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Effect of Solid and Liquid Manures on Growth and Yield of Maize (*Zea mays* L.) in Malwa Region of Punjab, India

Ashwin Singh [a++], Karan Verma [b#*], Ashish Kumar [c†], Mahakdeep Singh [d‡], Poonam Kumari [e^] and Lovepreet Singh [a++]

[a] Guru Kashi University, Talwandi Sabo, Bathinda (Punjab), India.
[b] Department of Agronomy, Faculty of Agriculture, Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala, Haryana, India.
[c] Department of Agronomy, College of Agriculture, CSK, HPKV, Palampur, Himachal Pradesh, India.
[d] Faculty of Agriculture, Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala, Haryana, India.
[e] Instructor in AWTC, Department of Human Development and Family Studies College of Community Science, CSKHPKV, Palampur, H.P., India.

Authors' contributions

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

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[++] M. Sc. Scholar;
[#] Associate Professor;
[†] Assistant Professor Agronomy;
[‡] Ph. D. Scholar;
[^] Instructor in AWTC;
**Corresponding author: E-mail: karanverma2123@gmail.com, karan.verma@mmumullana.org;*

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ABSTRACT

A field experiment was conducted entitled “Effect of Solid and Liquid Manures on growth and Yield of Maize” in Agronomy field at Guru Kashi University, Talwandi Sabo. The experiment was conducted in kharif 2023 in Randomized Block Design with three replications, under maize cropping system with eight nutrient management treatments. The data on number of plants revealed no significant difference between all other treatments and plant population observed similar at 30 and 60 DAS and reduced at 90 DAS. Similar to grain yield, the highest stover yield was observed in 75 percent recommended dose of Nitrogen VC Jeevamrit + 25 percent Panchgavya and 100 percent Recommended dose of Nitrogen Panchgavya with the value of 96.4 q/ha and 95.4q/ha, respectively. Solid and liquid manure treatment i.e., 100 percent Recommended dose of Nitrogen Panchgavya resulted in significantly higher dry matter accumulation by maize crop at all the observation stages. The diameter of cob directly affected grain yield and harvest yield. The highest numerical value of 100-grain weight (30.5 g) was recorded with the application of 100 percent Recommended dose of Nitrogen Panchgavya along with 75 percent Recommended dose of Nitrogen VC Jeevamrit + 25 percent Panchgavya. It is dependent mainly on genetic factors and is influenced little by the growing conditions.

Keywords: Maize; panchgavya; solid manure; jeevamrit; growth and development.

1. INTRODUCTION

Maize (scientifically known as Zea mays L.) is a staple cereal crop with widespread global significance, belonging to the grass family (Poaceae). The USA, China, and Brazil collectively contribute a substantial 63 percent to global maize production, with other major producers including Mexico, Argentina, India, Ukraine, Indonesia, France, Canada, and South Africa. This prominence places maize at the forefront of discussions on food security and agricultural sustainability. Amid the critical role maize plays in global agriculture, there exists an imperative to enhance its production. One effective approach involves optimizing plant productivity through the judicious management of plant nutrients via fertilization (Shah and Wu, 2019). However, the predominant use of inorganic fertilizers, while consistently providing high quantities, introduces challenges by negatively impacting the soil environment, ultimately leading to land degradation (Kopittke et al., 2019). An alternative, environmentally friendly nutrient source for plants lies in the utilization of organic fertilizers. These organic alternatives not only contribute to the improvement of the soil's physical, chemical, and biological properties but also alleviate the reliance on inorganic fertilizers (Antil and Raj, 2020). Solid manure, often in the form of farm waste, poultry litter, vermicompost and animal dung, emerges as a sustainable solution providing essential nutrients while enhancing soil structure. It promotes robust root development and nutrient uptake by maize plants (Ndubo, 2023). The comparative effects of these solid manure types necessitate a nuanced evaluation, considering factors like nutrient content, soil fertility improvement, water retention, and overall impact on plant health (Gao et al., 2020). Using liquid organic input preparations or formulations is one of the choices available for the use of organic inputs in organic crop cultivation (Sharma et al., 2015). Liquid organic formulations have not received much attention in mainstream scientific literature. The limited information that is available about them is primarily found in literature on biodynamic farming. In India, the traditional liquid fertilizer called panchagavya, has been shown to have a modest NPK content of 0.03-0.02-0.04 but a high iron content of 0.84 per cent. Other Indian liquid manure such as jeevamrut is reportedly used not as sources of nutrients but as plant growth enhancers. Jeevamrut is newly developed liquid manure that improves soil fertility and productivity by boosting microbial population. It is made from cow dung, cow urine, pulse flour, jaggary, and soil taken from virgin land or beneath the banyan tree canopy. There haven't been many studies on this topic, but those that have suggest that using jeevamrut increases crop productivity and growth (Boraiah, 2013). Organic farmers use liquid formulations such as panchagavya, beejamrut, and jeevamrut, which are fermented products that are used to enhance plant growth using ingredients that are readily available to them. They are abundant in beneficial microflora, which promotes plant growth, improves vegetative growth, and results in high-quality produce. Formulations prepared

from agricultural by- products viz., bran of grains, oil cakes, farmyard manure etc., are excellent growth carriers and storage media (Devakumar et al., 2011). The use of panchagavya, beejamrut, jeevamrit, and other liquid organic manures and biofertilizers in organic agriculture has gained popularity in the past few years. According to studies by Devakumar et al., (2008) and Sreenivasa et al., (2010), jeevamrut and beejamrut include a variety of advantageous microorganisms, including fungi, actinomycetes, nitrogen fixers, and phosphorus solubilizers. Liquid organic fertilizers, enriched with various essential nutrients and microorganisms, contribute to creating a conducive soil environment for optimal plant growth and development. The addition of microbes enhances nutrient availability and absorption, making the fertilizers more effective (Hafez et al., 2021). The potassium content in liquid organic fertilizers plays a vital role in amino acid and protein production, maintaining cell growth by sustaining proper pressure (Puteri et al., 2021). Importantly, the low chemical content of liquid organic fertilizers, not exceeding 5 percent, ensures a balanced and sustainable nutrient supply.

2. MATERIALS AND METHODS

A long-term experiment entitled “Effect of solid and liquid manure on growth of maize” was being conducted at the Guru Kashi University located in Talwandi sabo, Bathinda to observe the effect of different treatments on maize system under present study. Details of experiment: A representative soil sample, taken at a depth of 0 to 15 cm, was taken prior to the commencement of the experimental activities in the crop. The soil samples were pulverized, dried, and sieved using a 2 mm sieve before being subjected to a conventional technique for chemical property analysis. The experimental site selected for this study was the Guru Kashi University located in Talwandi sabo, Bathinda. Spanning over 80 acres, the station is characterized by a robust irrigation infrastructure. Its geographic coordinates are 29°57'38.3"N 75°07'20.3"E and 208 meters above mean sea level. The farm is situated in the main campus of the university. Treatments, T_1- (Control); T_2 - 100 percent Recommended dose of Nitrogen VC; T_3 - 75 percent Recommended dose of Nitrogen VC + 25 percent FYM; T_4 - 50 percent Recommended dose of Nitrogen VC + 50 percent FYM; T_5 - 100 percent Recommended dose of Nitrogen through Jeevamrit; T_6 - 75 percent Recommended dose of Nitrogen VC Jeevamrit + 25 percent Panchgavya; T_7 - 50 percent Recommended dose of Nitrogen VC Jeevamrit + 50 percent Panchgavya; T_8 - 100 percent Recommended dose of Nitrogen Panchgavya.

3. RESULTS AND DISCUSSION

The results of the field experiment entitled ***“Effect of Solid and Liquid Manures on growth and Yield of Maize”*** at laboratories of the, Soil Science in Guru Kashi University, Talwandi Sabo during *Kharif* season 2023.

3.1 Growth Parameters of Maize

Plant height: Plant height is a crucial growth factor that affects crop competitiveness as well as the availability of light and space for the plant. The canopy will form more quickly the taller the crop plant grows. Plant height generally increased gradually until the crop reached the harvest stage. The data pertaining to plant height of Maize at different stages of crop growth (30 DAS 60DAS and at harvest). The results revealed that the plant height of maize increased progressively increase with increase in the age of the crop. Plant height of maize as affected by different treatments, and after applying vermicomposting at 30 DAS the plant height increased significantly from 33.6 cm (control) to 38.4 cm when recommended dosage of fertilizers was applied. The similar trend in plant height has been observed at 60 DAS and at the time of harvest (90 DAS). At harvesting the plant height increased significantly from 199.2 cm (control) to 219.8 cm in the presence of recommended dosage of fertilizers. Similarly, it has been further increased significantly to 202.2 cm and 213.1 cm when 75 percent Recommended dose of Nitrogen VC Jeevamrit + 25 percent Panchgavyaand and 50 percent Recommended dose of Nitrogen VC + 50 percent FYM was applied respectively.

A critical examination of data revealed that application of solid manure that is 100 percent Recommended dose of Nitrogen VC (T_2) proved better to obtained taller plants of maize than liquid manure 100 percent Recommended dose of Nitrogen Panchgavya (T_8) on 30 DAS, 60 DAS and at harvest stage. In all three stages the plant i.e. taller in solid manure as compared to liquid manure because solid manure provides more organic matter to soil, which enhance the physical support to plant and increase the surface area of soil to get better absorption of nutrients. The similar results found (Vidyavathi et

al. 2012), Rahman et al. (2022) and Gomasta et al. (2024). The positive effects of nutrients, particularly nitrogen on photosynthetic activity, protein synthesis, cell division, cell elongation, meristematic activity and photosynthetic area can all be associated with better plant height of plants (Dar *et al*. 2014). The application of nitrogen content in manure with increasing levels has significantly increased the plant height due to the positive effect of nitrogen element on plant growth. Similar finding was reported by Asif *et al*., (2013) where there is significant effect of N and Zn observed in maize which attributed to more vegetative development that resulted in increased mutual shading and intermodal extension. Nitrogen is vital as it is the main component of chlorophyll, amino acids and building blocks of protein. The application of FYM improves the soil physical properties including water holding capacity which provides favourable environment for plant growth and development (Thumar *et al* 2016).

Leaf area index: The data on leaf index as influenced by different treatments combination of solid and liquid manure treatment i.e., application of 100 percent Recommended dose of Nitrogen Panchgavya (T_8) along with 50 percent Recommended dose of Nitrogen VC Jeevamrit + 50 percent Panchgavya (T_7) resulted in higher leaf area index at all the observational stages, whereas significantly lower leaf area index was observed with 75 percent Recommended dose of Nitrogen VC + 25 percent FYM (T_3) and control (T_1). Comparison between solid and liquid manure application of natural farming components. Panchgavya and Jeevamrit revealed higher leaf area index under organic nutrient management treatment. Quick release nutrients through application of chemical fertilizers resulting in better mobilization of synthesized carbohydrates to the amino acids and proteins, which in turn stimulates overall growth of plant (Gupta *et al*. 2007). Farmyard manure are rich source of macro-and micro-nutrients and growth hormones, which not only supply essential nutrients to the soil but also improve the physico-chemical and biological properties of the soil (Rawat and Pareek, 2003).

Dry matter accumulation: The data on effect of different nutrient solid and liquid manure treatments on dry matter accumulation (g m^{-2}) of maize. The critical examination of data clearly indicated that dry matter accumulation of maize was significantly influenced by different treatments of solid and liquid manure.

In combination of nutrient management treatment i.e.,100 percent Recommended dose of Nitrogen Panchgavya (T_8) along with 50 percent Recommended dose of Nitrogen VC Jeevamrit + 50 percent Panchgavya resulted in significantly higher dry matter accumulation by maize crop at all the observation stages i.e., 30 DAS, 60 DAS and at harvest, Application 100 percent Recommended dose of Nitrogen Panchgavya (T_8) of manure over 9 percent more significant than 50 percent Recommended dose of Nitrogen VC Jeevamrit + 50 percent Panchgavya and 67.4 percent over control (T_1) treatment on 30 DAS. Similar trend follow in 60 DAS as 7.1 percent and 29.3 percent as of same treatment and harvesting stage by 2.5 percent and 28.9 percent over 50 percent Recommended dose of Nitrogen VC Jeevamrit + 50 percent Panchgavya (T_7) and control (T_1) treatment.

Comparison between solid manure treatments and liquid manure application of Panchgavya and Jeevamrit revealed that organic nutrient management i.e., application of 100 percent Recommended dose of Nitrogen Panchgavya (T_8) liquid manure over 100 percent Recommended dose of Nitrogen VC (T_2) by 49.07 percent, 20.7 percent and 17.8 percent on 30 DAS, 60 DAS and harvest stage respectively. The data indicated that application liquid manure or addition of liquid manure that is jeevamrit and panchgavya produced more dry matter accumulation than solid manure like vermicomposting, farmyard manure and farm yard manure. Partitioning of photosynthates towards sink and active plant growth improves with nitrogen application contributes in higher dry matter accumulation. Better plant height leaf area index contributes to higher assimilation of photosynthates, consequently participated in more dry matter accumulation (Verma *et al*. 2012b).

3.2 Development Studies

Days to 50 percent tasseling, silking and Maturity period: The number of days taken for 50 percent tasseling by maize did not differ much significantly due to treatment effects. However, maximum days taken for 50 percent tasseling were record with 100 percent recommended dose of Nitrogen Panchgavya (T_8). The same trend follows in days to 50 percent silking. The data on Effect of solid and Liquid manure on developmental stages of maize crop. A close perusal of data further

Table 1. Effect of Soild and liquid manure on plant height (cm) at various growing stage of maize crop

Treatments	30 Days after sowing	60 Days after sowing	At Harvest
T_1 (Control)	33.6	179.3	199.2
T_2 100 percent Recommended dose of Nitrogen VC	38.4	199.8	219.8
T_3 75 percent Recommended dose of Nitrogen VC + 25 percent FYM	34.9	187.8	207.3
T_4 50 percent Recommended dose of Nitrogen VC + 50 percent FYM	35.5	193.4	213.1
T_5 100 percent Recommended dose of Nitrogen through Jeevamrit	28.9	180.5	200.2
T_6 75 percent Recommended dose of Nitrogen VC Jeevamrit + 25 percent Panchgavya	29.3	181.6	202.2
T_7 50 percent Recommended dose of Nitrogen VC Jeevamrit + 50 percent Panchgavya	28.6	176.3	196.3
T_8 100 percent Recommended dose of Nitrogen Panchgavya	29.3	171.2	188.2
Mean	32.31	183.74	203.29
S.E m (±)	1.33	3.31	3.51
CD (p=0.05)	2.66	6.63	7.01

Table 2. Effect of Solid and liquid manure on Leaf Area Index at various growing stage of maize crop

Treatments	30 DAS	60 DAS	At Harvest (90)
T_1 (Control)	0.46	2.10	2.05
T_2 100 percent Recommended dose of Nitrogen VC	1.60	2.12	2.86
T_3 75 percent Recommended dose of Nitrogen VC + 25 percent FYM	1.37	2.42	3.08
T_4 50 percent Recommended dose of Nitrogen VC + 50 percent FYM	1.53	3.20	3.45
T_5 100 percent Recommended dose of Nitrogen through Jeevamrit	1.49	3.00	3.11
T_6 75 percent Recommended dose of Nitrogen VC Jeevamrit+ 25 percent Panchgavya	1.56	2.45	2.89
T_7 50 percent Recommended dose of Nitrogen VC Jeevamrit + 50 percent Panchgavya	1.62	2.23	3.11
T_8 100 percent Recommended dose of Nitrogen Panchgavya	1.65	2.89	3.30
Mean	1.41	2.55	2.98
S.E m (±)	0.14	0.15	0.15
CD (p=0.05)	0.28	0.30	0.30

Table 3. Effect of Soild and liquid manure on Dry matter accumulation at various growing stage of maize crop

Treatments	30 DAS	60 DAS	At harvest (90 DAS)
T_1 (Control)	24.5	114.3	167.7
T_2 100 percent Recommended dose of Nitrogen VC	38.3	128.2	194.2
T_3 75 percent Recommended dose of Nitrogen VC + 25 percent FYM	41.6	116.9	186.2
T_4 50 percent Recommended dose of Nitrogen VC + 50 percent FYM	53.3	126.5	190.5
T_5 100 percent Recommended dose of Nitrogen through Jeevamrit	62.0	139.3	205.5
T_6 75 percent Recommended dose of Nitrogen VC Jeevamrit + 25 percent Panchgavya	71.3	151.2	221.1
T_7 50 percent Recommended dose of Nitrogen VC Jeevamrit + 50 percent Panchgavya	68.3	150.3	230.3
T_8 100 percent Recommended dose of Nitrogen Panchgavya	75.2	161.8	236.1
Mean	54.31	136.06	203.95
S.E m (±)	6.39	6.12	8.38
CD (p=0.05)	12.78	12.24	16.75

Table 4. Effect solid and liquid manure on developmental stages of maize crop

Treatments	Days to 50 percent tasseling	Days to 50 percent silking	Days to maturity
T_1 (Control)	53.2	58.3	93.5
T_2 100 percent Recommended dose of Nitrogen VC	51.3	56.5	90.9
T_3 75 percent Recommended dose of Nitrogen VC + 25 percent FYM	52.3	57.1	91.0
T_4 50 percent Recommended dose of Nitrogen VC + 50 percent FYM	53.1	59.3	93.5
T_5 100 percent Recommended dose of Nitrogen through Jeevamrit	51.8	58.1	92.5
T_6 75 percent Recommended dose of Nitrogen VC Jeevamrit + 25 percent Panchgavya	53.0	58.1	93.3
T_7 50 percent Recommended dose of Nitrogen VC Jeevamrit + 50 percent Panchgavya	51.6	61.1	95.0
T_8 100 percent Recommended dose of Nitrogen Panchgavya	54.3	60.3	95.6
Mean	52.58	58.60	93.16
S.E m (±)	0.36	0.55	0.59
CD (p=0.05)	0.71	1.10	1.19

Table 5. Effect of Solid and Liquid manure on growth components of maize crop at harvest

Treatments	Final Plant population (no)	Length of cob (cm)	Diameter of cob (cm)	Number of cobs/Plant	Number of grains/ cob
T_1 (Control)	162	15.0	12	1.0	281.9
T_2 100 percent Recommended dose of Nitrogen VC	168	15.6	14	1.0	299.8
T_3 75 percent Recommended dose of Nitrogen VC + 25 percent FYM	165	15.8	15	1.1	312.9
T_4 50 percent Recommended dose of Nitrogen VC + 50 percent FYM	165	15.8	13	1.0	321.9
T_5 100 percent Recommended dose of Nitrogen through Jeevamrit	177	15.9	15	1.1	312.7
T_6 75 percent Recommended dose of Nitrogen VC Jeevamrit + 25 percent Panchgavya	169	16.4	15	1.2	314.3
T_7 50 percent Recommended dose of Nitrogen VC Jeevamrit + 50 percent Panchgavya	166	16.1	15	1.1	328.7
T_8 100 percent Recommended dose of Nitrogen Panchgavya	170	16.9	16	1.2	316.4
Mean	167.75	15.94	14.38	1.09	311.08
S.E m (±)	1.60	0.20	0.46	0.03	5.09
CD (p=0.05)	3.20	0.40	0.92	0.06	10.18

Table 6. Effect of Solid and Liquid manure on growth components of maize crop at harvest

Treatments	Grain yield/cob (g)	100-grain weight (g)	Grain yield (q/ha)	Stover yield (q/ha)	Harvest index (percent)
T_1 (Control)	72.3	26.5	43.5	70.3	32.2
T_2 100 percent Recommended dose of Nitrogen VC	80.7	27.5	46.9	79.3	35.8
T_3 75 percent Recommended dose of Nitrogen VC + 25 percent FYM	75.3	28.2	44.9	78.1	36.8
T_4 50 percent Recommended dose of Nitrogen VC + 50 percent FYM	85.2	26.8	50.9	88.3	34.3
T_5 100 percent Recommended dose of Nitrogen through Jeevamrit	86.8	25.3	52.1	92.3	35.9
T_6 75 percent Recommended dose of Nitrogen VC Jeevamrit + 25 percent Panchgavya	90.1	30.0	56.3	96.4	36.3
T_7 50 percent Recommended dose of Nitrogen VC Jeevamrit + 50 percent Panchgavya	88.3	29.6	54.2	96.1	38.9
T_8 100 percent Recommended dose of Nitrogen Panchgavya	96.2	30.5	52.1	95.6	37.5
Mean	84.36	28.05	50.11	87.05	35.96
S.E m (±)	2.79	0.66	1.61	3.52	0.72
CD (p=0.05)	5.58	1.31	3.22	7.03	1.43

indicated maize taken significantly a greater number of days to attain physiological maturity of liquid manure treatment i.e., application of jeevamrit and panchagya and combine with this manure. Similar result found by Patel *et al* 2018 Application of panchgavya and jivamrutat branching stage and flowering stages shows significantly the largest pod yields compared to individual application. The observed data indicated that maize was taken equal number days to attain physiological maturity with 50 percent Recommended dose of Nitrogen VC + 50 percent FYM (T_4) treatment along with control (T_1). These results conformed to the assertion that difference in nutrient sources among treatments will lead to visible difference on vegetative growth of the plant (Ayoola and Adeniyan, 2006). Results were similar to previous research (El-Kholy et al., 2005; Shekh, 2006).

3.3 Yield Attributes of Maize

Final plant population: The data on plant population as influenced by different treatments a close observation of data on number of plants revealed no significant difference between all other treatments however, plant population observed similar 50 percent Recommended dose of Nitrogen VC + 50 percent FYM (T_4) with T_3 75 percent Recommended dose of Nitrogen VC + 25 percent FYM (T_3). However, higher population of maize plant found in liquid manure treatment 100 percent Recommended dose of Nitrogen Panchgavya (T_8) over treatments of solid manure. Similar result found by Mishra *et al*. (2019b).

Number of grains per cob: It is evident from the data that grain rows cob-1 (cm) was affected significantly by combination solid and liquid manure. The highest grain row was recorded with the treatment of 100 percent Recommended dose of Nitrogen Panchgavya (T_8) and remained at par to T_6, T_7, T_5, T_4, T_2, T_3 but significantly superior to T_1. The number of grain rows per cob varied with nutrient application as these outcomes substantiate by the findings of Bakry et al., (2009). This might be due to continuous supply of nutrients to the plants in plots liquid manure and synergistic effect of nutrients and compost that might have led to improved nutrient use efficiency and thereby better development of maize grains. Similar findings were reported by Wailare and Kesarwani (2017).

3.4 Number of Cobs Per Plant

Length of cob: Application of liquid manure 100 percent Recommended dose of Nitrogen Panchgavya (T_8) was superior in cob length as compared to other treatments except when it was combined like in 50 percent Recommended dose of Nitrogen VC Jeevamrit + 50 percent Panchgavya (T_7) and 75 percent Recommended dose of Nitrogen VC Jeevamrit + 25 percent Panchgavya (T_6). The control and other solid manure treatments have no more significant difference in cob length. The numbers of cobs produced per plant in all the treatments similar trend follow in the study of Afe *et al* 2015.

Diameter of cob: The results on cob diameter (cm) as affected by nitrogen management techniques using liquid manure and solid manure and it was discovered that the cob diameter was not significant compared to the other solid manure treatments. The treatments with 100 percent Recommended dose of Nitrogen Panchgavya (T_8) produced the cob diameter with the greatest value (16 cm), and the cob diameter with the lowest value (15.0 cm) was obtained with control (T_1). According to some experts' findings, applying nitrogen as a liquid manure increased the cob diameter values (Kara *et al*., 1999; Turk and Alagoz, 2018).

Grain yield per cob: Application of nitrogen as liquid manure and in combination with solid manure increased the number of grains per cob insignificantly in this field experiment. The increment in number of grains per cob might be due to the presence of magnesium in multi-nutrients solution as grains number are direct index of pollen viability and where magnesium is proved to increase fruit set and pollen viability and significant effect on pollen formation as reported by Saracoglu *et al*., 2011. The data clearly advocated benefits of liquid manure besides application of nitrogen, phosphorus and potassium as a source of solid manure, it improves microbial activities, better supply of macro and micro nutrients viz., sulphur, zinc, copper, boron which are not supplied in sufficient amount by application of natural farming components and reduces nutrient losses (Yadav *et al*. 2000). The higher maize yield obtained FYM amended plots might associate with better supply pattern of nutrients and improved soil properties (Singh *et al*. 2004).

100-grain weight: 100-grain weight is an important yield attribute which affects the yield of

any crop. The data on effect of different treatments on 100-grain weight. The data revealed that different treatments had no significant influence on 100-grain weight. Regardless of the type of manure (solid and liquid) the most effective method of application of ear length, number of rows/ear, number of seeds/row, 100 grain, weight, and grains yield/plant is with dressing soil application because microorganisms have the ability to produce some growth regulator substances, by root colonising bacteria, which it may play a significant role in plant growth by promoting photosynthesis, translocation, and accumulating (Panwar *et al*., 2006; Tarang *et al.*, 2013). The highest numerical value of 100-grain weight (30.5 g) was recorded with the application of 100percent Recommended dose of Nitrogen Panchgavya (T_8) along with 75 percent Recommended dose of Nitrogen VC Jeevamrit + 25 percent Panchgavya (T_6). It is dependent mainly on genetic factors and is influenced little by the growing conditions.

Grain yield: Results indicated that the highest grain yield of 56.3q/ha was recorded with combined application of 75 percent Recommended dose of Nitrogen VC Jeevamrit + 25 percent Panchgavya (T_6) and it remained at par to 50 percent Recommended dose of Nitrogen VC Jeevamrit + 50 percent Panchgavya (T_7), but significantly superior to rest of the other treatments. The solid manure that are vermicomposting, farm yard manure with liquid manure jeevamrit and panchgaya are no much difference in grain yield. Similar findings by Hajnal-Jafari et al., (2012) who indicated that grain yield increased with addition of manure. Yield in crop depends on the rate of photosynthate assimilates in plants and their translocation to the reproductive parts particularly to the grain. Higher plant growth after easy nutrient availability in soil resulted in accelerated food production in maize photosynthetic parts leading to the superior cob and grain production. Additionally, the crop's seed production was increased by bacteria, and organic amendment (Panwar *et al*., 2006). The sufficient amount by application of solid and liquid manure components and reduces nutrient losses (Yadav *et al*. 2000). The higher maize yield obtained vermicomposting amended plots might associate with better supply pattern of nutrients and improved soil properties (Singh *et al*. 2004). Use of organic composting in enhanced crop production also examined by other studies in various crops (Apu et al., 2022; Sultana et al., 2022).

Stover yield: Similar to grain yield, the highest stover yield was observed in 75 percent Recommended dose of Nitrogen VC Jeevamrit + 25 percent Panchgavya (T_6) and 100 percent Recommended dose of Nitrogen Panchgavya (T_8) with the value 96.4 q/ha and 95.4q/ha, respectively. This was followed by the treatment receiving 50 percent Recommended dose of Nitrogen VC Jeevamrit + 50 percent Panchgavya (T_7) which recorded 96.1 q/ha and it remained at par to 100 percent Recommended dose of Nitrogen through Jeevamrit (T_5), 50 percent Recommended dose of Nitrogen VC + 50 percent FYM (T_4) and 75 percent Recommended dose of Nitrogen VC + 25percent FYM (T_3) with the value 92.3 q/ha, 88.3 q/ha and 78.1 q/ha respectively. The efficient utilization of nutrient from soil through split application of fertilizer particularly nitrogen (Alipatra *et al*. 2012) and improved physico-chemical properties of soil though application of organic manures are associated with the better use efficiency of nitrogen leading to better growth and yield of maize.

Harvest index: The data on harvest index under different nutrient management treatments have been clearly indicated no significant different was observed among various treatments. It was because of the fact that harvest index is controlled by the genetic makeup of the variety and is affected little by environmental factors or cultivation practices. Yazdani *et al*., (2009) showed that application of organic matter (NPK) gradually improved ear weight, row number, biological yield and harvest index and grain number/row and ultimately increased grain yield of maize as compared with mineral fertilizers. Grain becomes a dominant sink of plant nutrients at their maturity stage and all the photo assimilates are deposited in the grains as compared to other parts of the plant (Ahmad *et al*., 2013).

4. CONCLUSION

From this study it may be concluded that, application of 100 percent recommended dose of Nitrogen Panchgavya (T_8) resulted in significantly higher leaf area index at all the observational stages in *Kharif* 2023 and remained at par with integrated with other treatments. The highest numerical value of 100-grain weight (30.5 g) was recorded with the

application of 100 percent recommended dose of Nitrogen Panchgavya (T_8) along with 75 percent recommended dose of Nitrogen VC Jeevamrit + 25 percent Panchgavya (T_6). It is dependent mainly on genetic factors and is influenced little by the growing conditions. Solid and liquid manure treatment i.e., 100 percent Recommended dose of Nitrogen Panchgavya (T_8) resulted in significantly higher dry matter accumulation by maize crop at all the observation stages i.e., 30 DAS, 60 DAS, 90 DAS and at harvest although this treatment was statistically at par with other treatments. Grain yield of maize is higher than 100 percent liquid manure over solid manure same trend was followed by days to maturity. Liquid manure effect maturity cycle. The diameter of cob is directly affect the yield of grain, Grain yield and harvest yield. Similar to grain yield, the highest stover yield was observed in 75 percent Recommended dose of Nitrogen VC Jeevamrit + 25 percent Panchgavya (T_6) and 100 percent Recommended dose of Nitrogen Panchgavya (T_8) with the value 96.4 q/ha and 95.4q/ha, respectively. This was followed by the treatment receiving 50 percent Recommended dose of Nitrogen VC Jeevamrit + 50 percent Panchgavya (T_7) which recorded 96.1 q/ha. The study showed that application of organic matter (NPK) gradually improved ear weight, row number, biological yield and harvest index and grain number/row and ultimately increased grain yield of maize as compared with mineral fertilizers. Grain becomes a dominant sink of plant nutrients at their maturity stage and all the photo assimilates are deposited in the grains as compared to other parts of the plant.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

1. No any copied original manuscript
2. Uses some references already mentioned under this paper
3. No uses any of copied techniques

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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