Original Research Article

EFFECT OF ORGANIC AND INORGANIC NUTRIENT SOURCES ON GROWTH AND YIELD OF MAIZE (*Zea mays* L.)

Abstract:The present investigation titled "Effect of Organic and Inorganic Nutrient Sources on Growth and Yield of Maize" was conducted during *kharif* season of 2022 at Chamelti Agriculture Farm, MS Swaminathan School of Agriculture, Shoolini University, Solan, and Himachal Pradesh. The field experiment was laid out in Randomized Block Design comprising of 10 treatments and 3 replications which are (T_1) Control, (T_2) 100% RDF, (T_3) 120% RDF, (T_4) 50% RDF + FYM (10 t), (T_5) 75% RDF + FYM (5 t), (T_6) 100% RDF + FYM (5 t) + Mulch, (T_7) 50% RDF + Vermicompost (2.5 t ha^{-1}), (T_8) 75% RDF + Vermicompost (2.5 t ha^{-1}), (T_9) 100% RDF + Vermicompost (2.5 t ha^{-1}) + Mulch) and (T_{10}) 75% RDF + FYM (5 t) + Vermicompost (2.5 t ha^{-1}) + Mulch. Mustard stover @ 2 t ha^{-1} was used as mulching.RDF used is (100:40:40 kg ha^{-1}) was applied through urea (46% N), SSP (16% P_2O_5) and MOP (60% K_2O). One third N and full dose of P and K was applied at the time of sowing as basal application. Remaining nitrogen was applied in 2 equal splits at 30 and 50 DAS as top dressing. PSC-3322 variety of maize was used for sowing. Other crop management practices were followed as per the recommendation of the area. . This study concluded that application of 120 % RDF recorded significantly higher plant height, yield andwas economically better than other treatments.

INTRODUCTION

The rising population and consumption, reduction in available land and other productive units are placing unprecedented pressure on the current agriculture and natural resources to meet the increasing food demand. Achieving food security under sustainable system possesses a significant challenge in the developing world and is highly critical for alleviating poverty. To circumvent this challenge, crop producers tended to over use certain inputs such as chemical fertilizers and pesticides which in turn have already started deteriorating environment and soil as well. To meet the world's future food security and sustainability needs, food production must grow substantially, while the negative impact of agriculture on environment must shrink dramatically at the same time (Foley et al., 2011). In India, maize is the third most important cereal crop after rice and wheat. It has got immense potential therefore, called as "Miracle crop" and also as "Queen of Cereals". Maize, with its high content of carbohydrates, fats, proteins, some of the important vitamins and minerals has acquired a well-deserved reputation as a poor man‘s nutricerea' and contributes more than 9% to national food basket. Maize grain has elevated nutritive value as it contains about 72% starch, 10% protein, 4.8% oil, 5.8% fiber and 3% sugar (Rafiq *et al.*, 2010). The consumption pattern for maize produced in India at present includes poultry feed (52%), human food (24%), animal feed (11%), starch (11%), brewery (1%) and seed (1%) (Dass *et al.,* 2007).

It occupies 9.86 million ha area and production of 31.51 million tonnes of production with average productivity of 3195 kg ha^{-1} (Agricultural Statistics at a Glance, 2021). The area, production and productivity of maize in Himachal Pradesh is 26.74 thousand ha, 725014 metric ton and 2730 kg ha-1respectively. In Solan district of

Himachal Pradesh total area under maize is 22435 ha with the production of 73276 matric tones and average productivity of about 3270 kg ha^{-1} (Statistical Abstract of Himachal Pradesh, 2021-22).

It is evident that the productivity of maize in tropical nations is constrained due to inherently poor soil fertility, low soil organic matter and further more low water holding capacity. Maize crop has a higher nutrient uptake character and leaves soil exhaustive. The method of nutrition and its management plays a crucial role in production of maize. The cereal production versus fertilizer consumption of India indicates low fertilizer use efficiency (Prasad, 2009).

Farmyard manure is a traditional, well known, readily available and widely used input since time immemorial. It is a conspicuous organic component of an integrated nutrient supply system, which improves soil health, increases the productivity and releases macro and micronutrients. It is costlier than chemical fertilizers on nutrient basis but other beneficial effect on soil aggregates, cation exchange capacity, water holding capacity, fertilizers use efficiency, microbial activity and nutrient availability in soil (Sharma *et al.*, 2004).

Vermicompost plays a significant role in improving the fertility of top soil and in boosting the productivity of the crop. Vermicopost has also been advocated as good organic manure for use in integrated nutrient management practices in field crops (Singh and Nepalia, 2009**.** It is proven fact that productivity of any crop cannot be further increased by use of high doses of fertilizer alone. Balanced nutrition through right proportion of organic manures and chemical fertilizers is essential for boosting QPM production and sustaining soil productivity (Singh et al., 2017).

MATERIALS AND METHODS

The present research work titled "Effect of Organic and Inorganic Nutrient Sources on Growth and Yield of Maize (*Zea mays* L.)" was carried out during kharif season of 2022 at Chamelti Agriculture Farm, MS Swaminathan School of Agriculture, Shoolini University of Biotechnology and Management Sciences, Solan. The experimental plot was assigned well-drained soil which had homogenous fertility and textural arrangementGeographically, Chamelti Agriculture Farm is situated 30 km away from Solan city at an elevation of 1,270 meters above mean sea level lying between latitude 30^0 85'67.30 N and longitude 77^0 13'20.38 E. It falls under the mid-hill zone of Himachal Pradesh. The field of the experimental site represented ideal spatial unit in respect of texture, make up and fertility status. The soil of the experimental site was sandy loam in texture, slightly alkaline in reaction with EC in safer range, medium in organic carbon, available nitrogen, potassium and high in available phosphorus. The field experiment was laid out in Randomized Block Design comprising ten treatments and replicate thrice. The experiment consists (T_1) Control, (T_2) 100% RDF, (T_3) 120% RDF, (T_4) 50% RDF + FYM (10 t), (T_5) 75% RDF + FYM (5 t), (T_6) 100% RDF + FYM (5 t) + Mulch, (T_7) 50% RDF + Vermicompost (2.5 t ha-1), (T_8) 75% RDF + Vermicompost (2.5 t ha-1), (T_9) 100% RDF + Vermicompost (2.5 t ha-1) + Mulch) and (T_{10}) 75% RDF + FYM (5 t) + Vermicompost (2.5 t ha-1) + Mulch. Mustard stover @ 2 t ha-1 was used as mulching. Recommended dose of nitrogen, phosphorus and potassium (100:40:40 kg ha-1) was applied through urea (46% N), SSP (16% P2O5) and MOP (60% K2O). One third nitrogen and full dose of phosphorous and potassium was applied at the time of sowing as basal application. Remaining nitrogen was applied in two equal splits at 30 and 50 DAS as top dressing. However, FYM and Vermicompost were applied one month before sowing. PSC-3322 variety of maize was used for sowing. Other crop management practices were followed as per the recommendation of the area.

STATISTICAL ANALYSIS

The data presented in the thesis are the mean values. All the observations are statistically analyzed by using the analysis of variance. The results were tested for the treatments mean by applying F- test of significance on the basis of null hypothesis (Cochran and Cox, 1957). Wherever necessary, standard errors along with critical difference at 5 % of significance were computed for discriminating the treatment effects for chance effects.

RESULTS AND DISCUSSION

A. Growth parameters

Different growth parameters such as plant height and dry matter accumulation were showed in (Table 1). Among treatments, (T_3) 120% RDF recorded significantly higher plant height (40.50 cm) which was statistically at par with (T_9) 100% RDF + Vermicompost (2.5 t ha^{-1}) + Mulch, (T_6) 100% RDF + FYM (5 t ha^{-1}) + Mulch and (T_2) 100% RDF, respectively. However, least plant height was noted under (T_1) control treatment. The higher level of nitrogen increased the availability and absorption of nitrogen which resulted in more vegetative growth due to increase in plant height on account of enlargement of cells and increased photosynthesis Mohamoud et al. (2002); (Tiwana et al., 2003); Sobhana et al. (2012); Gul et al. (2015) and Wadile et al. (2016).

Whereas application of (T_3) 120% RDF recorded significantly higher dry matter accumulation (18.33 g plant^{-1}) which was statistically at par with (T_9) 100% RDF + Vermicompost (2.5 t ha-1) + Mulch, (T_6) 100% RDF + FYM (5 t ha-1) + Mulch and (T_2) 100% RDF, respectively. However, least dry matter accumulation (11.98 g plant^{-1}) was noted under (T_1) control treatment.

B. Yield attributes

Data on the effect of organic and inorganic nutrient sources on various yield attributes parameters of maize have been presented in Table 2. Among the treatments, application of (T_3) 120% RDF recorded significantly higher number of cobs plant^{-1} (2.20), cob length (21.45 cm), number of grains cobs^{-1} (221.45) and seed index (26.51 g)however , least number of cobs plant^{-1} (1.20), cob length (15.94 cm), number of grains cobs^{-1}(142.35) and seed index (26.05 g)was noted under (T_1) control treatment.Maximum number of rows cob-1 was recorded under the application of 120 % RDF through inorganic source mainly due to more availability and steady nutrients release. Use of fertilizer did bring about significant improvement in overall growth of the crop by providing needed nutrients from initial stage and increase in supply of N, P and K in more synchronize way. These findings are corroborate the results of Iqbal et al. (2014) and Nagavani and Subbian (2014) in maize.

C. Yield

Data on the effect of organic and inorganic nutrient sources on yield of maize have been presented in Table 3.Among the treatments, application of (T_3) 120% RDF recorded significantly higher grain yield (3753 kg ha^{-1}), stover yield (13511 kg ha^{-1}), biological yield (17264 kg ha^{-1}) and harvest index (21.74%) however least grain yield (1805 kg ha^{-1}), stover yield (6697 kg ha^{-1}), biological yield (8502 kg ha^{-1})and harvest index (21.23%) was noted under (T_1) control treatment.. The probable reason for these results might be attributed to better nitrogen availability. Nitrogen being a major constituent of chlorophyll molecule, might have played a positive role in increasing the photosynthetic activity and ultimately reflected in the acceleration of meristametic activity and increase in the yield. The significant positive correlation between yield and various other parameters have indicated the positive response of higher dose fertilizers on various other parameters. The results of present investigation are in close agreement with the findings of Girija Devi (2002); Dudhat et al. (2004); Hani et al. (2006); Kumar et al. (2008); Rizwan *et al.* (2008); Ramanjaneyulu *et al.* (2010) and Reddy and Bhanumurthy (2010).

D. Economics

Data on the effect of organic and inorganic nutrient sources on Economics is showed in Table 4. Among the treatments, application of (T_3) 120% RDF recorded significantly higher gross returns (₹ 123099 ha^{-1}), net returns (₹ 90513 ha^{-1}) and B: C ratio

(2.78)The data clearly revealed that higher gross returns, net returns and B:C ratio were observed under application of (T_3) 120% RDF over rest of the treatments. This might be due to higher yield and least cost of cultivation. Integration of vermicompost and FYM with inorganic source in different proportion recorded low net realization and B:C ratio mainly due to high cost of manure over 120 % RDN through inorganic source. These results are in accordance with the findings Meena *et al.* (2013) and Nagavani and Subbian (2014).

Table 1. Effect of organic and inorganic nutrient sources on growth parameters

Treatments	Plant Height at harvest (cm)	Dry Matter at harvest (g plant-^{1})
T_1: Control	177.63	82.43
T_2: 100% RDF	212.90	98.79
T_3: 120% RDF	222.00	103.02
T_4: 50% RDF + FYM (10 t ha^{-1})	192.45	89.30
T_5: 75% RDF + FYM (5 t ha^{-1})	197.90	91.83
T_6: 100% RDF + FYM (5 t ha^{-1}) + Mulch	216.25	100.35
T_7: 50% RDF + Vermicompost (2.5 t ha^{-1})	196.69	91.27
T_8: 75% RDF + Vermicompost (2.5 t ha^{-1})	198.39	92.06
T_9: 100% RDF + Vermicompost (2.5 t ha^{-1}) + Mulch	219.20	101.72
T_{10}: 75% RDF + FYM (5 t ha^{-1}) + Vermicompost (2.5 t ha^{-1}) + Mulch	199.90	92.76
SEm±	6.60	3.11
LSD (p=0.05)	19.91	9.00

Table 2. Effect of organic and inorganic nutrient sources on yield attributes

Treatments	Cobs plant^{-1}	Cob length (cm)	Grains cob^{-1}	Seed index (g)
T_1: Control	1.20	15.94	142.35	26.05
T_2: 100% RDF	2.00	19.12	194.31	26.32
T_3: 120% RDF	2.20	21.45	221.45	26.51
T_4: 50% RDF + FYM (10 t ha^{-1})	1.40	17.24	174.63	26.14
T_5: 75% RDF + FYM (5 t ha^{-1})	1.60	18.31	184.65	26.21
T_6: 100% RDF + FYM (5 t ha^{-1}) + Mulch	2.00	19.42	197.37	26.39
T_7: 50% RDF + Vermicompost (2.5 t ha^{-1})	1.40	17.61	180.61	26.18
T_8: 75% RDF + Vermicompost (2.5 t ha^{-1})	1.60	18.49	188.85	26.26
T_9: 100% RDF + Vermicompost (2.5 t ha^{-1}) + Mulch	2.00	19.78	200.65	26.44
T_{10}: 75% RDF + FYM (5 t ha^{-1}) + Vermicompost (2.5 t ha^{-1}) + Mulch	1.60	18.71	191.98	26.29

SEm±	0.06	0.39	74.58	0.18
LSD (p=0.05)	0.21	1.24	21.54	NS

Table 3. Effect of organic and inorganic nutrient sources on economic

Treatments	Yield (kg ha^{-1})			Harvest index (%)
	Grain yield	Stover yield	Biological yield	
T_1: Control	1805	6697	8502	21.23
T_2: 100% RDF	3315	12133	15448	21.46
T_3: 120% RDF	3753	13511	17264	21.74
T_4: 50% RDF + FYM (10 t ha^{-1})	2231	8255	10486	21.28
T_5: 75% RDF + FYM (5 t ha^{-1})	2815	10387	13202	21.32
T_6: 100% RDF + FYM (5 t ha^{-1}) + Mulch	3451	12562	16013	21.55
T_7: 50% RDF + Vermicompost (2.5 t ha^{-1})	2416	8939	11355	21.28
T_8: 75% RDF + Vermicompost (2.5 t ha^{-1})	2942	10856	13798	21.32
T_9: 100% RDF + Vermicompost (2.5 t ha^{-1}) + Mulch	3542	12857	16399	21.6
T_{10}: 75% RDF + FYM (5 t ha^{-1}) + Vermicompost (2.5 t ha^{-1}) + Mulch	3025	11132	14157	21.37
SEm±	103	421	536	0.43
LSD (p=0.05)	312	1274	1619	NS

Table 4. Effect of organic and inorganic nutrient sources on yield

Treatments	Economics (₹ ha^{-1})			B:C ratio
	Cost of cultivation	Gross returns	Net returns	
T_1: Control	24000	59801	35801	1.49
T_2: 100% RDF	31155	109329	78174	2.51
T_3: 120% RDF	32586	123099	90513	2.78
T_4: 50% RDF + FYM (10 t ha^{-1})	34578	73847	39269	1.14
T_5: 75% RDF + FYM (5 t ha^{-1})	32866	93091	60225	1.83
T_6: 100% RDF + FYM (5 t ha^{-1}) + Mulch	34655	113608	78953	2.28
T_7: 50% RDF + Vermicompost (2.5 t ha^{-1})	40078	79969	39891	1
T_8: 75% RDF + Vermicompost (2.5 t ha^{-1})	41866	97292	55426	1.32
T_9: 100% RDF + Vermicompost (2.5 t ha^{-1}) +	43655	116495	72840	1.67

Mulch				
T_{10}: 75% RDF + FYM (5 t ha^{-1}) + Vermicompost (2.5 t ha^{-1}) + Mulch	45366	99946	54580	1.2

CONCLUSION

On the basis of experimental finding summarized above, the following conclusions are drawn: Marked improvement in growth, yield attributes and yield of maize were observed with application of (T_3) 120% RDF which was statistically at par with (T_9) 100% RDF + Vermicompost (2.5 t ha^{-1}) + Mulch, (T_6) 100% RDF + FYM (5 t ha^{-1}) + Mulch and (T_2) 100% RDF over rest of the treatments.

On the basis of B: C ratio, application of (T_3) 120% RDF was found to be remunerative for maize under Mid hills of Himachal Pradesh.

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