



Effect of Decomposed Crushed Seeds, Oil Cakes and Deoiled Cakes of Neem on Growth and Development of Maize (*Zea mays*)

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Authors' contributions

This work was carried out in collaboration between both authors. Author SCK designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author CN managed the analyses of the study. Both authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted to study the "Effect of decomposed crushed seeds, oil cakes and deoiled cakes of neem on maize (*Zea mays*)" under the greenhouse condition. The three forms of neem cakes were subjected to decomposition for a period of 30, 60 and 90 days in a plastic containers of capacity five kg. The chemical composition of deoiled cake was 4.51 % N, 0.79 % P, 1.40 % K, 57 ppm Zn, 640 ppm Fe, 1.40 ppm Ca and oil content 1.09 % while in oil cake and crushed seeds 4.21 and 3.99 % N, 0.71 and 0.64 % P, 1.30 and 1.10 % K, 49 and 43 ppm Zn, 630 and 633 ppm Fe, 1.40 and 1.30 ppm Ca and oil content 10.27 and 22.53 % respectively. The Plant height, root length, fresh weight, dry weight and chlorophyll (SPAD) has increased by increasing number of days of decomposition and the significant increase was observed in deoiled cake at 90 days of decomposition as compare to oil cake and crushed seeds at 30, 60 and 90 days of decomposition.

Keywords: Decomposition; SPAD; deoiled cake; Zea mays.

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1. INTRODUCTION

India is self-sufficient in the production of food grains due to intensive cropping with increased use of chemical fertilizers under irrigated conditions. However, modern chemical based agricultural practices have led to several new challenges viz., degradation of soil, declined productivity, increased pollution hazards etc. Under such situations, organic and integrated nutrient management play significant role in improving the productivity and sustainability of soil fertility. The likely large-scale bio-energy crop plantations for producing bio-fuels following promotional activities of the government and increased awareness among the public are expected to result in the production of large quantities of by-products such as oil cakes (after oil expulsion from seeds). The resulting oil cakes can be recycled as valuable sources of major and micro-nutrients. The utility of neem oil seed cake as a fertilizer as well as a pesticide on economically important crop species is well established [1].

Neem, *Azadirachta indica* is native to the arid regions of the Indian sub-continent, where it grows to 12-24 m high at altitudes between 50 and 100 m with 130 mm of sufficient rainfall per annum for its normal growth. Neem is also called 'arista' in Sanskrit- a word that means 'perfect, complete and imperishable'. The seeds, bark and leaves contain compounds with proven antiseptic, antiviral, antipyretic, anti-inflammatory, anti-ulcer and antifungal uses. Fresh fruit yield per neem tree ranges between 37 and 50 kg per year at maturity. Neem has an ability to withstand extreme heat and water pollution is well known and it also helps to improve fertility of the soil and to rehabilitate degraded wastelands and the United Nations declared it as the "Tree of the twenty first century". Its large scale production promises to help alleviate several global environmental problems like deforestation, desertification, soil erosion and perhaps even global warming (if planted on a truly large scale). Large scale neem plantations can help in rehabilitation of degraded forest lands and vast tracts of wastelands and greening the environment.

The supply of nutrients through neem cake with different formulation and with different time zone for decomposition has been identified for growth and development of maize, which is also a major source of fodder. Neem is used as manure for improving the soil fertility and thus promoting

plant growth. Neem manure is gaining popularity because it is environmental friendly and also the compounds found in it help to increase the nitrogen and phosphorous content in soil. It is rich in sulphur, potassium, calcium, nitrogen etc. Neem cake is used to manufacture high quality organic or natural manure, which does not have any aftermaths on plants, soil and other living organisms. Helps in eliminating bacteria responsible for denitrification. Increases the yield of crops, helps to reduce the usage of fertilizers thus reducing the cost of cultivation. It has antifeedant properties that help to reduce the number and growth of insects and pests (Subbalakshmi et al. 2012).

2. MATERIALS AND METHODS

2.1 Location of Experiment

Experiments were conducted under greenhouse conditions (13.083727° N, 77.577329° E) in the Bio-fuel research unit, Department of Forestry and Environmental Science, UAS, GKVK, Bangalore.

2.2 Collection of Material for Decomposition

Neem seeds were collected from Hassan and oil is extracted from the seeds in the Bio-fuel unit located at GKVK campus, Bangalore and de-oiled cake generated from solvent extraction method which were used for experiments.

The experiment was conducted in the greenhouse, Bio-fuel unit, Department of Forestry and Environmental Sciences, UAS, Bangalore under laboratory conditions. The treatment details are as given below:

Treatment	Treatment details
T ₁	Control
T ₂	Raw crushed neem seeds
T ₃	Neem oil cake
T ₄	Deoiled cake

2.3 Determination of Oil Content Using Soxtherm Using Standard Procedure

The oil content of crushed seeds, oil cake and deoiled cake of neem was determined by soxtherm method as per the standard procedure as fallows, Sun dried seeds were powdered in mixer grinder and then three grams of powder

was weighed with precision to three decimal places and the powdered seed samples were taken in a cotton thimble and plugged with cotton and placed in pre-weighed Soxhlet jars containing boiling stones and about 100 ml of petroleum ether was added and placed in Soxhlet apparatus through which this oil is extracted by running the preprogrammed Soxhlet apparatus for 4 h 35 min. After completion of extraction, the remaining petroleum ether and moisture is removed by keeping it in hot air oven at 110°C for 1 h and then the jars were removed from the oven and placed in desiccators containing CaCO₃ for one hour to remove moisture then the oil content in the seeds was determined using the formulae

$$\text{Oil content (\%)} = (W2 - W1/W) \times 100$$

2.4 Observations Recorded

The following observations were recorded at 30 and 60 d after planting. Shoot length, SPAD chlorophyll is recorded and at harvest, root length, total fresh weight and total dry weight were recorded after 60 days of plant growth.

2.5 Statistical Analysis

Statistical analysis of the data was carried out for completely randomized design. The level of significance used in 'F' test was P=0.01. Critical difference was calculated wherever 'F' test was significant.

3. RESULTS AND DISCUSSION

The chemical composition of different forms of neem oil cake were analyzed and indicated that the deoiled cake had 4.51% N, 0.79% P, 1.40% K, 57 ppm Zn, 640 ppm Fe, 1.40 ppm Ca and oil 1.09% while in oil cake and in crushed seeds 4.21 and 3.99% N, 0.71 and 0.64% P, 1.30 and

1.10% K, 49 and 43 ppm Zn, 630 and 633 ppm Fe, 1.40 and 1.30 ppm Ca and oil content 10.27 and 22.53% respectively and The analysis indicated that the soil had pH-5.46, EC-0.21 dS m⁻¹, Org.-C-0.42%, N-281.7 kg ha⁻¹, P -25.8 kg ha⁻¹, K-61.5 kg ha⁻¹, Fe ppm-31.52, Zn ppm-2.05, Mn ppm-48.69, Cu ppm-3.74.

3.1 Effect of Different Forms of Neem Cakes at Different Stages of Decomposition on Vegetative Growth of Maize Plants

3.1.1 Plant height (cm)

It was noticed that there was significant difference in maize plant height among the treatments at 30 days after sowing (DAS). The treatment T₄ (31.80 cm) has recorded significantly higher plant height at 0 days after decomposition (DAD) over the treatments T₁ (31.60 cm) followed by T₃ (23.70 cm) and T₂ (14.60 cm) and in case of 30 DAD, 60 DAD and 90 DAD the similar trend was recorded i.e. the treatment T₄ (35.9, 38.2 and 39.24 cm) has showed significantly higher plant height over T₃ (32.8, 35.1 and 35.2 cm), T₁ (29.75, 29.20 and 32.71 cm) and T₂ (21.3, 32 and 32.7 cm) respectively. Similarly at 60 DAS the significantly higher plant height was recorded at 0 DAD, 30 DAD, 60 DAD and 90 DAD in treatment T₄ which consists of deoiled cake (59.80, 64.20, 60.35 and 63.17 cm) over T₃ (49.80, 52.30, 53.50 and 56.40 cm), T₂ (38.40, 47.30, 51.97 and 53.51 cm) and T₁ (45.90, 46.70, 46.90 and 46.53 cm) respectively. This is in accordance with the results observed by Devamani [2]. Where higher growth parameters are attributed to the higher uptake of nutrients, greater efficiency of plants to utilize them for growth and yield. Similarly Lee et al. [3] on lettuce, Houx et al. [4] on red clover, Okur et al. [5] on butter-head lettuce, also reported similar findings.

Table 1. Effect of decomposed neem cakes on maize plant height (cm)

Treatments		0 DAD		30 DAD		60 DAD		90 DAD	
		30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
Control	T ₁	31.60	45.90	29.75	46.70	29.20	46.90	32.71	46.53
Crushed seeds	T ₂	14.60	38.40	21.30	47.30	32.00	51.97	33.23	53.51
Oil cake	T ₃	23.70	49.80	32.80	52.30	35.11	53.50	35.22	56.41
Deoiled cake	T ₄	31.80	59.80	35.94	64.20	38.20	60.35	39.24	63.17
SEM		0.49	1.06	0.62	1.12	0.70	1.04	0.78	1.21
C.D.(0.05)		1.47	3.18	1.87	3.38	2.12	3.12	2.34	3.65

Note: DAD – Days after decomposition, DAS - Days after sowing

Table 2. SPAD chlorophyll meter reading in maize at 30 and 60 days after sowing with different time intervals of decomposition

Treatments	0 DAD		30 DAD		60 DAD		90 DAD	
	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
Control	18.21	26.93	19.64	28.32	17.36	24.83	20.03	27.86
Crushed seeds	7.21	18.78	13.25	21.09	14.99	22.63	20.38	28.12
Oil cake	21.11	26.38	22.80	28.00	19.21	27.01	24.18	33.67
Deoiled cake	23.16	33.16	24.31	34.90	23.86	32.86	26.93	37.15
SEM	0.31	0.49	0.39	0.58	0.39	0.50	0.43	0.54
C.D.(0.05)	0.94	1.46	1.17	1.75	1.19	1.50	1.30	1.63

Note: DAD – Days after decomposition, DAS - Days after sowing

Table 3. Effect of decomposed neem oil cakes on root length of maize (cm)

Treatments	0 DAD	30 DAD	60 DAD	90 DAD
Control -T ₁	29.70	31.00	40.40	29.60
Crushed seeds -T ₂	26.60	27.20	24.20	21.31
Oil cake -T ₃	39.30	37.20	48.70	37.60
Deoiled cake -T ₄	45.10	61.00	63.20	80.80
SEM	0.72	0.80	0.95	0.92
C.D.(0.05)	2.18	2.40	2.87	2.76

Note: DAD – Days after decomposition

Table 4. Effect of different forms of neem cake at different time intervals of decomposition on fresh weight and dry weight (g/plant) of maize

Treatments	0 DAD		30 DAD		60 DAD		90 DAD	
	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight
Control -T ₁	43.77	19.35	41.88	18.90	44.01	19.80	45.36	20.21
Crushed seeds -T ₂	13.29	5.78	22.54	10.46	39.84	16.58	47.93	21.03
Oil cake -T ₃	49.86	21.87	57.03	29.36	58.16	30.45	67.83	38.50
Deoiled cake -T ₄	64.06	35.65	68.18	39.87	69.83	41.89	74.12	45.78
SEM	0.93	0.42	0.98	0.48	1.14	0.56	1.19	0.65
C.D.(0.05)	2.81	1.26	2.96	1.46	3.44	1.70	3.58	1.95

Note: DAD – Days after decomposition

3.1.2 SPAD chlorophyll

The data revealed at 30 DAS that the deoiled cake treated plants maintained higher SPAD chlorophyll in T₄ (23.16, 24.31, 23.86 and 26.93) in 0 DAD, 30 DAD, 60 DAD and 90 DAD respectively over T₃ (21.11, 22.8, 19.21 and 24.18) followed by T₁ (18.21, 19.64, 17.36 and 20.03) and T₂ (7.21, 13.25, 14.99 and 20.38) respectively. Whereas at 90 DAD which received crushed seeds T₂ (20.38) is on par with control T₁ (20.03). Similarly at 60 DAS the data revealed that the deoiled cake treated plants maintained higher chlorophyll (33.16, 34.90, 32.86 and 37.15) in 0 DAD, 30 DAD, 60 DAD and 90 DAD

respectively over oil cake (26.38, 28.00, 27.01 and 33.67) followed by control (26.93, 28.32, 24.83 and 27.86) and T₂ (18.78, 21.09, 22.63 and 28.12) respectively. Results illustrated that there was a significant relationships between chlorophyll content with nutrients that too N and P which implies higher application of nutrients is directly proportional to amount of chlorophyll content. Similar results confirmed the potential for SPAD-502 readings to determine the N status of wheat. Follett et al. [6] found a positive association between chlorophyll meter readings and leaf N concentrations, soil inorganic N concentrations and grain yield for dryland winter wheat in Colorado.

3.1.3 Root length (cm)

The root length after harvest at 60 days after sowing in 90 DAD was found to be higher in treatment T₄ (80.80 cm). Application of decomposed material has significant beneficial effect on root length. This could be due to increase in the availability of essential nutrients such as N, P and K in available form to plants. The deoiled cake helped in nitrification and resulted in better root development and thus resulted in higher root length, resulting in better growth. Similar results were found by Amjad et al. [7]. The root length with increasing the organic fertilizer application results in root tissue a significant accumulation of N and C under cow dung and oil cake treatments compared with the control treatment. Manure application rates significantly increased the accumulation of N and C in root tissue hence root length is higher.

3.2 Fresh Weight and Dry Weight (g)

The fresh weight (74.12 g) and dry weight (45.78 g) of maize plants were observed higher in T₄ which received deoiled cake. This is in accordance with the results of Memon et al. [8], who reported that the potential of agricultural waste composts, pongamia cake, banana waste and pressmud. The results of the experiment showed highly significant increase in plant height, fresh weight, dry weight yields and NPK contents with the application of fertilizers, particularly nitrogen. Application of un-decomposed manure, undecomposed banana waste and un-decomposed pressmud generally reduced plant growth and dry matter yields as compared to control. Similar results were shown by Boateng et al. [9]; Kannan and Prasanthrajan [10] for poultry manure on growth and yield of maize. The above studies are in line with the results obtained in this study.

4. CONCLUSION

The effect of different forms of neem cake on maize crop plant growth in green house conditions was found to have better growth in treatments T₄ (Deoiled cake at 90 DAD) in terms of plant height, chlorophyll content, fresh and dry weight of maize crop followed by treatment T₃ (Oil cake at 90 DAD). The outcome of the experiment showed that, the application of deoiled cake has faster and higher nutrient release compared to oil cake and crushed seeds. Hence a higher nutrient release and decomposition was observed in 90 DAD so we can effectively use in

short duration crops like vegetables or we can effectively plan according to critical crop growth period.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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