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IMPACT OF DIFFERENT LAND CONFIGURATIONS WITH INTEGRATED NUTRIENT MANAGEMENT ON QUALITY AND PRODUCTIVITY OF *KHARIF* MAIZE *(Zea mays* L.*)*

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ABSTRACT

Present study was conducted at Student's Research Farm, P.G. Department of Agriculture, Khalsa College, Amritsar, Punjab, India in *kharif* season of year 2021. The field experiment was laid out in split plot design (SPD). The field experiment was comprised of 18 treatment combinations with three main plot treatments (bed planting , ridge sowing and flat sowing) and six as sub plot treatments of integrated nutrient management *viz.,* 100% RDN through chemical fertilizer (T_1), 100% RDN through FYM (T_2), 100% RDN through vermicompost (T_3), 50% RDN through chemical fertilizer + 50% RDN through FYM (T_4), 50% RDN through chemical fertilizer + 25% RDN through FYM + 25% RDN through vermicompost (T_5), 50% RDN through FYM + 50% RDN through vermicompost (T_6) and was replicated thrice. Among different land configurations, bed planting produced significantly higher growth and yield attributes of *kharif* maize as compared to flat sowing method. Maximum grain yield of 40.80 q ha^{-1} was recorded in bed planting methods which was statistically at par with ridge sowing method (39.31 q ha^{-1}) but was significantly higher than that recorded under flat sowing (37.42 q ha^{-1}). In case of INM combinations results revealed that growth characters like plant height (214.02 cm), LAI (3.69), dry matter accumulation (211.03 g ha^{-1}) at periodic intervals as well as yield attributes such as cob length (18.95cm), grains cob^{-1} (531), weight of individual cob (204 g), test weight (228.42 g), shelling percentage (81.94%), grain yield (42.62 q ha^{-1}) and stover yield (97.05 q ha^{-1}) were significantly higher with treatment T_4 (50% recommended N through chemical fertilizer + 50% recommended N through FYM). Different land configuration treatments did not significantly influenced the protein content in maize grains but in case of treatments of INM combinations protein content was significantly higher in treatment T_4 (50% recommended N through chemical fertilizer + 50% recommended N through FYM (8.75%).

(Key words: *Kharif* maize, INM, land configurations, yield attributes, yield, quality)

INTRODUCTION

Maize (*Zea mays* L.) is an important *kharif* crop. It belongs to Poaceae family. It is originated from Mexico. Maize is third important cereal crop in the world after wheat and rice with respect to area under cultivation and production. India stands 4th in area under maize cultivation which is around 4 per cent of the total world area and 2 per cent of total production. Among Indian states Madhya Pradesh and Karnataka has highest area under maize (15% each) followed by Maharashtra (10%), Rajasthan (9%) and Uttar Pradesh (8%). Maize occupied 107.8 thousand hectares, with a production of 395.1 thousand tonnes in the Punjab state during 2021-22. The average yield was 36.65q ha^{-1} (Anonymous, 2021). In India, about 28% of maize produced is used for food purpose, about 11% as livestock feed, 48% as poultry feed, 12% in wet milling industry and 1% as seed (Layek *et al.,* 2016). The production potential of maize crop under Punjab condition is very low compared to the other developed countries. There are number of factors responsible for its low production and productivity in Punjab such as, agro climatic conditions, imbalance use of inputs and constraints to adopt agronomic interventions. Apart these problems judicious use of chemical fertilizers and organic nutrients and their proper management have deep rooted effect on its production and productivity.

Integrated nutrient management (INM) or integrated nutrient supply (INS) system aims at achieving efficient use of chemical fertilizers in conjunction with organic manures. In addition to having a positive influence on soil health, INM is effective in restoring and maintaining soil fertility, crop yield, preventing micronutrient deficiencies, improving nutrient use-efficiency and economizing fertilizer use (Singh *et al.,* 2012). Imbalance use of inorganic fertilizers and lack of organic fertilization are the related causal factors for decline of their properties (Beshir and Abdulkerim, 2017). The ill practices followed by the Punjab farmers' *viz.*, adoption of monotony in crop rotations and burning of

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paddy straw had deteriorated soil health and intensified the pollution growth to its maximum limits. An emphasis has been given to identifying some other alternatives of inorganic fertilizers, burning of rice straw and over use of synthetic chemicals, which are blamed for most of the problems associated with conventional agriculture (Kumar and Singh, 2016). The organic sources besides supplying N, P and K also make unavailable sources of elemental nitrogen, bound phosphates and micronutrients into available form to facilitate plant to absorb the nutrients.

There is a scope to increase the maize productivity through various agronomic manipulations. Method of sowing is a major factor to mitigate the vagaries of climate which is also responsible for soil moisture storage, judicious use of water, good crop stand and better crop growth. There is a risk of lodging in *kharif* maize due to adverse weather conditions particularly at later stages of the crop. Water lodging at flowering can reduce grain yield by about 50%. Planting methods can also improve the drainage to a quite good extent. Sowing on ridges and bed planting can meet this purpose. These methods may resist lodging and will produce higher grain yield than flat sowing. Bed planting is a method of planting a crop on the top of raised bed with a definite number of rows often one or two bed^{-1} (Sayer, 2003). The conventional flat planting is the common practice of raising crops in India but this practice caused the degradation and inefficient use of basic resources and various inputs. Planting of maize on raised beds and ridges provide a better option for managing water, nutrients and weeds as observed by Freeman *et al.* (2007).

MATERIALS AND METHODS

The present study was carried out during *kharif* season of 2021-22 at Student's Research Farm, P.G. Department of Agriculture, Khalsa College, Amritsar, Punjab, India. The geographical coordinates of the experimental site were 31^0 38'19" N and 74^{0}49'50" E and the height above the sea level was 230 m. Amritsar is characterised by semi-arid climate, typical of north-west India and experiences mainly four seasons winter season (December to March), summer season (April to June), monsoon season (July to September) and post-monsoon season (October to November), where both winters and summers are extreme. The monsoon generally starts in the first week of July and mean annual rainfall fluctuate around 75 cm. The experiment was focused on maize hybrid variety NMH-1258, to check the effect of land configurations with integrated nutrient management on quality and productivity of maize. The seed was sown with a distance of 60 cm between rows and 20 cm between plants. The seed rate used was 20 kg ha^{-1}. The soil of experiment field was sandy loam. The soil was neutral in reaction and low in soluble salts, having normal pH (8.3), normal EC (0.21dSm^1), high organic carbon (1.34 g kg^{-1}), before sowing the crop. The field experiment was laid out in split plot design (SPD). The field experiment was comprised of 18 treatment combinations with three main plot treatments (bed planting , ridge sowing and flat sowing) and six as sub plot treatments of integrated nutrient management *viz.,* 100% RDN through chemical fertilizer (T_1), 100% RDN through FYM (T_2), 100% RDN through vermicompost (T_3), 50% RDN through chemical fertilizer + 50% RDN through FYM (T_4), 50% RDN through chemical fertilizer + 25% RDN through FYM + 25% RDN through vermicompost (T_5), 50% RDN through FYM + 50% RDN through vermicompost (T_6) and was replicated thrice. The net plot size was 12.25 m^2. Observations on periodic plant height, leaf area index and dry matter accumulation were recorded at 25, 50, 75 DAS and at harvesting. Observations on yield attributes such as number of grains cob^{-1}, length of cob, weight of cob, 1000 grains weight and grain yield, stover yield, harvest index and protein (%) were also recorded. Harvest index (HI) was calculated by formula:

HI (%) = Economic (grain) yield / Biological yield × 100

Protein content (%) was calculated by formula:

Protein (%) = Per cent nitrogen × 6.25 (constant)

RESULTS AND DISCUSSION

Growth parameters and yield attributes of maize

The data revealed that land configurations had a significant effect on growth parameters (plant height, LAI, and dry matter accumulation at harvest) and on yield attributing parameters (cob length, weight of individual cob) of *kharif* maize (Table 1). Among the land configurations, *kharif* maize on bed planting produced the tallest plant (203.96 cm), having the maximum LAI (3.53), DMA (206.54 q ha^{-1}), cob length (19.00 cm), weight (201.93 g), number of grains cob^{-1} (497.16) and 1000 grains weight (223.61 g). Plants under bed plantation had 11.5%, 16.5%, 17.4% higher plant height, LAI and DMA than that under flat bed planting respectively. The results were confirmed by the findings of Singh and Vashist (2015) and Kaur (2011), who also recorded higher growth parameters and yield in case of bed (78.2 q ha^{-1}) and ridge planted (74.8 q ha^{-1}) crop as compared to flat planting (70 q ha^{-1}) in maize.

Among the integrated nutrient management practices, conjoint application of 50% RDN through chemical fertilizer + 50% RDN through FYM (T_4) produced significantly taller maize plants (214.02 cm), higher LAI (3.69), higher DMA (211.03 q ha^{-1}), cob length (18.95 cm), weight (204 g), 1000 kernels weight (228.42 g) and grains cob^{-1} (588) than other INM treatments. Similar results were found by Tetarwal *et al.* (2011) that recommended dose of fertilizer (40-15 kg N-P ha^{-1}) + FYM 10 t ha^{-1} produced higher plant growth parameters *i.e.* plant height (207.3 cm), DMA (149.1 g plant^{-1}) and yield attribute *i.e.* no. of cobs plant^{-1} (1.4) and grains cob^{-1} (209) at Agricultural Research Sub Station, Alkera Jhalawar, Rajasthan by Amanullah and Khan (2017).They reported that maize crop fertilized with 150 kg ha^{-1} produced taller plants (184 cm) as compared to other treatments.

Table 1. Effect of land configurations with INM on growth parameters and yield attributes of hybrid *kharif* maize

Treatments	Plant height (Days after sowing) (cm)				Dry matter accumulation (Days, after sowing) (g)				Leaf area index (Days after sowing)(cm^2)				Cob length (cm)	Weight of cob (g)	No. of grains cob^{-1}	1000 grains weight (g)
	25	50	75	At Harvest	25	50	75	At harvest	25	50	75	At harvest				
Land configuration																
Bed planting (M_1)	68.76	192.18	203.18	203.96	11.46	118.62	170.05	206.54	1.09	4.10	4.68	3.53	19.00	201.93	497.16	223.61
Ridge planting (M_2)	68.32	184.76	194.26	194.87	9.38	115.98	165.82	200.50	1.01	3.97	4.53	3.32	17.87	191.58	460.94	205.01
Flat planting (M_3)	63.53	176.09	182.01	182.78	8.14	112.90	163.55	175.83	0.95	3.91	4.34	3.03	15.44	185.15	403.05	200.88
SE(m)±	1.01	3.59	2.72	2.89	0.47	1.20	1.42	3.99	0.03	0.04	0.11	0.11	0.86	4.10	18.68	3.50
CD at 5 %	3.03	10.78	8.18	8.62	1.43	3.61	4.26	11.90	0.09	0.12	0.32	0.31	2.59	12.31	56.05	10.52
Integrated nutrient management																
100% RDN through chemical fertilizer (T_1)	65.84	177.88	186.96	187.83	8.48	117.90	164.18	207.21	1.14	3.74	4.30	3.34	17.07	189.32	425.77	203.77
100% RDN through FYM (T_2)	64.98	171.95	181.54	182.40	8.11	94.88	160.60	185.11	0.98	3.43	3.98	2.96	15.82	186.52	405.33	193.84
100% RDN through vermicompost (T_3)	65.26	172.21	183.51	183.80	8.41	108.62	162.36	195.95	1.11	3.59	4.06	3.07	16.82	186.65	406.11	201.55
50% RDN through chemical fertilizer +50% RDN through FYM (T_4)	70.36	206.07	213.35	214.02	12.90	130.01	173.66	211.03	1.26	4.18	4.71	3.69	18.95	204.00	531.00	228.42
50% RDN through chemical fertilizer +25% RDN FYM+25% RDN through vermicompost (T_5)	66.21	178.98	187.37	188.25	8.89	125.03	166.90	196.43	1.17	3.95	4.56	3.41	17.85	191.20	430.88	207.41
50% RDN through FYM+50% RDN through vermicompost (T_6)	68.56	198.96	206.16	206.95	11.17	127.24	171.15	209.05	1.20	4.04	4.68	3.54	18.09	199.65	523.22	224.01
SE(m)±	0.86	3.72	3.85	3.87	0.46	1.79	0.91	2.89	0.04	0.07	0.09	0.09	0.52	2.22	9.71	5.01
CD at 5%	–	11.16	11.50	11.63	1.39	5.38	2.75	8.64	0.12	0.21	0.27	0.27	1.57	6.62	29.13	15.04
Interactions (M x T)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
SE(m)±	0.94	3.90	4.02	5.10	0.92	2.59	3.13	5.21	0.11	0.17	0.24	0.21	0.87	3.20	14.63	3.94
CD at 5%	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 2. Effect of land configuration with INM on yield and quality parameters of hybrid *kharif* maize

Treatments	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})	Harvest index (%)	Protein (%)
Land configuration				
Bed planting (M_1)	40.80	79.21	35.52	8.11
Ridge planting (M_2)	39.31	65.50	37.81	8.10
Flat planting (M_3)	37.42	55.53	38.60	8.10
SE(m) ±	0.75	3.06	0.92	0.003
CD at 5%	2.27	9.20	–	–
Integrated nutrient management				
100% RDN through chemical fertilizer (T_1)	38.73	54.31	37.25	8.17
100% RDN through FYM (T_2)	36.00	49.64	38.21	7.58
100% RDN through vermicompost (T_3)	38.41	52.82	37.77	8.12
50% RDN through chemical fertilizer +50% RDN through FYM (T_4)	42.62	97.05	35.43	8.75
50% RDN through chemical fertilizer+25% RDN through FYM+25% RDN vermicompost (T_5)	39.54	59.56	36.74	7.88
50% RDN through FYM+50% RDN through vermicompost (T_6)	39.81	87.32	36.04	8.40
SE(m) ±	0.86	2.71	0.42	0.12
CD at 5%	2.59	8.11	–	0.36
Interactions	–	–	–	–
SE(m) ±	1.45	3.55	0.51	0.28
CD at 5%	–	–	–	–

Interaction effect of different land configuration and integrated nutrient management treatments with respect to plant growth parameters *viz.,* plant height, dry matter accumulation, leaf area index and yield attributes such as number of grains cob^{-1}, weight of cob, length of cob and 1000 grains weight were found to be non-significant.

Yield and quality parameters of maize

Land configuration had significant effect on yield and quality parameters of *kharif* maize (grain yield, stover yield, harvest index and protein content). Highest grain yield was observed in bed planting techniques (40.80 q ha^{-1}) and at par with ridge planting techniques (39.31 q ha^{-1}). Bed planting produced higher stover yield (79.21 q ha^{-1}) and harvest index was higher in flat bed techniques. Land configuration does not cause any significant effect on protein content. Similar results were observed by Tanveer *et al.* (2014), who reported maximum grain yield in bed sowing (6.24 t ha^{-1}) followed by ridge sowing (5.97 t ha^{-1}) and flat sowing methods (5.2 t ha^{-1}).

In case of INM treatments grain yield (42.62 q ha^{-1}) and stover yield (97.05 q ha^{-1}) was observed significantly higher in treatment T_4 (50% RDN through chemical fertilizer + 50% RDN through FYM). Harvest index was recorded significantly higher in treatment T_2 (100% RDN through FYM *i.e.* 38.21%). Among all the treatments grains of treatment T_4 had the significantly higher protein content *i.e.* 8.75% as compared to other treatments. These results are in line with the findings of Verma, (2011), who observed that application of 100 kg N ha^{-1} with 7.50 t ha^{-1} FYM at the sowing of 25 Oct. significantly influenced the growth, yield and quality of maize and was recorded 9.35 and 23.07 % more grain yield over the other treatment combinations. Yadav *et al*. (2017) observed significantly higher seed yield (54.15 q ha^{-1}) and stover yield (81.25 q ha^{-1}) by application of 50% urea + 50% neem coated urea.

Interaction effect of different land configuration and integrated nutrient management treatments with respect to grain yield, stover yield, harvest index and protein content were found to be non-significant.

It is stated from the results that different land configurations, bed planting produced significantly higher growth and yield attributes of *kharif* maize as compared to flat sowing method. Maximum grain yield of 40.80 q ha^{-1} was recorded in bed planting methods which was statistically at par with ridge sowing method (39.31 q ha^{-1}) but was significantly higher than that recorded under flat sowing (37.42 q ha^{-1}). Treatment N_4 (50% RDN through chemical fertilizer +50% RDN through FYM) recorded significantly higher values of growth, yield and quality parameters than other treatments and was found to be best suited combination of integrated nutrient management in hybrid *kharif* maize.

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