of nutrients (Stevenson, 1994; O' Brien and Barker, 1996). Many investigators obtained best results by using organic manure for several medical and aromatic plants (Aflatuni, 1993). The suitability and usefulness of organic manure has been attributed to high availability of NPK content (Kilande *et al*., 2011). Increasing the rates of organic material decomposing and releasing nutrient for plant uptake. They improve the physical properties of the soil as well (Sharafzadeh and Ordookhani, 2011; Dauda *et al*., 2008).

Organic fertilizers are obtained from animal manure or plant sources like green manure. Hence, organic manure can serve as alternative to mineral fertilizers (Dauda *et al*., 2008; Mishra and Jain, 2013). Ayoola and Makinde (2008) reported that organic fertilizer resulted in significant increase in soil carbon, nitrogen, pH, cation exchange capacity and exchangeable Ca, Mg and K which invariably enhance crop yield and productivity.

The role of organic manures in improving soil structure and fertilizer is well understood. Considering the economic importance of Kalmegh and environmental problems caused by chemical application, it is important to cultivate Kalmegh using organic fertilizer. Different organic manures influence differently in terms of growth and yield of plant. Thus, it is necessary to know the best source of organic manure and rates of application which help in increasing the growth and yield. In view of this background, this study was aimed to evaluate the effects of different types and application rates of organic manures on growth and yield of Kalmegh.

Materials and methods

A field experiment was conducted at the Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand during November, 2012 to March, 2013. The research field is located 13° 43′ 36.21″ N, 100° 46′ 48.45″ E at an altitude of 1.5 m above mean sea level. The farm soil was Bangkok series and clay in texture. The experiment was laid out in split plot in randomized complete block design with three replications. Main plot consisting of three organic manure (cow, pig and chicken manures) and sub plot was five levels of organic manure applications (2.5, 5, 7.5, 10 and 12.5 ton ha^{-1}, respectively).

Cultural operation: About 25 days old seedlings were transplanted at the spacing of 20x20 cm plot size was 2x3 m^2. After transplanting, a light irrigation was given until the seedlings were well established, after which full

irrigation was given to fulfill water requirement of the crop. During the experiment, the plants were protected from insected and check regularly for any potential diseased. About 2 manual weeding were done at 30 and 60 days after transplanting (DAT) to minimize the weed competition. For organic fertilizer application, the required manures as different levels were weighed, added and well mixed in the soil a few days prior to the transplant of the seedling. Manure pH in H_2O was determined with TOA pH meter HM-20S (TOA Electronic Ltd. Japan). Nitrogen concentration was determined by micro Kjeldahl method (Black, 1965). For determination P and K were digested with nitric-perchloric acid solution and absorption of color was measured with spectrophotometer at 660 nm wave length and atomic absorption spectrophotometer, respectively. Chemical compositions of manure are presented in Table 1.

Plant growth and biomass production: Observation on growth and yield attributed viz., plant height, stem, leaf, flower and pod dry weight, leaf area index were recorded during pod formation at 100 DAT from 10 randomly selected plants from each plot. Plant height was measured with a calibrated rule from the soil surface to the top of the plant. The leaf area was estimated by using LI-COR 300 leaf area meter. Leaf area index calculated for the crop as given by Watson (1952). The plants harvested from each treatment were dried at 60°C till constant weight and weighed dry matter. Data on total dry weight yield were recorded at 100 DAT from 1x2 m^2 in each plot.

Statistical analysis: All data were subjected to analysis of variance (ANOVA) using SAS statistical software version 9.1 (SAS Institute Inc., Cary, NC. USA) and mean were compared using least significant different (LSD) at the 0.05 probability level by SPSS for windows (version 16.0).

Results and discussions

Nutrient content of organic manures

In Table 1 nutrient status of organic manure used in the experiment. Manure pH of chicken and pig was slightly acidic (6.21 and 6.46) compared to the value of cow (7.20). The nutrient content of the organic manures tried viz., chicken, pig and cow manures were 2.65, 2.11 and 2.33 ; 1.40 , 2.40 and 1.88; 1.30, 0.81, 1.02 percent N,P,K, respectively.

Plant height and stem dry weight

The maximum plant height and stem dry weight were 30.48 cm and 11.06 g $plant^{-1}$ in chicken manure whereas the cow manure gave the lowest in plant height (26.23 cm) and stem dry weight (6.37 g $plant^{-1}$). Plant height and stem

dry weight increased with increasing rates of organic manure. The highest plant height and stem dry weight were 34.31 cm and 10.94 g plant^{-1} under 12.5 ton organic manure ha^{-1}.

Table 1. Chemical properties and nutrient contents of organic manures used in this study

Parameter	Chicken manure	Pig manure	Cow manure
pH (1 : 2.5)[1)]	6.21	6.46	7.20
Total N (%)[2)]	2.65	1.40	1.30
Total P(%)[3)]	2.11	2.40	0.81
Total K (%)[4)]	2.33	1.88	1.02

1) 1 : 2.5 water : fertilizer measured by pH meter, 2) Kjeldahl method. 3 and 4) measured by spectrophotometer and by atomic absorption spectrometer.

Leaf dry weight and leaf area index

The leaf dry weight per plant was significantly influenced by the different types of manures and levels of manure application. The maximum leaf dry weight per plant (10.95 g) was recorded with chicken manure and followed by pig and cow manure, respectively. For all levels of manures, the highest leaf dry weight (12.12 g) was registered under 12.5 ton organic manure ha^{-1} which was statically higher than other lower levels (Table 2). The trend of increasing leaf dry weight and number of leaf per plant with the application of organic manure was also recorded by Goenadi (1985). The application of increasing levels of organic manure increased the growth, which might have been due to the balance availability of nutrients to the plants that resulted in a favorable soil environment. These favorable conditions increased the nutrient availability and water holding capacity of the soil resulting in enhanced growth and yield (Rashid *et al*., 2013).

Leaf area index (LAI) is a crucial growth in dices determining the capacity of plant to trap solar energy for photosynthesis and has marked effect on growth and yield of plant. The influence on leaf area index remained significant under different types of organic manure and application levels (Table 2). The highest leaf area index (1.95) was obtained under chicken manure which was statistically at par with pig manure (1.22) and cow manure (1.08), respectively. In the case of different levels of organic manures, maximum leaf area index (2.64) was recorded at 12.5 ton ha^{-1} which was statistically higher than 10 ton ha^{-1} (1.65), 7.5 ton ha^{-1} (1.16), 5 ton ha^{-1} (1.04) and 2.5 ton ha^{-1}(0.56).

Flower and pod dry weight

In Table 2, the maximum flower and pod dry weight per plant (2.61 g) was recorded with chicken manure whereas cow manure gave the lowest (1.31 g). Flower and pod dry weight per plant were significantly increased with the increment levels of organic manure. The highest flower and pod dry weight per plant was obtained under 12.5 ton ha^{-1} (2.96 g) which was statistically at par with 7.5 ton ha^{-1} (1.74 g) but significantly higher than 5 ton ha^{-1} (1.55 g) and 2.5 ton ha^{-1} (1.20 g).

Table 2. Plant height, stem, leaf, flower and pod dry weight and leaf area index of Kalmegh at 100 days after transplanting grown under different organic manures and different rates of manure application

Treatments	**Plant height (cm)**	**Stem DW (g $plant^{-1}$)**	**Leaf DW (g $plant^{-1}$)**	**LAI**	**Flower and pod DW (g $plant^{-1}$)**
Organic manures					
Cow	26.23	6.37	8.08	1.08	1.31
Pig	29.18	8.18	9.17	1.22	1.93
Chicken	30.48	11.06	10.95	1.95	2.61
Rates of organic manures					
2.5 ton ha^{-1}	24.68	6.76	7.28	0.56	1.20
5 ton ha^{-1}	26.23	7.65	8.79	1.04	1.55
7.5 ton ha^{-1}	28.67	8.56	9.01	1.16	1.74
10 ton ha^{-1}	29.27	8.75	9.80	1.65	2.30
12.5 ton ha^{-1}	34.31	10.94	12.12	2.64	2.96
Mean	28.63	8.53	9.40	1.41	1.95
LSD(0.05)(organic manures)	1.07	3.10	2.62	0.84	0.65
LSD(0.05)(rates of organic manures)	1.95	1.80	3.04	0.46	0.20
LSD(0.05)(organic manures) x (rates of organic manures)	ns	ns	ns	ns	ns
C.V.(%)(organic manures)	16.72	24.51	20.46	20.11	23.54
C.V.(%)(rates of organic manures)	13.09	29.82	26.26	28.38	35.10

LAI = leaf area index ; DW = dry weight ; ns = no significant at the 0.05 probability level.

Total dry weight and Total dry weight yield

In Table 3, total dry weight and total dry weight yield varied with type of manures and application levels. Total dry weight and yield of chicken manure were significantly higher at the similar application levels of pig and cow manures. This might be attributed to the stimulating effect of chicken manure

that supplies plant with nutrients required for better yield (Abdelrazzag, 2002). For application manure at different levels, higher rate of manure (10 and 12.5 ton ha^{-1}) gave a significantly higher total dry weight 20.85 and 26.02 g $plant^{-1}$ and yield 2,471 and 3,069 kg ha^{-1} than other rates. These results are in good agreement with the findings of several researchers which revealed that organic manuring increasing the vegetative growth and biomass production effectively (Roy *et al*., 2010; Dinesh *et al*., 2010 ; Mohapatha and Das, 2009 ; Manikerri, 2006). Moreover, Manhas and Gill (2010) found that increment of application of organic manure increased the growth, dry matter accumulation, yield and quality of plant. (Mishra and Jain, 2013; Sanjutra *et al*., 2008; Ramesh *et al*., 2011).

Table 3. Total day weight and dry weight yield of Kalmegh at 100 days after transplanting grown under different organic manures and different rates of manure application

Treatments	**Total dry weight (g $plant^{-1}$)**	**Total dry weight yield (kg ha^{-1})**
Organic manures		
Cow	15.76	1,775
Pig	19.28	2,229
Chicken	24.62	2,970
Rates of organic manures		
2.5 ton ha^{-1}	15.24	1,767
5 ton ha^{-1}	17.99	2,068
7.5 ton ha^{-1}	19.31	2,252
10 ton ha^{-1}	20.85	2,471
12.5 ton ha^{-1}	26.02	3,069
Mean	19.89	2,324
LSD (0.05)(organic manures)	2.65	704
LSD (0.05)(rates of organic manures)	1.64	450
LSD (0.05)(organic manures) x (rates of organic manures)	ns	ns
C.V. (%)(organic manures)	20.51	24.41
C.V. (%)(rates of organic manures)	27.76	26.88

ns = no significant at the 0.05 probability level.

Conclusion

From the results of present investigation, on the basis of plant growth and dry weight yield it may be concluded that chicken manure produced

significantly higher plant height, stem and leaf dry weight, leaf area index, total dry weight and dry weight yield compared with other manure types used. Increasing the rate of applied manure from 2.5 ton ha^{-1} to 12.5 ton ha^{-1} significantly increased all the growth and yield attributes measured. However, application of 12.5 ton ha^{-1} of chicken manure produced the highest growth and yield and is therefore recommended.

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