Environment and Ecology 42 (2A) : 579—583, April—June 2024
Article DOI: https://doi.org/10.60151/envec/XNJK3693
ISSN 0970-0420

Correlation Studies on Growth, Yield Parameters and Yield of Maize as Influenced by Conservation Tillage Practices and Site-Specific Nutrient Management in Maize (*Zea mays* L.)

Sarath Kumar Duvvada, Ganesh Chandra Malik, Mahua Banerjee, Binoy Kumar Saren

Received 5 October 2023, Accepted 28 February 2024, Published on 6 May 2024

ABSTRACT

To meet the ever increasing needs of the growing human population ensuring sustainable use of natural resources, maintaining the standards essential for competing in the global market especially in case of major cereals like rice, wheat and maize is a never ending challenge. Keeping this in mind, to increase the productivity of maize by resource conservation techniques with different nutrient management practices, an experiment was laid out at a farmer's field of Chella, Kamarapara, West Bengal, during pre-*kharif* season of 2022. The treatments consisted of 2 levels of tillage practices and 7 levels of SSNM treatments. The experimental finding revealed no significant difference between grain and stover yield with different tillage treatments. Whereas significantly higher grain and stover yield `was seen with SSNM through NE, lower grain and stover yield was recorded with control. Correlation studies revealed that plant height, dry matter accumulation, crop growth rate, cob girth, cob length, number of grain rows per cob, and number of cobs were highly significant and positively correlated with grain yield.

Keywords Conservation tillage, Correlation, Maize, SSNM, Yield.

INTRODUCTION

South Asia recently had a significant population surge followed by increased food, fiber and fodder demand. India, where the population has risen to more than one billion people, has also experienced this surge in human resources. To meet the global market for land and water for the survival of the human race is to meet the needs of the ever-increasing population, which depends primarily on three cereal crops: Rice, wheat, and maize (Neupane *et al.* 2022). Concerning climatic change and changes brought on by global warming, the objective becomes more challenging. As it may become a mystery for resource-poor developing countries, the insecurity of food resources and changes in livelihood brought on by climatic change could be a warning signal for national security (Farooq *et al.* 2022). In India, area under maize is 10.4 million ha, with a total production of 33.2 million tonnes and yield of 3349 kg ha^{-1} with a diverse range of soil, climatic, biological, and management conditions (Agricultural statistics at a glance 2022). In West Bengal,

Sarath Kumar Duvvada[1], Ganesh Chandra Malik[2], Mahua Banerjee[3]*, Binoy Kumar Saren[4]

[2,4] Professor, [3]Associate Professor
[1,2,3,4]Dept of Agronomy, Palli Siksha Bhavana, Institute of Agriculture, Visva-Bharati University, Santiniketan 731235, West Bengal, India

Email : mahua.banerjee@visva-bharati.ac.in
*Corresponding author

the area under maize is 0.37 million ha, with a total production of 2.64 million tonnes and with a yield of 7158 kg ha^{-1} which contribute 3.68% of all India production (Agricultural statistics at a Glance 2022). Conservation agriculture includes continuous minimal mechanical soil disturbance, permanent organic soil cover with crop residues or cover, and diverse, efficient, and economically viable crop rotations. It becomes a remedial and mitigating practice that offers opportunities for input cost savings, climate change adaptation and improvement in resource use efficiency, among other effects (Anil *et al.* 2022). According to Kassam *et al.* (2022), conservation agriculture is a method of crop production that involves a paradigm shift from heavy tillage to minimal or no tillage and the establishment of a permanent organic soil cover with an appropriate crop rotation. Contrary to popular belief, tillage can be decreased without affecting yield. The precise technology known as site-specific nutrient management (SSNM) offers a method for the timely administration of fertilizer at the best rate. In order to reduce the supply and demand of nutrients based on their variation in time and geography, SSNM is a dynamic, field-specific nutrition management technique used during a particular cropping season. The SSNM's balanced nutrient administration promoted higher growth, improving plant growth and yield characteristics and the source-sink relationship. According to Singh *et al.* (2015), this may have caused the maize yield under SSNM to increase. Mandal *et al.* (2013) noticed that the balanced nutrient management has been linked to improved soil organic carbon. This is explained by the balanced nutrient treatment providing better shoot and root biomass (Parihar *et al.* 2017). The goal of site-specific nutrient management using 'nutrient expert®' (NE-SSNM) guided tools is to help farmers adjust their fertilizer use to make up the difference between the nutrient needs of a high-yield crop and the nutrient supply from native, naturally occurring sources in the soil. According to Sapkota *et al.* (2021), management of nutrients based on NE-SSNM produced higher yields that were more lucrative and potentially reduced greenhouse gas emissions.

Although the ability of conservation tillage and SSNM individually to increase maize production has been acknowledged, there still needs to be a thorough understanding of their combined impact and possible synergies. Since conservation tillage techniques and site-specific nutrient management impact maize development, yield parameters, and yield, this research article systematically analyzes their relationships. The main goal of this study was to evaluate how conservation tillage and SSNM interacted to affect many aspects of maize development and yield, such as plant height, leaf area, biomass accumulation, ear characteristics and grain yield. By examining the relationships among these critical factors, we seek to clarify the fundamental mechanisms contributing to increased maize production in sustainable farming practices. As a result, the present study aims to provide essential insights into how site-specific nutrient management and conservation tillage practices interact, providing a rationale for maize cultivation techniques based on scientific principles. Such information is vital to achieving food security, sustainable agriculture, and environmental stewardship in the face of global challenges.

MATERIALS AND METHODS

During the 2022 pre-*kharif* season, a field experiment was carried out in a farmer's field in the village of Chella Kamarpada. The location is 230 62' N latitude, 870 62' E longitude, and 60 m above mean sea level. The soil used for the experiment has a sandy loam texture and a pH of 5.07. The experiment was laid out in a split-plot design with the main plot (T_0: Zero tillage and T_1: Conventional tillage) containing two tillage practices, whereas the subplot includes seven different site-specific nutrient management practices [(F_0: Control, F_1: Farmers Practice (100:50:40 N: P_2O_5: K_2O kg ha^{-1}), F_2: 100% RDF (RDF @ 120:60:40 N: P_2O_5 : K_2O kg ha^{-1}), F_3 : SSNM through Nutrient Expert ® (NE) (130:44:66 N: P_2O_5: K_2O kg ha^{-1}), F_4: F_3 – N (44:66 P_2O_5: K_2O kg ha^{-1}), F_5: F_3 - P_2O_5 (130:66 N: K_2O kg ha^{-1}), F_6: F_3 - K_2O (N: P_2O_5 kg ha^{-1})] replicated three times. Maize was sown on 1st forth-night of February, and the variety used for the experiment was Bioseed 9544, where nutrients were applied as per the recommendations of NE for F_3 to F_6. All other recommended agronomic practices were carried out on all the plots during the experiment. From the net plot, cobs were harvested and dried under the sun, and by using a hand seller, all the grains were removed,

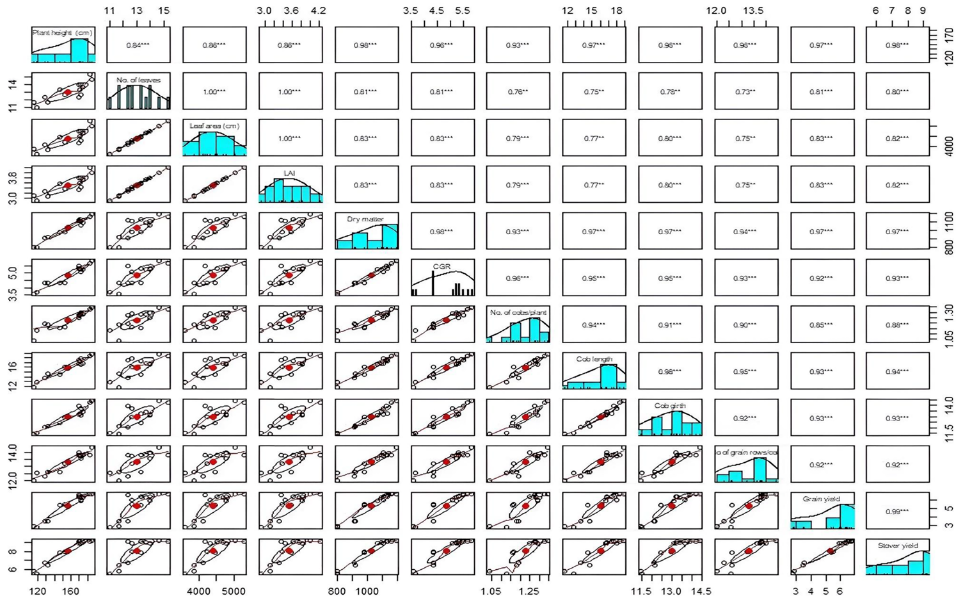

Fig. 1. Correlations among growth, yield components and yields of maize.

and weight was measured. The stover yield of maize has been calculated from the net plots after proper sundry. The correlation coefficients of plant height, number of leaves, leaf area, leaf area index, dry matter accumulation, crop growth rate, no. of cobs per plant, cob length, cob girth, number of grain rows per cob, grain yield, and stover yield were analyzed using R-Studio software and presented in Fig. 1 with *** indicates (p<0.001) and ** shows (p<0.01).

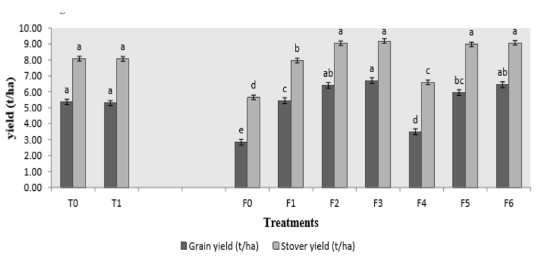

Fig. 2. Effect of grain and stover yield (t ha^{-1}) as influenced by tillage and site-specific nutrient management in maize. *Means with the same letter are not significantly different as per DMRT post-hoc analysis. T_0: Zero tillage, T_1: Conventional tillage, F_0: Control, F_1: Farmers practice (100:50:40 N: P_2O_5: K_2O kg ha^{-1}), F_2: 100% RDF (RDF@ 120:60:40 N: P_2O_5: K_2O kg ha^{-1}), F_3: SSNM through Nutrient Expert ® (NE) (130:44:66 N: P_2O_5: K_2O kg ha^{-1}), F_4: F_3 – N (44:66 P_2O_5: K_2O kg ha^{-1}), F_5: F_3 - P_2O_5 (130:66 N: K_2O kg ha^{-1}), F_6: F_3 - K_2O (130:44 N: P_2O_5 kg ha^{-1}).

Table 1. Effect of grain and stover yield (t ha^{-1}) as influenced by tillage and site-specific nutrient management in maize. *Means with the same letter are not significantly different as per DMRT post-hoc analysis.

Treatment	Yield (t ha^{-1})	
	Grain yield	Stover yield
Tillage practices		
T_0 : Zero tillage	49.74^{a}	61.62^{a}
T_1 : Conventional tillage	54.62^{a}	58.03^{a}
Nutrient management practices		
F_0 : Control	43.00^{e}	50.00^{d}
F_1 : Farmers practice	50.75^{c}	59.76^{b}
F_2 : 100% RDF	56.90^{ab}	63.90^{a}
F_3 : SSNM (NE)	59.25^{a}	67.86^{a}
F_4 : F_3-N	47.45^{d}	55.33^{c}
F_5 : F_3-P_2O_5	53.17^{bc}	60.17^{a}
F_6 : F_3-K_2O	54.75^{ab}	61.75^{a}

RESULTS AND DISCUSSION

Grain yield

No significant differences were noticed among tillage treatments concerning the grain yield of maize (Table 1 and Fig. 2). Zero tillage (T_0) recorded higher grain yield, which was closely followed by conventional tillage (T_1). A significant difference was noticed among nutrient management treatments, and the maximum grain yield was recorded when the crop was fertilized with SSNM through Nutrient Expert® (F_3), which was at par with 100% RDF (F_2) and F_3 - K_2O (F_6) and the minimum grain yield was noticed in control (F_0). The higher yield attributes and physiological indices recorded under SSNM lead to better crop health and a better source-sink relationship, which might resulted in enhanced maize yield over other nutrient management practices (Manjunath *et al.* 2021, Ghosh *et al.* 2021).

Stover yield

Statistical analysis of data collected during the investigation shows a significant effect of tillage practices on the stover yield of maize (Table 1 and Fig. 2). Maximum stover yield was noticed under zero tillage (T_0), which was closely followed by conventional tillage (T_1). The no-tillage practice could achieve stable production equivalent to conventional tillage because continuous no-tillage gradually improved the soil condition for root system development and enhanced the crop growth and yield, which might be directly due to the increase in yield attributing characteristics. Nutrient management had a significant effect on stover yield. The higher stover yield was noticed with SSNM through Nutrient Expert® (F_3), which was at par with 100% RDF (F_2), F_3 - P_2O_5 (F_5), and F_3 - K_2O (F_6), and the lower stover yield was noticed in control (F_0).

Correlations among growth, yield components and yields of maize

From the Fig. 1, it is clearly observed that grain yield showed a highly positive and highly significant correlation with stover yield (0.99***), plant height (0.97***), dry matter accumulation (0.97***), cob length (0.93***), cob girth (0.93***), crop growth rate (0.92***), number of grain rows per cob (0.92***), number of cobs per plant (0.85***), leaf area (0.83***), leaf area index (0.83***) and number of leaves (0.81***). Positive and significant correlation of stover yield noticed with grain yield (0.99***), plant height (0.98***), dry matter accumulation (0.97***), cob length (0.94***), cob girth (0.93***), crop growth rate (0.93***), number of grain rows per cob (0.92***), number of cobs per plant (0.88***), leaf area (0.82***), leaf area index (0.82***) and number of leaves (0.80***). Plant height exhibited positive and significant correlation with dry matter accumulation (0.98***), grain yield (0.97***), cob length (0.97***), stover yield (0.96***), cob girth (0.96***), crop growth rate (0.96***), number of grain rows per cob (0.96***), number of cobs per plant (0.93***), leaf area (0.86***), leaf area index (0.86***) and number of leaves (0.84***). Dry matter accumulation showed positively significant correlation with plant height (0.98***), crop growth rate (0.98***), grain yield (0.99***), stover yield (0.97***), cob length (0.94***), cob girth (0.93***), number of grain rows per cob (0.92***), number of cobs per plant (0.88***), leaf area (0.82***), leaf area index (0.82***) and number of leaves (0.80***). Positive and significant correlation of cob girth noticed with cob length (0.98***), dry matter accumulation (0.97***), plant height (0.96***), crop growth rate (0.95***), grain yield (0.93***), stover yield (0.93***), number of grain rows per cob (0.92***), number of cobs per plant (0.91***), leaf area (0.80***), leaf area index (0.80***) and number of leaves (0.78***). Cob length showed progressive and significant correlation with cob girth (0.98***), plant height (0.97***), dry matter accumulation (0.97***), crop growth rate (0.95***), number of grain rows per cob (0.95***), number of cobs per plant (0.94***), stover yield (0.94***), grain yield (0.93***), leaf area (0.77**), leaf area index (0.77**) and number of leaves (0.75**). Significantly positive correlation of number of grain rows per cob with plant height (0.96***), crop growth rate (0.95***), cob length (0.95***), dry matter accumulation (0.94***), number of cobs per plant (0.94***), cob girth (0.92***), stover yield (0.92***), grain yield (0.92***), leaf area (0.77**), leaf area index (0.77**) and number of leaves (0.75**). Number of cobs per plant indicated positively significant correlation with crop growth rate (0.96***), cob length (0.94***), dry matter accumulation (0.93***), plant height (0.93***), cob girth (0.91***), number of grain rows per cob (0.90***), stover yield (0.88***), grain yield (0.85***), leaf area (0.75**), leaf area index (0.75**) and number of leaves (0.73**). Expressively optimistic correlation of crop growth rate with plant height (0.96***), number of cobs per plant (0.96***), cob girth (0.95***), cob length (0.95***), dry matter accumulation (0.94***), number of grain rows per cob (0.93***), stover yield (0.93***), grain yield (0.92***), leaf area (0.83***), leaf area index (0.83***) and number of leaves (0.81***). Leaf area and leaf are index exhibited significantly positive correlation with number of leaves (1.00***), plant height (0.86***), dry matter accumulation (0.83***), grain yield (0.83***), crop growth rate (0.83***), stover yield (0.82***), cob girth (0.80***), cob length (0.77**), number of cobs per plant (0.79***), number of grain rows per cob (0.75**). As better growth parameters and yield attributes of maize recorded in our study under different tillage practices and these are directly correlated with grain, stover and biological yields of the maize, might helped in enhancing the yields.

CONCLUSION

SSNM with NE resulted in more grain and stover yield of maize whereas grain yield showed significant and positive correlation with stover yield, plant height, number of leaves, leaf area, leaf area index, dry matter accumulation, crop growth rate, no. of cobs per plant, cob length, cob girth and number of grain rows per cob.

ACKNOWLEDGMENT

Authors would like to Acknowledge Department of Agronomy, Palli Siksha Bhavana for their continuous support throughout experiment.

REFERENCES

Anil AS, Sharma VK, Jiménez-Ballesta R, Parihar CM, Datta SP, Barman M, Chobhe KA, Kumawat C, Patra A, Jatav SS (2022) Impact of long-term conservation agriculture practices on phosphorus dynamics under maize-based cropping systems in a sub-tropical soil. *Land* 11 (9) :1488. https://doi.org/10.3390/land11091488.

Farooq MS, Uzair M, Raza A, Habib M, Xu Y, Yousuf M, Yang SH, Ramzan Khan M (2022) Uncovering the research gaps to alleviate the negative impacts of climate change on food security : A Review. *Front Plant Sci* 13 : 927535. doi: 10.3389/fpls.2022.927535. *Field Crops Res* 154 : 178—187.

Ghosh D, Mandal M, Pattanayak SK (2021) Long term effect of integrated nutrient management on dynamics of phosphorus in an acid inceptisols of tropical India. *Commun Soil Sci Plant Anal* 52 (19) : 2289—2303.

Kassam A, Friedrich T, Derpsch R (2022) Successful experiences and lessons from conservation agriculture world wide. *Agronomy* 12 (4) :769. https://doi.org/10.3390/agronomy12040769.

Mandal N, Dwivedi BS, Meena MC, Singh D, Datta SP, Tomar RK, Sharma BM (2013) Effect of induced defoliation in pigeonpea, farmyard manure and sulphitation pressmud on soil organic carbon fractions, mineral nitrogen and crop yields in a pigeonpea–wheat cropping system.

Manjunath H, Jat SL, Parihar CM, Meena BR, Radheshyam, Kadam PV, Bhupender K, Kumhar BL (2021) Precision nutrient management influences growth, yield attributes and yield of *kharif* maize (*Zea mays* L.). *Maize J* 10 (1) : 46—52.

Neupane D, Adhikari P, Bhattarai D, Rana B, Ahmed Z, Sharma U, Adhikari D (2022) Does climate change affect the yield of the top three cereals and food security in the World ? *Earth* 3 (1) : 45—71. https://doi.org/10.3390/earth3010004.

Parihar CM, Jat SL, Singh AK, Majumdar K, Jat ML, Saharawat YS, Pradhan S, Kuri BR (2017) Bio-energy, water-use efficiency and economics of maize-wheat-mung bean system under precision-conservation agriculture in semi-arid agroecosystem. *Energy* 119 : 245—256.

Sapkota TB, Jat ML, Rana DS, Khatri-chhetri A, Jat HS, Bijarniya D, Sutaliya JM, Kumar M, Singh LK, Jat RK, Kalnaniya K, Prasad G, Sindu HS, Rai M, Satyanarayana T, Majumdar K (2021) Crop nutrient management using nutrient expert improves yield, increases farmers' income and reduces greenhouse gas emissions. *Sci Rep* 11 : 1564. https://doi.org/10.1038/s41598-020-79883-x.

Singh VK, Shukla AK, Singh MP, Majumdar K, Mishra RP, Rani M, Singh SK (2015) Effect of site-specific nutrient management on yield, profit and apparent nutrient balance under predominant cropping systems of upper gangetic plains. *Indian J Agric Sci* 85 : 335—343.