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B Kavya
PG Scholar, Agricultural College,
Mahanandi, Andhra Pradesh, India

M Srinivasa Reddy
Principal Scientist & Head
(Agronomy), ARS, Kavali, SPSS
Nellore, Andhra Pradesh, India

PV Ramesh Babu
Scientist (Agronomy), RARS,
Maruteru, Andhra Pradesh, India

P Kavitha
Principal Scientist (Soil Science),
RARS, Nandyal, Andhra Pradesh,
India

Impact of various conventional and non-conventional manures on growth and yield of Maize (*Zea mays* L.) in scarce rainfall zone of Andhra Pradesh

B Kavya, M Srinivasa Reddy, PV Ramesh Babu and P Kavitha

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Abstract

The present investigation was carried out to study the Impact of various conventional and non-conventional manures on growth and yield of Maize (*Zea mays* L.) in Scarce Rainfall Zone of Andhra Pradesh at Agricultural College Farm, Agricultural College, Mahanandi, Acharya N. G. Ranga Agricultural University during *rabi* Season, 2022-2023. The experiment comprises ten treatments viz., T₁: control, T₂: neem cake @ 750 kg ha⁻¹, T₃: pongamia cake @ 750 kg ha⁻¹, T₄: cotton seed cake @ 750 kg ha⁻¹, T₅: vermicompost @ 2.5 t ha⁻¹, T₆: farm yard manure @ 10 t ha⁻¹, T₇: neem oil @ 75 l ha⁻¹, T₈: pongamia oil @ 75 l ha⁻¹, T₉: cotton seed oil @ 75 l ha⁻¹ and T₁₀: recommended dose of N, P, K kg ha⁻¹ (250:60:60). The experiment was laid out in randomized block design with three replications. Among different treatments, application of recommended dose of NPK @ 250:60:60 kg ha⁻¹ (T₁₀) significantly increased the growth attributes like plant height, Leaf Area Index (LAI), dry matter accumulation, no of days to tasselling and silking, yield attributes such as cob length, no of grains per cob, test weight and grain and stover yields of maize over other sources of nutrient from conventional and non-conventional manures like compost, vermicompost, oil cakes and non-edible oils. Harvest index (%) does not exhibit any significant variations across different treatments tried during the study.

Keywords: Maize, conventional manures, non-conventional manures, growth and yield

Introduction

Maize (*Zea mays* L.), known as the “Queen of Cereals,” It is cultivated on approximately 205 million hectares across 165 countries producing 1210 million tonnes with a productivity of 6000 kg/ha (FAO STAT, 2024) [2]. Maize comprises 60-68% starch and 7-15% protein, and is notably rich in phosphorus and potash. In India, maize is grown on an area of 12.09 million hectares, with a production output of 43.40 million tonnes and a productivity rate of 3590 kg ha⁻¹ (www.indiastat.com, 2023-2024) [10]. Specifically, in Andhra Pradesh, maize cultivation in an area of 3.30 lakh hectares, yielding a production of 21.48 lakh tonnes and a productivity of 6510 kg ha⁻¹ in 2023-2024 (www.indiastat.com).

In India, the attainment of food grain self-sufficiency was facilitated by intensive farming and the application of chemical fertilizers during the Green Revolution period. However, these agricultural practices, along with the indiscriminate use of fertilizers to meet nutrient requirements, have resulted in soil health degradation, atmospheric pollution, and a decline in crop productivity. Nutrient management is particularly crucial for maize cultivation (Adhikari *et al.*, 2016) [1]. The application of appropriate nutrient quantities is essential for optimal crop growth and grain yield. In contrast to chemical fertilizers, the utilization of various non-conventional sources such as compost, vermicompost and farmyard manure provides all kinds of nutrients while also modifying soil physical, chemical and biological parameters includes soil structure, soil organic matter content, microbial activity, moisture retention capacity, water infiltration and ultimately enhancing crop yield. Additionally, non-edible oilcakes, such as neem, cottonseed and pongamia oils have long been employed for nutrient supplementation and pest management. These oilcakes also supply secondary and micronutrients and organic matter, thereby enhancing nitrogen use efficiency, soil structure, water holding capacity, and beneficial microbial activity, while suppressing pathogens.

Corresponding Author:
M Srinivasa Reddy
Principal Scientist & Head
(Agronomy), ARS, Kavali, SPSS
Nellore, Andhra Pradesh, India

The non-conventional oils such as neem cake contains nitrogen (5.2%), phosphorus (1.0%), and potash (1.4%) with fungicidal and nematicidal properties, cotton seed cake contains oil (3.1-3.3%), moisture (9-10%), and crude proteins (14-15%) which also acidifies alkaline soils and serves as a natural slow-release biofertilizer rich in minerals and pongamia (*Pongamia pinnata*), a leguminous tree, provides nitrogen (4.89%), phosphorus (1.52%), potassium (1.49%), minerals, amino acids, and boosts microbial activity including earthworms. It is an excellent organic fertilizer.

Keeping these factors in consideration, a field experiment was conducted at Agricultural College, Mahanadi with an objective to study the impact of various conventional and non-conventional manures on growth and yield of maize.

Materials and Methods

A field experiment was conducted during *rabi* 2022-23 at College Farm, Agricultural College, Mahanandi, ANGRAU to study the “Impact of various conventional and non-conventional manures on growth and yield of maize (*Zea mays* L.)”. The experimental field soil was sandy loam in texture with neutral in pH (7.33), low in organic carbon (0.48%), low in available nitrogen (248 kg ha⁻¹), medium in available phosphorus (49 kg

ha⁻¹) and high in available potassium (586 kg ha⁻¹). The experiment comprises ten treatments viz., Control (T₁), Neem cake @ 750 kg ha⁻¹(T₂), Pongamia cake @ 750 kg ha⁻¹(T₃), Cotton seed cake @ 750 kg ha⁻¹(T₄), Vermicompost @ 2.5 t ha⁻¹(T₅), Farm yard manure @10 t ha⁻¹(T₆), Neem oil @ 75 l ha⁻¹(T₇), Pongamia oil @ 75 l ha⁻¹(T₈), Cotton seed oil @ 75 l ha⁻¹(T₉) and Recommended dose of N, P, K @ 250:60:60 kg ha⁻¹(T₁₀). The experiment was laid out in a randomized block design (RBD) with three replications. The entire quantity of phosphorus and potassium was applied as basal and nitrogen was applied in three equal split doses *i.e.*, at basal, knee high stage and tasseling stages and entire quantity of neem, pongamia and cotton seed cakes were finely ground and applied @ 750 kg ha⁻¹ at 10 DAS. Entire quantity of neem, pongamia and cotton seed oils @ 75 l ha⁻¹ were diluted 100 times and a pinch of detergent was added to get homogenous solution and used for drenching of plants at base one week after sowing. Organic sources like farm yard manure (FYM) @ 10 t ha⁻¹ and vermicompost @ 2.5 t ha⁻¹ were applied prior to the sowing of maize seeds. Maize hybrid NMH 8352 was used in the study. The spacing adopted was 60 cm X 20 cm and the data from five tagged plants were collected and subjected to statistical analysis by Panse and Sukhatme (1978) [9].

Table 1: Impact of different conventional and non-conventional manures on growth parameters of Maize (*Zea mays* L.)

Treatments	Plant height (cm)	Leaf area index	Dry matter accumulation (Kg ha ⁻¹)	Days to 50% tasselling	Days to 50% Silking
T ₁ : Control	177.84	5.40	12399	62.33	64.67
T ₂ : Neem cake @ 750 kg ha ⁻¹	209.75	5.81	18546	59.00	62.33
T ₃ : Pongamia cake @ 750 kg ha ⁻¹	197.89	5.55	18362	59.00	62.67
T ₄ : Cotton seed cake @ 750 kg ha ⁻¹	185.64	5.91	17293	59.33	62.33
T ₅ : Vermicompost @ 2.5 t ha ⁻¹	222.85	5.69	17144	59.67	63.00
T ₆ : Farm yard manure @10 t ha ⁻¹	187.83	5.28	17689	61.33	64.00
T ₇ : Neem oil @ 75 l ha ⁻¹	225.13	5.34	17123	60.67	63.33
T ₈ : Pongamia oil @ 75 l ha ⁻¹	184.34	5.69	13735	61.33	64.33
T ₉ : Cotton seed oil @ 75 l ha ⁻¹	193.97	5.55	14456	61.00	63.67
T ₁₀ : Recommended dose of N, P, K @ 250:60:60 kg ha ⁻¹	255.31	6.14	19356	57.00	59.67
SEm±	2.59	0.09	637.76	0.38	0.44
CD (p=0.05)	7.69	0.26	1750.87	1.81	1.52

Table 2: Impact of different conventional and non-conventional manures on yield attributes and yield of Maize (*Zea mays* L.)

Treatments	Cob length (cm)	No. of grains cob ⁻¹	100 seed weight (g)	Grain yield (kg ha ⁻¹)	Stover yield (kg ha ⁻¹)	Harvest Index (%)
T ₁ : Control	13.80	380.07	24.42	3491	4249	44.89
T ₂ : Neem cake @ 750 kg ha ⁻¹	16.92	540.20	28.58	5508	6483	46.06
T ₃ : Pongamia cake @ 750 kg ha ⁻¹	14.14	393.67	26.07	4315	5561	43.49
T ₄ : Cotton seed cake @ 750 kg ha ⁻¹	14.57	380.73	25.33	3961	5447	41.86
T ₅ : Vermicompost @ 2.5 t ha ⁻¹	13.82	385.93	24.91	5129	7324	40.94
T ₆ : Farm yard manure @10 t ha ⁻¹	14.00	442.87	27.32	4602	6480	41.53
T ₇ : Neem oil @ 75 l ha ⁻¹	16.08	446.40	27.23	5699	6863	45.38
T ₈ : Pongamia oil @ 75 l ha ⁻¹	14.99	392.87	25.12	4272	6413	39.58
T ₉ : Cotton seed oil @ 75 l ha ⁻¹	14.59	406.73	24.61	5043	6920	41.92
T ₁₀ : Recommended dose of N, P, K @ 250:60:60 kg ha ⁻¹	17.66	566.20	29.75	8731	9290	49.02
SEm±	0.42	26.78	0.77	598.8	271.0	3.38
CD (p=0.05)	1.26	79.54	2.29	1779.2	805.1	NS

Results and Discussion

Impact on Growth parameters

Results revealed that the higher growth parameters (Table 1) viz., plant height (255.31cm), Leaf Area index (6.14), Dry matter accumulation (19356 kg ha⁻¹) was obtained with the application of recommended dose of N, P, K @ 250:60:60 kg ha⁻¹(T₁₀) over different sources of conventional and non-conventional manures. However, the treatment T₄ *i.e.*, application of cotton seed cake

@ 750 kg ha⁻¹at par with the treatment T₁₀ (Recommended dose of N, P, K @ 250:60:60 kg ha⁻¹) in obtain the similar leaf area index (5.91). The lower growth parameters like plant height (177.84cm) and dry matter accumulation (12399 kg ha⁻¹) were obtained with control (T₁). However, the lower leaf area index (5.28) was attained with the application of farm yard manure @ 10 t ha⁻¹(T₆). The increases in growth parameters might be due to the utilization of balanced inorganic fertilizers potentially led

to the production of phytohormones, chlorophyll and vitamins, contributing to the enhancement of maize crops' ability to capture greater solar radiation increased the leaf area and plant height. The enhanced plant height and leaf area potentially facilitated increased light absorption through foliage which in turn lead to the production of food material through photosynthesis which ultimately resulted in higher dry matter accumulation. The similar results were obtained by Meena *et al.* (2013) [8], Kharche *et al.* (2020) [4], and Mahato *et al.* (2020) [6].

Impact on Tasseling and silking

Regarding 50% tasseling and silking (Table 1), the treatment T₁₀, i.e., the application of the recommended dose of N, P, K at 250:60:60 kg ha⁻¹, resulted in the shortest duration, achieving 50% tasseling in 57.00 days and 50% silking in 59.67 days. Conversely, T₁ (control) showed delayed tasselling and silking, taking approximately 62.33 days for tasseling and 64.67 days for silking. This acceleration in tasseling and silking can likely be attributed to the adequate nutrient supply provided by the recommended fertilizer dose, which promoted faster plant growth. These findings align with the results of Meena *et al.* (2013) [8].

Impact on Yield attributes and Yield

Higher yield attributes (Table 2) like cob length (17.66cm), no of grains per cob (566.20) and 100 seed weight (29.75g) were achieved with the application of recommended dose of N, P, K @ 250:60:60 kg ha⁻¹(T₁₀). The higher number of grains per cob and test weight were comparable to the treatment in which neem cake @ 750 kg ha⁻¹(T₂) was applied. The lower number of grains per cob (380.07) and test weight (24.42) except cob length were registered with control (T₁). The application of the vermicompost @ 2.5 t ha⁻¹ (T₅) resulted in the shortest cob length (13.82 cm). The increase in yield attributes such as cob length, number of grains per cob and 100 seed weight observed recommended dose of N, P, K @ 250:60:60 kg ha⁻¹ might be credited to the successful utilization of appropriate amount of nutrients which resulted in the enhancement of growth attributes, ultimately leading to enhanced yield attributes. Similar results were also reported by Meena *et al.* (2013) [8] and Madhukar *et al.* (2021) [5].

Data on yield (Table 2), revealed that application of recommended dose of N, P, K @ 250:60:60 kg ha⁻¹ (T₁₀) resulted in the highest grain yield (8731 kg ha⁻¹) and stover yield (9290 kg ha⁻¹). On the other hand, T₁ (control) resulted in the lowest grain yield (3491 kg ha⁻¹) and stover yield (6480 kg ha⁻¹). The application of N, P, K @ 250:60:60 kg ha⁻¹ (T₁₀) resulted in the higher grain yield, demonstrating a 250% increase compared to the control (T₁). This yield was 58% greater than that achieved with Neem cake at 750 kg ha⁻¹ (T₂), 102% higher than with Pongamia cake at 750 kg ha⁻¹ (T₃), 120% more than with cotton seed cake at 750 kg ha⁻¹ (T₄), 70% above vermicompost at 2.5 t ha⁻¹ (T₅), 89% over farm yard manure at 10 t ha⁻¹ (T₆), 53% more than Neem oil at 75 l ha⁻¹ (T₇), 104% higher than Pongamia oil at 75 l ha⁻¹ (T₈), and 73% greater than cotton seed oil at 75 l ha⁻¹ (T₉). In case of organic manures, vermicompost at 2.5 t ha⁻¹ (T₅) proved more effective than farm yard manure at 10 t ha⁻¹ (T₆). Among the various oilcakes, Neem oil cake at 750 kg ha⁻¹ (T₂) yielded better results than both Pongamia cake at 750 kg ha⁻¹ (T₃) and cotton seed cake at 750 kg ha⁻¹(T₄). As for non-conventional oils, Neem oil at 75 l ha⁻¹ (T₇) led to higher yields, followed by cotton seed oil at 75 l ha⁻¹ (T₉) and Pongamia oil at 75 l ha⁻¹ (T₈).

The higher grain and stover yields of maize attributed to an abundant supply of essential nutrients from inorganic fertilizers. The grain and stover yields were influenced by various factors

such as the production and accumulation of photosynthates which depends on the leaf area, chlorophyll content and extent of distribution into sink (grain) and also growth of plant during the early stages of plant. The provision of adequate nitrogen through urea may have affected the leaf area and chlorophyll content, resulting in enhanced photosynthesis that in turn lead to accumulation of more photosynthates. Similar results were also documented by Mahato *et al.* (2020) [6], Madhukar *et al.* (2021) [5] and Gurjar *et al.* (2022) [3].

Impact on Harvest Index (%)

Higher harvest index (49.02) showed in table 2 was obtained with the treatment T₁₀ i.e., recommended dose of N, P, K @ 250:60:60 kg ha⁻¹ and it was at par with all the remaining treatments. The provision of sufficient nutrients using inorganic fertilizers in T₁₀ (recommended dose of N, P, K @ 250:60:60 kg ha⁻¹) has the potential to increase biomass and grain yield. However, it does not appear to have a substantial impact on the harvest index, as supported by previous studies conducted in maize by Mahmood *et al.* (2017) [7] and Mahato *et al.* (2020) [6]. Based on the results presented, it can be concluded that the application of the recommended doses of nitrogen, phosphorus and potassium at 250:60:60 kg ha⁻¹ respectively, through chemical fertilizers was more effective in promoting the growth, yield attributes and yield of maize compared to other nutrient sources. Furthermore, the use of various conventional and non-conventional organic manures did not result in any significant improvement in soil properties, likely due to the experiment being conducted over a single growing season. Hence, it needs long-term experiments to achieve better results with various conventional and non-conventional organic manures in maize.

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