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Effect of growth and yield of maize (*Zea mays* L.) by optimization of nitrogen through organic and inorganic sources cropunder climatic conditions of Punjab

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Abstract
Experiment was conducted during *zaid* season of 2020-21 at the Agricultural Research Farm Dhablan of the G.S.S.D.G.S. Khalsa College Patiala, Punjab. Field experiment was laid out in spilt plot design with 16 different treatments with 3 replications, combination of organic and in –organic fertilizer levels. The soil of experimental field was clay in texture with pH 7.6 and organic carbon 0.58%, available nitrogen 184.4 kg ha^{-1}, available phosphorus 19.10 kg ha^{-1} and available K 144.9 kg ha^{-1}. Different levels of nitrogen also influenced the plant height at 30, 60 and 90 days. Plant height frequently increases with increase in nitrogen levels during all stages of crop growth. Maximum plant height, number of leaves and dry weight with nitrogen application @ 125% ha^{-1} whereas the lower plant height, number of leaves and dry weight found over the control treatment (N_0). Increase in height, number of leaves and dry weight might be due to positive effect of nitrogen on the growth of the plant which leads to rapid increase in length of internodes and plant height, number of leaves and dry weight. Maximum biological yield among all the nitrogen level, 217.91 q ha^{-1} data were recorded with $N_{125\%}$ application which is significantly higher over the control (175.31 q ha^{-1}). Grain yield increased with FYM_{20} application over the control which was 73.97 q ha^{-1}. High level of nitrogen increased the grain yield which was near about 72.97 q ha^{-1} Similarly maximum harvest index (37.07%) was found at highest nitrogen level of N_0while the minimum harvest index (33.43%) seen in control treated plots.

Keywords: Maize, plant height, seed yield

Introduction
Maize (*Zea mays* L.) is the third most versatile emerging food grain crop. In India, maize ranks third in terms of production among the cereals. It is widely adapted crop and is grown under extreme diverse climatic conditions ranging from tropical to temperate regions. There is no cereal in this world which has so immense potential and that is why it is also represent with other name as queen of cereals. Maize in America and India is referred to as corn which literally means "that which sustains life". Botanically, it belongs to grass family *Graminaceae/Poaceae*. Maize has tremendous variability in kernel color, texture, composition and appearance. It is an annual plant with an extensive fibrous root system. It is a diploid species, with a chromosome number of 2n = 20 and it followed C_4 pathway.
Maize is normally a tall annual grass with a solid stem. Usually in maize plant, 12-18 leaves are present in it. Being a monoecious plant it has two types of inflorescence i.e. female inflorescence which develops into an ear also known as cob and the male inflorescece which contains the male flowers also known as tassel. Generally, maize grain contains about 10% protein, 4% oil, 70% carbohydrate, 2.3% crude fiber, 1.4% ash, 10% albuminoides and substantial quantities of Vitamin A, Nicotinic acid, Riboflavin, Vitamin E (Singh *et al.* 2012) [6].

Materials and Methods
Experiment was conducted during *zaid* season of 2020-21 at the Agricultural Research Farm Dhablan is situated at about 24-46 ^{0}N latitude and 76-24 ^{0}E longitude at an altitude of about 250 m above the mean sea level. The experiment was laid out in split plot design with 3 replications. From the five randomly selected plants the heights were recorded in cm. The numbers of leaves were counted from the sample plants and the values of these were averaged.

To study the dry weight of five plants were collected from the sampling rows of each plot at 30 days interval from sowing till harvest of the crop. These fresh samples were air dried and then dried in an oven at 60 °C till a constant weight was obtained and weighed to record the average dry weight of the plant. The weight of the sun dried harvested crop was recorded from net plot area and expressed in quintal per hectare after subtracting the seed yield. Seed yield of each plot excluding the border and sampling row was weighed in kilo gram and converted into q ha^{-1}.

Results and Discussion

In case of FYM, plant height was also affected significantly at all stages. Application of FYM @ 20 t ha^{-1} produced the tallest plant height (29.51 cm, 95.11 cm, 169.76 cm) at 30, 60 and 90 DAS over the control (FYM_0) which is (25.51 cm, 87 cm, 156.90 cm). Different levels of nitrogen also influenced the plant height at 30, 60 and 90 days. Plant height frequently increases with increase in nitrogen levels during all stages of crop growth. Highest plant height (31.55cm, 100.87cm and 174.72 cm) observed at 30, 60 and 90 DAS with nitrogen application @ 125%ha^{-1} whereas the lower plant height (23.11 cm, 78.29 cm and 147.09 cm) found over the control treatment (N_0). Increase in height might be due to positive effect of nitrogen on the growth of the plant which leads to rapid increase in length of internodes and plant height. Verma (2011) [8] research shows similar result as he identified that plant height increases with increase in the nitrogen levels.

In addition, a significant response seen in term of number of leaves with the application of FYM observed at all stages of observation which were (4.95 cm, 9.81 cm, 11.70 cm) but minimum number of leaves were observed in the control replication (3.82 cm, 8.18 cm and 10.29 cm) during 30 DAS interval. Analysis of data revealed that nitrogen had a significant effect on number of leaves $plant^{-1}$. More number of leaves were produced with optimum nitrogen dose as compared to low nitrogen doses at all stages. Highest number of leaves $plant^{-1}$ were recorded (5.62cm, 10.81cm and 12.90 cm) at $N_{125\%}$ ha^{-1}.

In FYM treated plots, FYM20t ha^{-1} accumulated high dry weight of plant which is near about 29.34 g $plant^{-1}$, 143.73 g $plant^{-1}$, 247.18 g $plant^{-1}$, 313.93 g $plant^{-1}$ at 30, 60, 90 and at harvest stage which is significantly higher over the control at all stages of crop growth. Among the nitrogen treated plots, $N_{125\%}$ produced higher dry matter (29.67 g, 147.99 g, 250.84 g and 331.21 g $plant^{-1}$) at 30, 60, 90 and at harvest stage over the low level of nitrogen treated plots which is $N_{75\%}$ and control. This is due to high photosynthetic rate in crop help to increase the total dry matter production of the plant. FYM treatment had a significant effect on grain yield. Maximum grain yield (73.97 q ha^{-1}) was found with FYM 20t ha^{-1} and minimum grain yield (62.4 q ha^{-1}) was found over the control.

Nitrogen had also a significant effect on the yield of the grains. Maximum yield (72.97 q ha^{-1}) was found with the nitrogen application of the $N_{125\%}$ and minimum grain yield (65 q ha^{-1}) was found at the control plots. The reason might be due to increase in nitrogen level increases the photosynthetic rate and increase in the efficiency of the carbohydrates. Significant higher stover yield was found in the FYM 20t ha^{-1} which was 134.54 q ha^{-1} while 129.24 q ha^{-1} yield also obtained from the treatment FYM10t ha^{-1}which is much more over the control 122.87 q ha^{-1}. The higher stover yield also found by Sujatha, *et al*. 2008 [7] and Raman and Suganya (2018) [11] through INM approach. Increasing in nitrogen levels also boost up the stover yield. Similarly maximum straw yield (144.94 qha^{-1}) was observed under the nitrogen application of $N_{125\%}$ and minimum stover yield (110.31qha^{-1}) was recorded at the control plots. FYM significant affects the biological yield also. Maximum biological yield (208.51 qha^{-1}) was found with 20t ha^{-1} FYM treatment and minimum biological yield (185.27 qha^{-1}) was found over the control. This is due to continuous supply of nutrient will increase the biological yield.

Maximum biological yield (217.91 qha^{-1}) was found at high nitrogen dose $N_{125\%}$ and minimum biological yield (175.31 qha^{-1}) was found at the control plots. This might be due to nitrogen level increases better crop growth rate and leaf area index which automatically enhances the biological yield Similar results were found by Rajashekhar *et al.* 2019 [2] and Mishra *et al.* 2019 [1]. Both treatment i.e. FYM and Nitrogen shows significant effect on harvest index. The highest harvest index (36.23%) recorded with FYM10t ha^{-1} treated plots in comparison to FYM0, FYM 5t and FYM20t ha^{-1}. Similar results were found by Shah *et al.* 2017 [4] and Sharma *et al.* 2019 [5]. Similarly maximum harvest index (37.07%) was found at highest nitrogen level of N_0while the minimum harvest index (33.43%) seen in control treated plots. Yigermal *et al.* 2019 [10] and Yadav *et al.* 2019 [9].

Table 1: Effect of farmyard manure and inorganic nitrogen level onperiodic plant height of *zaid* maize

Treatments	Plant height (cm)			
	30DAS	60DAS	90 DAS	At harvest
Farmyard Manure (t ha^{-1})				
0 t FYM	23.01	84.58	154.73	163.37
5 t FYM	26.56	90.43	162.38	173.53
10 t FYM	28.62	93.38	166.61	177.44
20 t FYM	29.51	95.11	169.76	180.62
S.Em(±)	0.36	0.338	0.295	0.564
CD 5%	1.412	1.326	1.159	2.216
Nitrogen (% of recommended dose)				
0% N	22.03	78.29	147.34	161.55
75% N	26.39	88.62	162.54	172.05
100% N	28.48	96.56	169.57	178.22
125% N	30.8	100.04	174.05	183.14
S.Em(±)	0.656	0.568	1.519	1.35
CD 5%	1.914	1.657	4.435	3.941

Table 2: Effect of farmyard manure and inorganic nitrogen level onperiodic Number of leaves $plant^{-1}$ of *zaid* maize

Treatments	Number of leaves $plant^{-1}$			
	30DAS	60DAS	90 DAS	At harvest
Farmyard Manure (t ha^{-1})				
0 t FYM	3.82	8.18	10.29	9.59
5 t FYM	4.29	8.76	10.81	10.25
10 t FYM	4.64	9.31	11.28	10.72
20 t FYM	4.95	9.81	11.7	11.13
S.Em(±)	0.051	0.139	0.118	0.132
CD 5%	0.2	0.545	0.464	0.52
Nitrogen (% of recommended dose)				
0% N	3.2	7.39	9.41	8.78
75% N	3.95	8.34	10.3	9.82
100% N	4.94	9.52	11.47	10.93
125% N	5.62	10.81	12.9	12.17
S.Em(±)	0.163	0.238	0.137	0.359
CD 5%	0.476	0.694	0.401	1.047

Table 3: Effect of farmyard manure and inorganic nitrogen level onperiodic dry weight of *zaid* maize

Treatments	Dry weight (g plant^{-1})			
	30DAS	60DAS	90 DAS	At harvest
Farmyard Manure (t ha^{-1})				
0 t FYM	23.36	126.88	224.02	281.9
5 t FYM	27.97	135.78	237.51	294.87
10 t FYM	28.82	140.31	241.69	306.94
20 t FYM	29.34	143.73	247.18	313.93
S.Em(±)	0.259	0.447	0.309	0.283
CD 5%	1.016	1.756	1.212	1.111
Nitrogen (% of recommended dose)				
0% N	23.72	123.63	219.33	264.74
75% N	27.23	133.53	235.63	288.53
100% N	28.86	141.54	244.6	313.16
125% N	29.67	147.99	250.84	331.21
S.Em(±)	0.535	0.625	1.104	0.697
CD 5%	1.56	1.824	3.224	2.033

Table 4: Effect of farmyard manure and inorganic nitrogen level on grain yield, stover yield and biological yield of *zaid* maize

Treatments	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest Index
Farmyard Manure (t ha^{-1})				
0 t FYM	62.4	122.87	185.27	33.83
5 t FYM	67.68	126.18	193.86	35.02
10 t FYM	73.15	129.24	202.39	36.23
20 t FYM	73.97	134.54	208.51	35.55
S.Em(±)	0.342	0.304	0.537	0.103
CD 5%	1.342	1.195	2.108	0.403
Nitrogen (% of recommended dose)				
0% N	65	110.31	175.31	37.07
75% N	67.79	122.63	190.42	35.56
100% N	71.44	134.94	206.39	34.57
125% N	72.97	144.94	217.91	33.43
S.Em(±)	0.772	0.666	1.067	0.28
CD 5%	2.255	1.943	3.115	0.817

Conclusion

Among the FYM levels, the better and maximum output regarding crop growth and yield were seen in 20 t ha^{-1} of FYM when it was applied during the initial stage of crop growth which helps to increase the soil physical, chemical and biological composition. However, maximum return seen in FYM_{10} due to its lesser treatment cost than FYM_{20} treatment. In-fact, in sub treatment, nitrogen plays an important role in terms of yield and growth attributes. $N_{125\%}$ shows statistically higher result.

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