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EFFECT OF DIFFERENT APPLICATION METHODS OF VARIOUS ORGANIC MANURES ON PLANT POPULATION AND GROWTH ATTRIBUTES OF *RABI* SWEETCORN

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ABSTRACT

A field experiment was conducted during *rabi*, 2023-24 to study the response of rabi sweet corn (*Zea mays*. Saccharata) to methods and application of various organic manures under integrated nitrogen management system in alfisols of southern Telangana zone. The experiment was laid out in a randomized block design with eleven treatments and three replications. The treatments consisted of integration of chemical fertilizer and various organic manures viz., poultry manure (PM), farm yard manure (FYM), vermicompost (VC), sheep manure (SM) and jeevamruta. The results showed that 75% Recommended dose of nitrogen (RDN) through chemical fertilizer + 25% RDN using poultry manure (PM) through band application achieved the tallest plants (188.4 cm), the highest leaf area index of 5.8 and this led to the highest drymatter production with 13045 kg ha^{-1}. This was comparable with 75% RDN + 25% RDN using farm yard manure (FYM) through band application and 100% Recommended dose of nitrogen. Band application of organic manures showed higher results than their broadcasting, which suggests that under integrated nitrogen management system, band application of organic manures on the day of sowing could be introduced in nutrient management for better growth of sweetcorn in alfisols of semi-arid region.
Keywords: Sustainable agriculture, green seeker, semi-arid region, dry matter, integrated nitrogen management

Introduction

In India, maize (*Zea mays* L.) was cultivated over an area of 9.89 Mha with an annual production of 31.6 Mt and an average productivity of 3,199 kg ha^{-1} (INDIASTAT, 2021). While in Telangana State, it was grown in 2.59 lakh ha with a total production of 17.56 lakh tons and productivity of 6,782 kg ha^{-1}. Sweet corn (*Zea mays* var. saccharata) is a specialty maize species that differs genetically from the field maize by mutation at the sugary (*su*) locus (Srdic *et al*., 2013). Sweet corn accounts for 8 and 25% of the World's corns area and production respectively. Sweet corn is well known nutrient exhaustive crop and responds considerably when provided with external nitrogen (N). Nitrogen is a highly mobile element, required in large quantities by crop plants. N is supplied through inorganic fertilizers in the country, which could affect soil health if used indiscriminately. Integrated nitrogen management (INM) practices are important to get maximum benefit from the use of organic and inorganic sources of nitrogen. Generally, various research institutions recommend 10 t ha^{-1} farm yard manure (FYM) for maize. The most common method of manure application used by the farmers is broadcasting and incorporation into the soil 15-20 days before sowing. Since maximum N in organic manures

was released during the initial phase i.e., 15-20 days after application, the farmer's practice of manures application i.e., 15 days before sowing may not be beneficial for crop growth (Ibrahim and Fatondji, 2020). Livestock based manures have become a scarce input in recent days because cattle rearing by farmers is declining due to the high cost of their maintenance and the increasing mechanization of agriculture. It must be used rationally in all crops including widely spaced maize crop through band application rather than covering the entire field as the usual practice in the conventional flat method (Way *et al*., 2013). In widely spaced maize crop, band application of organic manures can be more beneficial for improving soil properties as well as for growth and yield (Otinga *et al*., 2013). In this connection, the present short-term investigation was carried out to evaluate performance of different application methods of various organic manure on growth of sweetcorn.

Materials and Methods

The field experiment was carried out at College of Agriculture, Rjendranagar, PJTSAU, Hyderabad, Telangana state during *rabi*, 2023-24. The experimental site is geographically situated at an altitude of 548 m above mean sea level at 17°19'21"N latitude and 78°24'35"E longitude in the Southern Telangana agro-climatic zone of Telangana and it is classified under the semi-arid tropics (SAT) according to Troll's classification. The soil texture was clay loam with a pH of 7.4, low in organic carbon of 0.31%, low available nitrogen of 185.6 kg ha^{-1}, moderate available phosphorus of 28.73 kg ha^{-1} and high available potash of 309.4 kg ha^{-1}. The study was executed with eleven treatments *viz*., T_1-Control (No RDN); T_2-100% Recommended Dose of Nitrogen (RDN); T_3-75% RDN + 25% RDN through poultry manure (PM) by band application; T_4-75% RDN + 25% RDN through poultry manure (PM) by broadcasting; T_5-75% RDN + 25% RDN through Jeevamruta by band application; T_6 - 75% RDN + 25% RDN through Vermicompost (VC) by band application; T_7-75% RDN + 25% RDN through Vermicompost (VC) by broadcasting; T_8-75% RDN + 25% RDN through Farmyard manure (FYM) by band application; T_9-75% RDN + 25% RDN through Farmyard manure (FYM) by broadcasting; T_{10}-75% RDN + 25% RDN through Sheep manure (SM) by band application; T_{11} - 75% RDN + 25% RDN through Sheep manure (SM) by broadcasting. The crop was sown on 31-oct of 2023 with a spacing of 60 x 20 cm. RDF of 120:60:50 kg NPK ha^{-1}(PJTSAU. 2020) in the form of urea, single superphosphate and murate of potash was applied. In T_1 no nitrogen was applied, while in T_2 50% RDN was applied at basal, remaining in two equal splits at knee heigh and tasseling. Whereas, in T_3-T_{11}, 75% of RDN was applied in three equal split doses (basal, knee heigh and tasseling) and 25% N was applied through organic manures where broadcasting is done 15 days before sowing and band application on the day of sowing. While the entire quantity of phosphorous and potassium was applied basally at the time of sowing. Observations on growth parameters were recorded following standard procedures. The plant population was counted with a 1 m^2 quadrant in each treatment in three different locations. Plant height was measured with a 1m scale. For dry matter production, the representative plants were dried in the shade initially and later in a hot air oven at 60°C until a constant weight was reached. The weights were recorded and reported as drymatter production (gm^{-2}). Leaf area index (LAI) was estimated with the following formula. The chlorophyll content of leaves was measured on the standing crop from the tagged plants in the net plot using a SPAD (Soil Plant Analysis Development) meter. Spectral reflectance expressed as NDVI (Normalized difference vegetation index) was measured using a handheld Green Seeker optical sensor unit.

$$LAI = \frac{\text{Total leaf area } (cm^2)}{\text{Land area occupied by the plants } (cm^2)}$$

Results and Discussions

Plant population m^{-2}

The data (Table-1) shows that using different organic manure application methods along with recommended nitrogen doses did not lead to significant differences in plant population, both initially and at the final stage. The average plant population was 8.1 plants per square meter initially and 8.0 plants per square meter at the final stage.

Plant height (cm)

The treatments significantly influenced plant height (Table-1). At knee heigh, the highest plant height was recorded i.e., 81.1 cm in 75% RDN + 25% RDN through poultry manure (PM) by broadcasting which was statistically on par with T_9. While at tasseling 75% RDN + 25% RDN through poultry manure (PM) by band application had the tallest plants at 173.2 cm, statistically comparable with all the treatments except the control. At harvest, the tallest plants were recorded at 188.4 cm in 75% RDN + 25% RDN through poultry manure (PM) by band application which was on par with the plant height in all other treatments, except for T_5 (160.7 cm) and T_1(120.7 cm). However, at all stages, T_1 observed the

lowest plant height with 50.5cm, 113.1 cm and 120.7 cm. The increase in plant height with 75% RDN + 25% RDN using poultry manure (PM) through band application was primarily due to the availability of nitrogen from poultry manure throughout the growing season (Sudhansu, 2013). These findings are in alignment with shakunthala *et al*. (2018) and Rasool *et al*. (2015). All the band placement treatments recorded higher plant height than concerned organic manure under broadcasting may be because of the concentration of nutrients in the root zone due to band placement. Band placement is likely to concentrate nutrients near the rhizosphere, leading to better nutrient availability and uptake efficiency (Schröder *et al*., 2015).

Table 1 : Effect of different application methods of various organic manures under integrated nitrogen management system on plant population, plant height and dry matter production in sweetcorn

Treatments	Plant population		Plant height (cm)			Drymatter production (kg ha^{-1})		
	Knee heigh	Tasseling	Knee heigh	Tasseling	Harvest	Knee heigh	Tasseling	Harvest
T_1 – Control (No RDN)	8.1	8.1	50.5	113.1	120	532.1	1967	3994
T_2 - 100% Recommended Dose of Nitrogen (RDN)	8.3	8.3	74.3	161	182.5	1674.3	3296	12393
T_3-75% RDN+25% RDN through poultry manure (PM) by band application	8.0	7.9	72.9	173.2	188.4	1587.2	3619	13045
T_4 - 75% RDN + 25% RDN through poultry manure (PM) by broadcasting	8.2	8.2	81.1	166.6	177	1791.6	3176	12067
T_5 - 75% RDN + 25% RDN through Jeevamruta by band application	8.1	8.0	60.7	148.3	160.7	1366.9	2869	8551
T_6 - 75% RDN + 25% RDN through Vermicompost (VC) by band application	8.0	7.9	67.4	161.1	177.5	1527.6	3308	11369
T_7 - 75% RDN + 25% RDN through Vermicompost (VC) by broadcasting	8.1	8.0	70.7	153.4	165.4	1587.4	3214	11429
T_8 - 75% RDN + 25% RDN through Farmyard manure (FYM) by band application	8.1	8.0	71.4	169.1	182.5	1669	3477	12930
T_9 - 75% RDN + 25% RDN through Farmyard manure (FYM) by broadcasting	8.1	8.1	78.7	162.9	173.1	1557	3159	12036
T_{10} - 75% RDN + 25% RDN through Sheep manure (SM) by band application	8.1	7.9	67.3	161	177.3	1588.2	3074	11451
T_{11} - 75% RDN + 25% RDN through Sheep manure (SM) by broadcasting	8.1	8.0	66.3	157.5	167.7	1538.5	2966	10941
SEm±	0.7	0.8	2.25	7.6	8.75	67.5	127	409
CV (%)	1.6	1.9	5.6	8.4	8.9	7.8	7.1	6.5
CD (P=0.05)	NS	NS	6.6	22.5	25.8	199	376	1207

Dry matter production (kg ha^{-1})

Significant variation in dry matter production was observed at the knee heigh, tasseling stage and harvest influenced by different methods of placement of various organic manures (Table-1). At knee heigh stage, the highest dry matter accumulation was observed with 75% RDN + 25% RDN through poultry manure (PM) by broadcasting, which was 1791.6 Kg ha^{-1}. 75% RDN + 25% RDN through poultry manure (PM) by band application observed the highest dry matter production at tasseling stage which was statistically comparable with T_8, T_6, and T_2. The numerical values for these treatments were 3619 kg ha^{-1}, 3477 kg ha^{-1}, 3308 kg ha^{-1}, and 3296 kg ha^{-1}, respectively. During harvest 75% RDN + 25% RDN through poultry manure (PM) by band application which is on par with T_8, T_2, T_4 and T_9 with drymatter production of 13045 Kg ha^{-1}, 12930 Kg ha^{-1}, 12393 Kg ha^{-1}, 12067 Kg ha^{-1} and 12036 kg ha^{-1} and significantly superior over all other treatments. The lowest value was observed in control at all stages i.e., 532.1 Kg ha^{-1}, 1967 kg ha^{-1} and 3994 kg ha^{-1}. Organic manure increased the amount of nitrogen available to the crop, and proper P and K fertilization improved the soil's nutritional status and increased the soil's organic carbon. This provides a more conducive rhizosphere for maize crop, a higher rate of aeration, increased soil microbial activity, and mineralization of nutrients (Sahoo et. al. 2021), leading to higher nutrient uptake and drymatter accumulation. Similar results were

reported by Kumar and Dhar (2010) and Rasool *et al*. (2015).

Leaf area index (LAI)

At all three stages, varied LAI (Table-2) values were observed because of various organic manures and their placement methods under INM. At knee heigh stage, the highest LAI was observed with 100% RDN (1.72) which is on par with T_3 (1.66). While at tasseling, the highest LAI (5.8) was recorded with 75% RDN + 25% RDN through poultry manure (PM) by band application, which was similar to T_2 (5.72) and 5.55 in T_8 (5.55). During harvest Highest LAI (4.09) was recorded in 100% RDN. This value was comparable to T_3, T_8, T_{10}, T_4, T_6, and T_9, and was significantly superior to the other treatments. The lowest LAI values i.e., 0.77, 1.79 and 1.55 was recorded in the control at knee heigh, tasseling and harvest respectively. Significant increase in the LAI was owing to the differences in nutrient release patterns, soil health improvements, and the specific effects of various organic manures. Effective nutrient management led to enhanced leaf growth and canopy development, resulting in notable variations in LAI based on the type (Jayaprakash *et al*., 2003) and application method of the organic manure used. These findings are consistent with the results of Ali *et al.* (2012) and Kannan *et al*. (2013).

SPAD Values

Accurate SPAD measurements help to assess nitrogen sufficiency and optimize fertilizer applications for better crop management. The SPAD readings were affected by various treatments as shown in Table-2 and Figure-1. The highest SPAD reading at the knee heigh stage was observed in 100% RDN at 36.49, followed by T_3 (36.27). T_2 (48.68) showed the highest SPAD readings at the tasseling stage, indicating better nitrogen availability. The control treatment again had the lowest SPAD reading at 33.67, showing significant nitrogen deficiency. While at harvest the highest SPAD readings were recorded in T_2 (35.5) which was at par with T_3 (35.2) and T_8 (34.7) which were significantly superior to all other treatments.

Table 2 : Effect of different application methods of various organic manures under integrated nitrogen management system on Leaf area index, spad and NDVI green seeker values in sweetcorn.

Treatments	Leaf area index			SPAD			NDVI (Green seeker)		
	Knee heigh	Tasseling	Harvest	Knee heigh	Tasseling	Harvest	Knee heigh	Tasseling	Harvest
T_1 – Control (No RDN)	0.77	1.79	1.55	23.33	33.67	18.9	0.27	0.42	0.37
T_2 - 100% Recommended Dose of Nitrogen (RDN)	1.75	5.72	4.09	36.49	48.68	35.5	0.44	0.66	0.53
T_3 - 75% RDN + 25% RDN through poultry manure (PM) by band application	1.66	5.80	3.98	36.27	50.87	35.2	0.41	0.62	0.57
T_4 - 75% RDN + 25% RDN through poultry manure (PM) by broadcasting	1.58	4.80	3.50	32.61	47.61	33.4	0.39	0.60	0.50
T_5 - 75% RDN + 25% RDN through Jeevamruta by band application	1.34	4.21	3.28	29.63	38.97	29.7	0.33	0.57	0.44
T_6 - 75% RDN + 25% RDN through Vermicompost (VC) by band application	1.54	4.96	3.47	31.43	41.43	33.4	0.33	0.61	0.53
T_7 - 75% RDN + 25% RDN through Vermicompost (VC) by broadcasting	1.52	4.52	3.34	30.39	40.39	30.6	0.35	0.59	0.48
T_8 - 75% RDN + 25% RDN through Farmyard manure (FYM) by band application	1.59	5.55	3.86	33.75	47.08	34.7	0.42	0.63	0.59
T_9 - 75% RDN + 25% RDN through Farmyard manure (FYM) by broadcasting	1.53	4.73	3.45	32.65	44.99	32.6	0.39	0.62	0.57
T_{10} - 75% RDN + 25% RDN through Sheep manure (SM) by band application	1.62	4.87	3.58	30.15	41.81	32.6	0.37	0.59	0.54
T_{11} - 75% RDN + 25% RDN through Sheep manure (SM) by broadcasting	1.45	4.49	3.39	29.64	40.97	30.1	0.34	0.57	0.51
SEm±	0.038	0.19	0.22	0.8	0.8	0.51	0.011	0.017	0.0131
CD (P=0.05)	0.113	0.57	0.66	3.2	3.4	1.5	0.031	0.05	0.0387
CV (%)	4.48	7.3	11.32	4.3	3.4	2.8	4.97	4.98	4.45

The significant chlorophyll content is due to the high nutritional value of organic manures and the presence of macro and micronutrients in manures has been proven to effectively support the growth of plants (Siddiqui *et al*., 2024). Nitrogen and potassium, which are highly nutritious, can lead to a notable increase in chlorophyll content by promoting chlorophyll formation, thus enhancing nitrogen uptake, metabolism, and assimilation (Mohsen *et al*., 2016). As a result, this will produce more food, containing a higher amount of carbohydrates that can contribute to increased chlorophyll levels and stimulate various vegetative and reproductive parameters (Saleem *et al*., 2013).

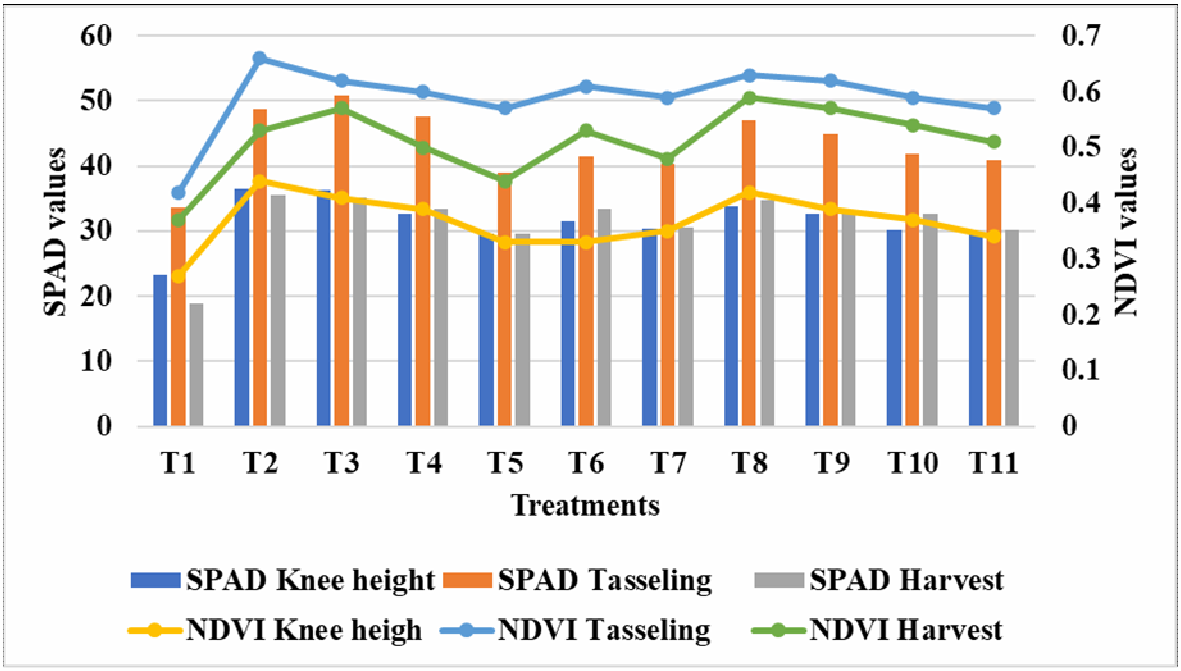

Fig. 1: SPAD and NDVI values of different application methods of various organic manures under integrated nitrogen management system

Green seeker

It was illustrated in Table-2 and Figure-1 that NDVI values of sweetcorn at three critical growth stages varied significantly in response to the treatments. 100% RDN showed the highest NDVI value (0.44) at knee height. This was statistically comparable to T_8 (0.42), T_3 (0.41), T_4 (0.39) and T_9 (0.39). At tasseling the highest NDVI value of 0.66 was recorded in treatments 100% RDN which is statistically on par with T_8 (0.63), T_3 (0.62), T_9 (0.62), T_6 (0.61), T_4 (0.6), T_7 (0.59), T_{10} (0.59). A similar trend followed from tasseling to harvest. However, the highest NDVI value was observed in T_8 (0.59), which was comparable to T_9 (0.57), T_3 (0.57), T_{10} (0.54), T_2 (0.53), T_6 (0.53), T_{11} (0.51), T_4 (0.5), and T_7 (0.48). In contrast, the control had the lowest NDVI values of 0.27, 0.42 and 0.37 at all three stages. The higher NDVI values show more availability and uptake of nitrogen. The green seeker sensor is sensitive to nitrogen, according to Foote *et al*. (2016), and can be used to detect crops need for nitrogen. Preza Fontes *et al*. (2019) found that NDVI had a stronger correlation with maize biomass and nitrogen uptake.

Conclusion

Among all treatments, 75% RDN + 25% RDN using poultry manure (PM) through band application and 75% RDN + 25% RDN using farm yard manure (FYM) through band application have the highest plant height and leaf area index that led to higher biomass production. These treatments were statistically on par with the treatment 100% Recommended dose of nitrogen. Among INM treatments in all manures band placement has the highest recordings of plant height, drymatter production, LAI, SPAD and NDVI values. The results suggests that band application of poultry manure or farm yard on the day of sowing could substitute 25% of nitrogenous fertilizer equal results on growth of *rabi* sweetcorn instead of broadcasting followed by their incorporation.

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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