

EFFECT OF SOWING DATES IN RELATION TO INTEGRATED NITROGEN MANAGEMENT ON GROWTH, YIELD AND QUALITY OF RABI MAIZE (*Zea Mays* L.)

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ABSTRACT

A field experiment was conducted during *rabi* season of 2006-07 and 2007-08 to study the effect of sowing dates and integrated nutrient management on growth, yield and quality of winter maize. The trial was laid out in split plot design with three replications, assigning total 27 treatment combinations i.e. three sowing dates (15 Oct, 25 Oct and 5 Nov) in main plots and three levels of nitrogen from inorganic fertilizer urea (50, 100 and 150 N₂O kg ha⁻¹) and two organic fertilizer (FYM, *Azospirillum*) and control in sub plots. The crop sown on 25 Oct significantly enhanced the growth and grain yield than early sowing 15 Oct and late sowing 5 Nov. While, 150 kg of N₂O ha⁻¹ application significantly increased over 100 and 50 kg N₂O ha⁻¹. However, N₂O application through FYM was found statistically at par with N₂O application through the *Azospirillum* in growth and grain yield during both years. But, application of 100 kg 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 percent more grain yield over the other treatment combinations.

Key words: Winter maize, sowing dates, INM, growth, yield.

INTRODUCTION

In cereals, maize is grown throughout the year mainly due to photo-thermo-insensitive character, hence called 'queen of cereal'. There are several factors that affect the productivity of winter maize; however, Balanced nutrition is an essential component of nutrient management and plays a significant role in increasing crop production and its quality. For the major processes of plant development and yield formation the presence of nutrient elements like N, P, K, S, Mg etc. in balanced form is essential as given by Colomb *et al.* (2000), Randhawa & Arora (2000). Another factor time of sowing is a non monetary input plays significant role in production and productivity of any crop. Maize is an exhaustive crop requires all types of macro and micro nutrients for better growth and yield potential. Among the various nutrients, nitrogen is the principal nutrients for better harvest require approximately 150 N₂O kg ha⁻¹ (Kong *et al.* 2008). Effective supply of nitrogen through inorganic and organic sources may increase the production of maize as well as improve the quality of food grains and soil environment. Crop responses to organic and biological nutrient carriers are not as spectacular as fertilizer but the supplementary and complementary use of such sources is known to enhance the utilization efficiency of fertilizers. The main advantages of organic fertilizer are ecological balance, low cost of cultivation, clean environment and nutritious food without reducing the human health (Hedge and Sudhakar, 2001). Farm Yard Manure (FYM) is the decomposition of dung and urine of farm animals along

with litter and left over material from roughages or fodder fed to the cattle, on an average it contains 0.5% N, 0.2% P and 0.5% K and *Azospirillum* is an important free living organism that can fix atmospheric nitrogen in to the soil ranging from 20 to 30 kg ha⁻¹ (Reddy & Reddy, 2003). In order to sustain soil fertility and productivity and to reap rich harvest of maize, it is important that FYM and *Azospirillum* (bio-fertilizers) have to be applied in adequate quantity, due to ever increasing cost of inorganic chemical fertilizers, their use in combination with organic sources has become imperative for sustained crop production (Nanjappa *et al.* 2001).

Organic agriculture achieves high plant yield by making efficient use of organic residues: To fertilize soil, it uses composted harvest residues and animal manure. This saves 50 to 150 kgN₂O, depending upon the crop, in synthetic nitrogen fertilizer per hectare which would otherwise need to be produced using not renewable fuels. Studies have shown that conventional arable farming operations in England consume some 17000 litres of fossil fuels embodied in fertilizers per 100 hectare of land each year. If one compares a field where chemical fertilizers have been used to grow the crops and field where organic inputs such as farm yard manure, vermicompost and panchagavya have been used, one can clearly see the presence of earthworms, millipedes and ants is more in an organic field. There is large areas are in semi-arid region where cattle rearing is main business of most of the farmers and they ever faced deficiency of green fodder, thus the maize will be helpful to solve this problem and it is very well known that maize plant has a large amount of vegetative part, to which we can incorporate within the soil, consequently it will be helpful

in maintaining soil fertility and productivity as organic residues helps to enriching the soil conditions. To overcome from above hazards this is need to promote, minimizing the use of chemical fertilizers and replace with organic resources. Thus present investigation of maize cultivation in U.P. will be helpful in increasing the production and productivity of maize as well as maintaining soil health, minimizing cost of cultivation and to solve the future problems.

MATERIALS AND METHODS

The experiment was conducted at the Brahmaand Mahavidyalaya Agricultural Research Farm, Post- Rath, District- Hamirpur, State- Uttar Pradesh, PIN- 210431, India during the winter (*rabi*) season of 2006-07 and 2007-08. The soil of experimental field was 'parwa' with slightly alkaline in reaction (pH 7.6) which was low in available nitrogen, medium in available phosphorus and high in available potassium containing 200.83 N₂O kg ha⁻¹, 29.28 P₂O₅ kg ha⁻¹ and 474.16 K₂O kg ha⁻¹ and 0.56% organic carbon content. The trial was laid out in Split Plot Design (SPD) with three replications assigning 27 treatment combinations of 3 sowing dates (15 Oct, 25 Oct and 5 Nov) in main plots, three level of Inorganic nitrogen supply through urea (50, 100 and 150 N₂O kg ha⁻¹) and two levels of organic nitrogen (FYM 7.5 t ha⁻¹ before 15 days of sowing in soil and *Azospirillum* by seed inoculation @ 500g per 10 kg of seed) and control in sub plots. Hybrid Ganga Safed- 2 variety of maize was sown according to the dates decided in the treatment, maintaining 45 cm row-to-row and 30 cm plant to plant distance with the seed rate of 25 kg ha⁻¹ at 2.5 cm depth. N₂O according to treatment and uniform dose of 60 kg P₂O₅ and 40 kg K₂O were applied in each plot, half of nitrogen and full dose of phosphorus and potash were applied as basal dose and remaining dose of nitrogen as top dressing after first irrigation at seedling stage was applied. Others compulsory activities viz. interculture and plant protection measures were applied as need based. To evaluate the leaf area Index (LAI) following formula was used:

LAI= Leaf Area / Ground area (Watson, 1947)

RESULTS AND DISCUSSION

Effect of sowing dates: All round improvement in growth and development characters viz. plant height and dry matter accumulation per plant were found significantly maximum in 25 Oct sowing date. It also enhanced the leaf area index resulting in more photosynthesis and food matter accumulation for longer period, which improved the growth, development and dry matter production per plant with respective date of sowing due to optimum sowing time, suitable growth

period and favourable climatic conditions especially temperature. Plant maturity and silking was also significantly affected under different dates of sowing during both the years. The significantly more number of days to maturity was observed in 25 Oct sowing followed by 15 Oct and 5 Nov dates of sowing during both the years and the average number of days to maturity were also more in 25 Oct sowing as compared to other dates of sowing, also supported by Andrew *et al.* (2006).

In respect to yield attributes such as diameter of cob and weight of cobs per plant were found significantly higher in 25 Oct sowing date over 15 Oct and 5 Nov dates of sowing in both the years. It could be due to the better growth and development of crop. Similarly, the grain yield was also increased significantly with the sowing of maize on 25 Oct than early and late sown crop. Kolawole *et al.* (2009) reported that these enhancement were due to more diameter of cob and weight of cobs per plant might be due to the better translocation system in maize plant enhance the production of yield due to the fact that good photosynthates accumulated in leaves and its transfer to economic part like grains, cobs etc. ultimately a fact the higher rate of photosynthesis. Percent of protein content in grain significantly affected due to dates of sowing in both the years, the highest protein value was recorded in 25 Oct sowing followed by 15 Oct and 5 Nov, the order of growth, yield attributes, yield and quality parameters were as 25 Oct > 15 Oct > 5 Nov.

Effect of Inorganic source: Nitrogen supplied through the inorganic source significantly influenced the plant height, leaf area index and number of days to maturity and silking were recorded significantly higher in 150 N₂O kg ha⁻¹ application followed by 100 N₂O kg ha⁻¹ and 50 N₂O kg ha⁻¹ in both the years. In regards to plant height at early stage of crop growth (30 days) N₂O dose were at par amongst each other, while at 60 days, 150 N₂O kg ha⁻¹ was found statistically at par with 100 N₂O kg ha⁻¹. It was mainly due to the increase in nitrogen content in soil which was responsible for all round enhancement of growth, increase metabolic activities, assimilation rate and cell division within the plant. Onasanya *et al.* (2009) and Saleem *et al.* (2009) found that the maximum dry matter accumulation per plant was the positive effect of growth characters; significantly more value was recorded with 150 N₂O kg ha⁻¹. The 50 N₂O kg ha⁻¹ and 100 N₂O kg ha⁻¹ dose were found statistically at par with each others during both the years. A differential response of nitrogen levels was observed to yield attributes and yield. The presented table 2 showed that the yield attributing characters such as diameter of cob, weight of cobs per plant, were found significantly more with 150 N₂O kg ha⁻¹ applications over 100 N₂O kg ha⁻¹ and 50 N₂O kg ha⁻¹ nitrogen doses respectively in both years and mean value also. It might have been owing to increased growth

characters with respective dose of nitrogen application i.e. 150 N₂O kg ha⁻¹. Mahmood *et al.* (2001) and Namakha *et al.* (2008) also found that it may be due to optimum and regular supply of nitrogen nutrient to plant from soil during growth period by more assimilation rate and it is integral part of protein the building blocks of plant. The grain yield was increased significantly maximum with 150 N₂O kg ha⁻¹ followed by other doses of nitrogen supply. The respective dose of nitrogen (150 N₂O kg ha⁻¹) increased 2.39% and 7.64% more grain yield over 100 N₂O kg ha⁻¹ and 50 N₂O kg ha⁻¹ nitrogen dose, respectively. The higher grain yield/unit area was due to the more diameter of cob. The results were confirmed with the findings of Moser *et al.* (2006). Content of protein in grains were recorded highest with in 150 N₂O kg ha⁻¹ application followed by 100 N₂O kg ha⁻¹ and 50 N₂O kg ha⁻¹ in both the years and mean value also. It was mainly due to sufficient amount of nitrogen nutrient to the winter maize crop and regular supply of nutrient for increasing growth and reproductive phases from the soil. The results were closely related to Sajedi *et al.* (2006).

Effect of organic sources: Organic source of nitrogen application also influenced the plant height, leaf area index, dry matter production/plant and days to maturity and silking were recorded significantly more with the addition of FYM followed by *Azospirillum* and control, respectively. In the initial observations of crop growth each organic source of nitrogen application was recorded

statistically at par between each other. While at later states FYM and *Azospirillum* source of nitrogen application were statistically similar among each other and both were significantly more over control for increasing above growth characters. It may be due to the fact that prolonged release of nutrients from FYM, increase the efficiency and favourable conditions. The increased leaf area index by supplied nutrients from FYM also increased photosynthesis assimilates in plant which finally pushed for increasing dry matter accumulation. The results were conformity with the findings of Sujatha *et al.* (2008) and Farhad *et al.* (2009) Yield attributing characters viz. diameter of cob and weight of cobs/plant were also calculated significantly more in FYM source of nitrogen application, maximum grain yield/unit area were also recorded with the addition of FYM source of nitrogen which was significant more over control in both the year. However, the FYM source of nitrogen application was at par with *Azospirillum* application in both the years. Lalei *et al.* (2009) reported that the production of grain yield and biomass from per unit area was the resultant of increased leaf area index and weight of cobs/plant. It may be due to better growth, development and dry matter accumulation with proper supply of nutrient to plant and increase the availability to other plant nutrients with the respective source of nitrogen application.

Table- 1: Growth characters of winter hybrid maize as influenced by dates of sowing and nitrogen sources.

Treatments	Growth characters								
	Plant height (cm) at 30 DAS			Leaf Area Index at 30 DAS			Dry weight plant ⁻¹ (g) at 30 DAS		
	2006-07	2007-08	Pooled	2006-07	2007-08	Pooled	2006-07	2007-08	Pooled
Dates of Sowing									
15 Oct- D ₁	10.67	10.94	10.81	32.97	30.77	31.87	2.07	2.01	2.04
25 Oct- D ₂	10.81	11.09	10.95	33.38	31.20	32.29	2.30	2.26	2.28
5 Nov- D ₃	9.73	9.98	9.86	30.12	27.86	28.99	1.88	1.83	1.86
SE±	0.13	0.15		0.20	0.26		0.01	0.01	
C.D. at 5%	N.S.*	N.S.*		0.58	0.74		0.05	0.04	
Inorganic source of N ₂ O application									
50 kg N ₂ O ha ⁻¹ - N ₁	10.22	10.48	10.35	31.56	29.34	30.45	1.99	1.93	1.96
100 kg N ₂ O ha ⁻¹ - N ₂	10.42	10.69	10.56	32.20	30.03	31.12	2.07	2.02	2.05
150 kg N ₂ O ha ⁻¹ - N ₃	10.57	10.84	10.71	32.72	30.45	31.59	2.20	2.14	2.17
SE±	0.21	0.23		0.31	0.36		0.03	0.02	
C.D. at 5%	N.S.	N.S.		0.83	0.73		0.08	0.04	
Organic source of N ₂ O application									
Control - O ₀	10.27	10.49	10.38	31.58	29.34	30.46	2.03	1.89	1.96
FYM - O ₁	10.51	10.91	10.71	32.57	30.41	31.49	2.13	2.08	2.11
<i>Azospirillum</i> - O ₂	10.43	10.71	10.57	32.32	30.08	31.20	2.09	2.04	2.07
SE±	0.21	0.23		0.31	0.36		0.03	0.02	
C.D. at 5%	N.S.	N.S.		0.63	0.73		0.08	0.04	
C.V. (%)	7.46	8.12		3.61	4.50		5.30	4.41	

N.S.*- Non-Significant

Table- 2: Growth characters of winter hybrid maize as influenced by dates of sowing and nitrogen sources.

Treatments	Growth characters								
	Plant height (cm) at harvest			Leaf Area Index 90 DAS			Dry weight plant ⁻¹ (g) at 90 DAS		
	2006-07	2007-08	Pooled	2006-07	2007-08	Pooled	2006-07	2007-08	Pooled
Dates of Sowing									
15 Oct- D ₁	179.25	183.99	181.62	175.95	166.82	171.39	157.09	152.43	154.76
25 Oct- D ₂	186.02	202.61	194.32	200.05	191.50	195.78	160.47	155.63	158.05
5 Nov- D ₃	171.71	175.04	173.38	141.37	132.22	136.80	146.57	141.81	144.19
SE±	1.00	1.20		1.47	1.19		1.57	1.38	
C.D. at 5%	2.79	3.33		4.10	3.30		4.37	3.79	
Inorganic source of N ₂ O application									
50 kg N ₂ O ha ⁻¹ - N ₁	173.99	178.40	176.20	165.14	155.96	160.55	150.28	145.63	147.96
100 kg N ₂ O ha ⁻¹ - N ₂	182.92	187.72	185.32	171.99	162.88	167.44	154.08	149.17	151.63
150 kg N ₂ O ha ⁻¹ - N ₃	190.07	195.52	192.80	180.24	171.50	175.87	159.78	155.07	157.43
SE±	1.47	1.74		2.10	1.75		2.37	2.00	
C.D. at 5%	2.97	3.51		4.23	3.53		4.77	4.02	
Organic source of N ₂ O application									
Control - O ₀	179.39	184.15	181.77	167.70	158.94	163.32	151.85	147.03	149.44
FYM - O ₁	184.76	189.80	187.28	176.74	187.44	182.09	157.93	153.09	155.51
<i>Azospirillum</i> - O ₂	182.82	187.69	185.26	172.82	163.96	168.39	154.38	149.75	152.07
SE±	1.47	1.74		1.93	1.80		2.37	2.00	
C.D. at 5%	2.97	3.51		3.88	3.22		4.77	4.02	
C.V. (%)	2.98	3.43		4.11	3.60		4.11	4.90	

Table- 3: Days to maturity and silking of winter hybrid maize as influenced by dates of sowing and nitrogen sources.

Treatments	Developmental characters					
	Days to Silking			Days to Maturity		
	2006-07	2007-08	Pooled	2006-07	2007-08	Pooled
Dates of Sowing						
15 Oct- D ₁	51.88	50.74	51.31	141.51	140.40	140.96
25 Oct- D ₂	53.55	52.66	53.11	143.25	141.96	142.61
5 Nov- D ₃	49.48	48.26	48.87	138.51	137.52	138.02
SE±	0.16	0.13		0.32	0.29	
C.D. at 5%	0.46	0.36		0.91	0.82	
Inorganic source of N ₂ O application						
50 kg N ₂ O ha ⁻¹ - N ₁	51.25	50.11	50.68	139.40	138.33	138.87
100 kg N ₂ O ha ⁻¹ - N ₂	51.44	50.88	51.16	141.25	140.14	140.70
150 kg N ₂ O ha ⁻¹ - N ₃	52.22	50.88	51.55	142.63	141.40	142.02
SE±	0.24	0.02		0.50	0.45	
C.D. at 5%	0.49	0.04		1.02	0.90	
Organic source of N ₂ O application						
Control - O ₀	51.22	50.33	50.78	139.92	138.89	139.41
FYM - O ₁	52.07	50.95	51.51	141.92	140.70	141.31
<i>Azospirillum</i> - O ₂	51.63	50.48	51.06	141.44	140.28	140.86
SE±	0.24	0.17		0.50	0.45	
C.D. at 5%	0.49	0.34		1.02	0.90	
C.V. (%)	1.74	1.24		1.32	1.18	

Table- 4: Yield attributes of winter hybrid maize as influenced by dates of sowing and nitrogen sources.

Treatments	Yield attributing characters					
	Diameter of cob (cm) at harvest			Weight of cobs plant ⁻¹ (g) at harvest		
	2006-07	2007-08	Pooled	2006-07	2007-08	Pooled
Dates of Sowing						
15 Oct- D ₁	4.31	4.15	4.23	84.40	92.10	88.25
25 Oct- D ₂	4.73	4.81	4.77	89.02	97.15	93.09
5 Nov- D ₃	4.25	4.14	4.20	78.08	76.28	77.18
SE±	0.02	0.02		0.48	0.28	
C.D. at 5%	0.06	0.07		1.29	0.80	
Inorganic source of N ₂ O application						
50 kg N ₂ O ha ⁻¹ - N ₁	4.22	4.09	4.16	81.57	79.48	80.53
100 kg N ₂ O ha ⁻¹ - N ₂	4.42	4.29	4.36	83.48	81.58	82.53
150 kg N ₂ O ha ⁻¹ - N ₃	4.88	4.53	4.71	86.45	84.48	85.47
SE±	0.03	0.04		0.72	0.28	
C.D. at 5%	0.07	0.08		1.44	0.58	
Organic source of N ₂ O application						
Control - O ₀	4.31	4.17	4.24	82.81	80.55	81.68
FYM - O ₁	4.53	4.40	4.47	85.03	83.20	84.12
<i>Azospirillum</i> - O ₂	4.45	4.33	4.39	83.66	81.70	82.68
SE±	0.03	0.04		0.72	0.28	
C.D. at 5%	0.07	0.08		1.44	0.58	
C.V. (%)	2.98	3.68		3.15	1.29	

Table- 5: Yield and quality in winter hybrid maize as influenced by dates of sowing and nitrogen sources.

Treatments	Yield (q ha ⁻¹) and quality attributing characters					
	Grain Yield (q ha ⁻¹)			Protein (%) in grain after harvesting		
	2006-07	2007-08	Pooled	2006-07	2007-08	Pooled
Dates of Sowing						
15 Oct- D ₁	35.49	34.91	35.20	8.09	8.07	8.08
25 Oct- D ₂	39.97	37.69	38.83	8.26	8.23	8.25
5 Nov- D ₃	30.47	29.26	29.87	8.03	7.88	7.96
SE±	0.30	0.22		0.01	0.01	
C.D. at 5%	0.84	0.62		0.03	0.03	
Inorganic source of N ₂ O application						
50 kg N ₂ O ha ⁻¹ - N ₁	33.25	32.24	32.75	8.04	8.01	8.03
100 kg N ₂ O ha ⁻¹ - N ₂	35.09	34.12	34.61	8.22	8.18	8.20
150 kg N ₂ O ha ⁻¹ - N ₃	35.52	35.39	35.46	8.13	8.10	8.12
SE±	0.41	0.34		0.01	0.01	
C.D. at 5%	0.84	0.69		0.03	0.03	
Organic source of N ₂ O application						
Control - O ₀	33.64	32.82	33.23	8.07	8.04	8.06
FYM - O ₁	35.92	34.91	35.42	8.19	8.14	8.17
<i>Azospirillum</i> - O ₂	35.31	34.03	34.67	8.13	8.11	8.12
SE±	0.41	0.34		0.01	0.01	
C.D. at 5%	0.84	0.69		0.03	0.03	
C.V. (%)	4.40	3.73		0.79	0.68	

Conclusion: It is clear from the results of investigation that with the application of either 7.5 t FYM/ha or *Azospirillum* treatments can produce the same grain yield of winter maize. As the application of inorganic fertilizer

of 100 N₂O kg ha⁻¹ with FYM enhanced the crop yield when sowing on 25 October rather than 15 October and 5 November, respectively.

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