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Effect of Different Levels of Nutrients and Dates of Sowing on Growth and Yield of Maize Crop (*Zea mays L.*)

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A B S T R A C T

A field experiment was conducted during *Kharif* season, 2015 at the Crop Research Farm, School of Forestry & Environment, SHIATS, Allahabad (U.P.) to find out the effect of different levels of nutrients and dates of sowing on growth and yield of maize (*Zea mays* L.) under Allahabad climatic condition. The experiment was lay out in factorial (3×4) Randomized Block Design with twelve treatments, replicated thrice. The results on to the different parameters was found significant, showed under treatment T_3 (10 July sowing date+135 kg nitrogen, 90 kg phosphorus,45 kg potash). The maximum plant height (212.56 cm), number of cob plant^{-1} (2.00),cob length (25.66 cm), cob girth (12.66 cm), weight of grains cob^{-1} (82.10 g), number of grains row cob^{-1} (14.03), number of grains cob^{-1} (395.26), dry weight plant^{-1} (157.36 g) was recorded in treatment T_3 [10 July DOS + 135 kg nitrogen ha^{-1}, 90 kg phosphours ha^{-1} and 45 kg potash ha^{-1}] (10 July DOS +150% NPK of Recomnded dose of fertilizer). The similar effect was also recorded in the yield and Yield attributes. Treatment T_3 (DOS 10 July+ nitrogen 135 kg,phosphorus 90 kg, potash 45 kg ha^{-1}) produced the maximum seed yield (57.33 q ha^{-1}), stover yield (88.66 q ha^{-1}), Test weight (222.00 g), Harvest index (39.26 %). Treatment T_3 (DOS 10 July+ nitrogen 135 kg, phosphorus 90 kg, potash 45 kg ha^{-1}) also recorded the highest gross return (97481 Rs ha^{-1}), net return (61216.88 Rs ha^{-1}) and benefit cost ratio (1.68).

Introduction

Maize (*Zea mays* L.) is an annual plant which belongs to family Gramineae. Maize is an important cereal of crop of world which is grown under diverse climatic conditions. Maize occupies a pride place among cereal crops in India and due to its high yield potential called the queen of cereals (Handbook of agriculture, ICAR). In India, maize (*Zea mays* L.) is the third most important cereal crop after rice and wheat. The production of maize is 17.01mt (Annual report, Ministry of Agriculture, Government of India 2015). It provides food, feed, fodder and serves as a sources of basic raw material for the number of industrial products *viz.*, starch, protein, oil, alcoholic beverages, food

sweeteners, cosmetics, more recently as bio-fuel etc. (Govt. of India). No other cereal is being used in as many ways as maize. 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). Maize is grown during south west monsoon season (June-September). As the crop is predominantly grown under rain fed conditions, it is subjected to both biotic and abiotic stresses which are largely influenced by the particularly distribution and quantity of rainfall. Weather is one of the key components influencing its production and productivity. Climate variability and change have a direct, often adverse, effect on the quantity and quality of agricultural production. The climate of an area is highly correlated with its vegetation and, by extension, the type of crop that can be cultivated. Temperature, rainfall, humidity, sunshine (day length) are important climatic elements that affect crop production. The overall predictability of these climatic elements is imperative for the day-to-day and medium term planning of farm operations (Sowunmi and Kintola, 2010).

Studies indicate that weather during cropping season strongly influence the crop growth and it accounts for two- third of the variation in productivity while other factors including soil and nutrient management account for one third of the productivity (Rao *et al.,* 1999). The predominant influence of weather is operative even before the crop is sown, as the moisture availability and the thermal regime of the seed zone determine the date of sowing and the appropriate cultivar to be sown. In spite of cultivation of high yielding varieties, improved cultural practices and plant protection measures, favorable weather is a must for good harvests (Rao *et al.,* 1999).

There are several evidences showing that, delay in sowing of maize beyond July results in yield reduction. In the event of late onset of monsoon rains and erratic rainfall farmers are forced to take- up sowing late *i. e.,* beyond July 15 and the sowing may even be extended to the end of August month. Shift in sowing dates directly influence both thermo and photoperiod and consequently a great bearing on the phasic development and partitioning of dry matter. Quantification of these effects may help in the choice of sowing time and match phenology of crop in specific environment to achieve higher grain yield. Hence, there is a need to study the influence of different weather parameters on the performance of maize grown different environments as affected by change in sowing date (Leelarani *et al.,* 2013).

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Materials and Methods

The experiment was carried out during *Kharif* season 2015 at Crop Research Farm, Department of Environmental Science, School of Forestry and Environment, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad (U.P.), which is located at $25^0$24' 42" N latitude, 81^0 50' 56" E longitude and 98 m altitude above the mean sea level. This area is situated on the right side of the river Yamuna by the side of Allahabad Rewa Road about 5 km away from Allahabad city. It consists of three sowing date 10 July, 20 July, 30 July and four levels of nutrients(NPK) control, 50% NPK of R.D.F,100% NPK of R.D.F.,150 %NPK of R.D.F. The soil was sandy loam in texture, the pH of the soil was slightly alkaline in reaction (7.4), it was low in organic carbon (0.30 %), low in available nitrogen content (187.3 kg ha^{-1}), medium in available phosphorus (34.5 kg ha^{-1}), low in available potassium (87.1 kg ha^{-1}) and low in available sulphur (5 ppm) contents. The dose of nutrients(NPK) in the form of UREA,DAP and muriate of potash was applied at Nitrogen 45 kg ha^{-1}, 90 kg ha^{-1}, 135 kg ha^{-1} and Phosphurs 30 kg ha^{-1}, 60 kg ha^{-1}, 90 kg ha^{-1} and Potash 15 kg ha^{-1} 30 kg ha^{-1} 45

kg ha^{-1} at the time of sowing as per the treatments. Treatments were T_0-(D_1+Nu0)@ 10 July DOS+Control nutrients(NPK),T_1-(D_1+Nu1) @ 10 July DOS+50% nutrients (NPK) of 50%R.D.F ha^{-1}, T_2-(D_1+ Nu2) @ 10July DOS + 100% Nutrients of R.D.F ha^{-1}, T_3 - (D_1+ Nu3) @ 10July DOS + 150% Nutrients of R.D.F ha^{-1}, T_4-(D_2+ Nu0)@ 20July DOS+Control nutrients (NPK), T_5-(D_2+Nu1) @ 20July DOS+50% nutrients (NPK) of 50% R.D.F $ha^{-1,}$ T_6-(D_2+ Nu2) @ 20JulyDOS+ 100% Nutrients of R.D.F ha^{-1}, T_7 - (D_2+ Nu3) @ 20July DOS + 150% Nutrients of R.D.F ha^{-1}, T_8-(D_3+Nu0) @30July DOS+Control nutrients (NPK), T_9-(D_1+Nu1) @ 30 July DOS + 50 % nutrients (NPK) of 50%R.D.Fha^{-1}, T_{10}-(D_3+Nu2) @ 30 July DOS + 100% Nutrients of R.D.F ha^{-1}, T_{11} - (D_3+ Nu3) @ 30July DOS + 150% Nutrients of R.D.F ha^{-1}. (R.D.F= Recommended dose of fertilizer).

Results and Discussion

Interaction effect of nutrients (NPK) Level and sowing date on growth parameter on maize

The interaction effects of different levels of Nutrients(NPK) and dates of sowing on plant height at 25 DAS was found non- significant and at 50 DAS was found significant and The effect of different levels of nutrients on plant height at 25 and 50 DAS was found significant sowing date on plant height was non-significant. The interaction effect of different levels of nutrients and dates of sowing on plant height at 25 DAS and 50 DAS was found non significant. The maximum plant height recorded at 25, 50, 75 DAS was 30.66 (T9-30July sowing date + 150 % of N.P.K of R.D.F $ha^{-1)}$, 160.30, 201.53 cm respectively in T_3-10July sowing date + 150% of N.P.K of R.D.F ha^{-1}). Similar results have also been recorded by Awasthi *et al.,* (2009) reported that crops sown on June 30, regardless of cultivar, gave the highest Plant height as compare to July 10 and July 20 sown crops.

The interaction effect of deferent levels of nutrients and dates of sowing on dry weight of $plant^{-1}$ was also found significant, the maximum dry weight 157.36 g was found in treatment combination D_1 +Nu_3 On 75 DAS respectively in T_3-10 July sowing date + 150% of N.P.K of R.D.F ha^{-1}.).

Similar results have also been recorded Kumar (2009), reported that application of 120 kg N ha^{-1} significantly increased the plant height and dry matter of sweet corn over 80, 40 kg N ha^{-1} and control for two successive years.

The interaction effects of different levels of Nutrients (NPK) and date of sowing on number of cob $plant^{-1}$was also found non significant, the maximum number of cob $plant^{-1}$ 2.00 was found in treatment combination D_1+Nu_3 respectively in (T_3-10July sowing date + 150%OF N.P.K of R.D.F ha^{-1}) on harvesting stage. Similar results have also been recorded by Awasthi *et al.,* (2009) reported that crops sown on June 30, regardless of cultivar, gave the highest harvest index, net returns and benefit: cost ratio, plant height, shoot girth, cob $plant^{-1}$, cob weight, cob length, grains cob^{-1}, grains weight cob^{-1}, 1000- grain weight, grain yield and stover yield as compare to July 10 and July 20 sown crops.

Interaction effect of different levels nutrients (NPK) and sowing date on yields attributes and yield of maize

The interaction effects of different levels of nutrients (NPK) and sowing date on grains cob^{-1}, grain yield cob^{-1} (g), and test weight significant. The highest number grains cob^{-1}, grain yield cob^{-1}, and test weight recorded 395.26, 82.40g, 222.00 g respectively in was found in treatment combination D_1 +Nu_3

respectively in (T_3-10July sowing date + 150%OF N.P.K of R.D.F ha^{-1}) Similar results have also been recorded by Parashar, (2011) At Udaipur (Raj.), maize sown on June 1st recorded highest cob, number of grains cob^{-1},number of plant, test weight, weight of grains cob^{-1} and grain yield over early (June 20) and late sowing (July 11) (APR, 2012).

The interaction effect of different levels of nutrients and dates of sowing on number of grains cob^{-1} was also found significant, the maximum number of grains cob^{-1} 395.26 was found in treatment combination D_1 +Nu_3.

The highest grain yield **(**q ha^{-1}), Stover yield (q ha^{-1}), Biological yield (q ha^{-1}) and harvest index**(%)** recorded 57.33,88.66,146,39.26in treatment combination D_1 +Nu_3 respectively in (T_3-10July sowing date + 150%OF N.P.K of R.D.F ha^{-1}).

Similar results have also been recorded by Awasthi *et al.*,(2009) reported that crops sown on June 30, regardless of cultivar, gave the highest harvest index, water use efficiency, net returns and benefit: cost ratio, plant height, shoot girth, cob plant^{-1},cob weight, cob length, grains cob^{-1}, grains weight cob^{-1}, 1000- grain weight, grain yield and stover yield as compare to July 10 and July 20 sown crops.

Effect of different levels of nutrients and sowing dates on Agrometerological indices

Growing degree day (GDD ^{0}C)

The effect of dates of sowing on GDD on flowering and Tasseling stage found significant, the maximum GDD 886.75 ^{0}C, 1311.08 ^{0}C was recorded in D_3 and minimum 839.08 ^{0}C, 1182.58 ^{0}C was found in.

The effect of different levels of nutrients on GDD was found significant, the maximum GDD 903.11 ^{0}C, was found in Nu_3 and at Tasseling stage thr maximum GDD 1303.88^{0}C was found in Nu_0 and minimum 814.66 ^{0}C was found in Nu_0, and at tasseling stage minimum 1169.88^{0}C was found in Nu_3.

The interaction effect of different levels of nutrients and dates of sowing on GDD on flowering stage was found non significant, the maximum GDD 933.66 ^{0}C was found in treatment combination D_3 +Nu_3 and minimum 803.66^0 C was recorded in D_1 + Nu_0. The interaction effect of different levels of nutrients and dates of sowing on GDD was also found significant at tessling stage, the maximum GDD 1366.33 ^{0}C was found in treatment combination D_3 +Nu_0 and minimum 1121.66 ^{0}C was recorded in D_1 + Nu_3

Similar result also recorded by Hara, (2003) At Ludhiana, the days taken for seedling emergence increased with delay in sowing dates. Days taken to attain Tesseling stage increased significantly as planting were delayed.

Heat use efficiency (kg ha^{-1} ^{0}C^{-1} day^{-1})

Dry matter basis (75 DAS)

The effect of different levels of nutrients and dates of sowing on HUE presented in table 1–4.

The effect of dates of sowing on HUE was found significant, the maximum HUE 9.00 kg ha^{-1} ^{0}C^{-1} day^{-1} was recorded in D_2 and minimum 8.85 kg ha^{-1} ^{0}C^{-1} day^{-1} was found in D_1 and critical difference at 5% level of significance was recorded 0.13.

The effect of different levels of nutrients on HUE was found significant, the maximum 10.09 kg ha^{-1} ^{0}C^{-1} day^{-1} was found in Nu_3 and minimum 7.65 kg ha^{-1} ^{0}C^{-1} day^{-1} was found in Nu_0 and critical difference at 5% level of significance was recorded 0.15.

Table.1 Interaction table on effect of different levels of Nutrients and sowing date on growth and yield of Maize (*Zea mays* L.)

Treatment combination	Plant height(cm)			Plant dry weight g	Number of cob plant^{-1}	Number of grain cob^{-1}	Grain yield cob^{-1} (g)
	25 DAS	50 DAS	75 DAS	75 DAS	AT HARVEST	AT HARVST	At Harvest
T_0 T_0: DOS 10 July +Control Nutrients	14.66	115.56	156.23	116.16	1.18	356.00	64.96
T_1:DOS 10 July +N45kg ha^{-1}, P 30 kg ha^{-1}, k15 kg ha^{-1}	33.33	137.23	182.10	136.43	1.66	362.33	69.23
T_2:DOS 10 July +N90kg ha^{-1}, P60kg ha^{-1}, k30kg ha^{-1}	20.66	142.63	192.16	147.86	1.83	380.23	74.50
T_3:DOS 10 July +N135kg ha^{-1}, P90kg ha^{-1}, k45kg ha^{-1}	**18.33**	**160.30**	**201.53**	**157.36**	**2.00**	**395.26**	**82.10**
T T_4: DOS 20 July + control nutrients	23.00	115.00	155.00	115.23	1.03	348.60	62.60
D T_5:DOS 20 July + N45 kg ha^{-1}, P 30 kg ha^{-1}, K 15kg ha^{-1}	30.33	136.20	180.40	133.10	1.33	356.20	66.36
T_6:DOS 20 July +N90kg ha^{-1}, P60kg ha^{-1}, k30kg ha^{-1}	15.66	140.30	189.40	143.23	1.66	373.36	72.26
T_7:DOS 20 July +N 135kg ha^{-1}, P90kg ha^{-1}, k45kg ha^{-1}	26.00	143.53	195.26	151.30	1.83	390.56	78.23
T_8: DOS 30 July + control nutrients	22.33	109.86	144.96	114.66	1.00	308.16	54.40
T T_9 :DOS 30 July + N45 kg ha^{-1}, P30 kg ha^{-1}, K15kg ha^{-1}	30.66	126.90	175.16	122.53	1.16	325.20	60.53
T_{10}:DOS 30 July +N90kg ha^{-1}, P60kg ha^{-1}, k30kg ha^{-1}	20.00	136.40	185.60	136.23	1.50	349.66	66.06
T_{11}:DOS 30 July +N135kg ha^{-1}, P90kg ha^{-1}, K45kg ha^{-1}	24.00	144.56	190.10	143.93	1.50	381.00	70.23
F- test	NS	NS		S	NS	S	S
S. Em (±)	5.31	3.41		0.73	0.14	1.11	0.34
C. D. at 5%	-	-	1.28			3.25	1.03

Table.2 Effect of different levels of nutrient and date of sowing on growing degree day GDD (°C day) at flowering and tasseling stage of maize

Treatment combinations	GDD (°C day) at flowering stage	GDD (°C day) at tasseling stage
T_0 : DOS 10 July +Control Nutrients	803.66	1243.66
T_1: DOS 10 July +N45kg ha^{-1}, P 30 kg ha^{-1}, k15 kg ha^{-1}	826.00	1206.66
T_2: DOS 10 July + N 90kg ha^{-1}, P60kg ha^{-1}, k30kg ha^{-1}	855.00	1162.33
T_3: DOS 10 July +N135kg ha^{-1}, P 90kg ha^{-1}, k45kg ha^{-1}	871.66	1121.66
T_4: DOS 20 July + control nutrients	810.33	1301.66
T_5: DOS 20 July + N45 kg ha^{-1}, P 30 kg ha^{-1}, K 15kg ha^{-1}	843.66	1283.33
T_6: DOS 20 July +N 90kg ha^{-1}, P60kg ha^{-1}, k30kg ha^{-1}	885.00	1232.66
T_7: DOS 20 July +N 135kg ha^{-1}, P90kg ha^{-1}, k45kg ha^{-1}	904.00	1163.00
T_8: DOS 30 July + control nutrients	830.00	1366.33
T_9 :DOS 30 July + N45 kg ha^{-1},P 30 kg ha ha^{-1}, K 15kg ha^{-1}	879.66	1347.00
T_{10}: DOS 30 July +N90kg ha^{-1},P60kg ha^{-1}, k30kg ha^{-1}	903.66	1306.00
T_{11}: DOS 30 July +N135kg ha^{-1},P90kg ha^{-1}, K45kg ha^{-1}	933.66	1225.00
F- test	NS	S
S. Em (±)	5.35	0.78
C. D. at 5%		2.35

Table.3 Effect of different levels of nutrients and dates of sowing on heat use efficiency at 75 DAS (Dry matter basis)

Levels of SD	At 75 DAS				Mean
	Level of Nutrients				
	Nu_0	Nu_1	Nu_2	Nu_3	
D_1 10 july	7.37	8.66	9.38	9.99	8.85
D_2 20 july	7.68	8.87	9.54	10.38	9.11
$D_3$30 july	7.90	8.45	9.39	9.92	8.91
Mean	7.65	8.66	9.43	10.09	
		F-test	S.Em. (±)		C.D. at 5%
Due to DS		S	0.04		0.13
Due to nutrients		S	0.05		0.15
Inter (DxNu)		S	0.09		0.27

Table.4 Interaction table on effect of different levels of Nutrients and sowing date on the yield and yield attributes of Maize (*Zea mays* L.)

Treatment combinations	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})	Harvest index (%)	Test weight (g)
T_0: DOS 10 July +Control Nutrients	30.00	69.33	30.21	174.33
T_1:DOS 10 July +N45kg ha^{-1},P 30 kg ha^{-1},k15 kg ha^{-1}	38.66	78.00	33.12	191.66
T_2:DOS 10 July + N 90kg ha^{-1}, P60kg ha^{-1},k30kg ha^{-1}	43.33	81.66	34.66	204.33
T_3:DOS 10 July +N135kg ha^{-1},P 90kg ha^{-1},k45kg ha^{-1}	**57.33**	**88.66**	**39.26**	**222.00**
T_4: DOS 20 July + control nutrients	27.64	67.26	29.12	170.62
$T_{5:}$ DOS 20July+ N45 kg ha^{-1} , P 30 kg ha,$^{-1}$ K 15kg ha^{-1}	35.75	74.44	32.44	188.40
T_6:DOS 20 July +N 90kg ha^{-1},P60kg ha^{-1}, k30kg ha^{-1}	42.43	79.48	34.80	198.47
T_7:DOS 20 July +N 135kg ha^{-1}, P90kg ha^{-1}, k45kg ha^{-1}	54.87	85.40	39.10	210.66
T_8: DOS 30 July + control nutrients	25.36	63.23	28.62	158.20
$T_{9:}$DOS 30 July+N45 kg ha^{-1}, P 30 kg ha^{-1}, K 15kg ha^{-1}	31.62	70.33	31.03	165.23
$T_{10:}$DOS 30 July +N90kg ha^{-1}, P60kg ha^{-1}, k30kg ha^{-1}	42.09	75.29	3585	172.20
$T_{11:}$DOS 30 July +N135kg ha^{-1}, P90kg ha^{-1}, K45kg ha^{-1}	49.92	79.33	38.63	190.64
F- test	S	S	S	S
S. Em (±)	0.34	0.38	0.02	0.48
C. D. at 5%	1.03	1.18	0.07	1.46

The interaction effect of different levels of nutrients and dates of sowing on HUE was also found significant, the maximum HUE 10.38 kg ha^{-1} $^0C^{-1}$ day^{-1} was found in treatment combination D_2 +Nu_3 and minimum 7.37 kg ha^{-1} $^0C^{-1}$ day^{-1} was recorded in D_1 + Nu_0 and critical difference at 5% level of significance of interaction was recorded 0.27.

similar result also have been recorded by Leelarani *et al.,* (2013) is that HUE decreases with delay sowing of maize crop and nutrient levels has significant effect on HUE.

The result of the experiment are concluded as the maximum plant height $plant^{-1}$, number of cob $plant^{-1}$, cob girth $plant^{-1}$, cob length $plant^{-1}$, number of grains cob^{-1}, grain yield cob^{-1}, grain yield q ha^{-1}, stover yield q ha^{-1}, biological yield q ha^{-1} was found in the treatment combination T_3, 150% of R.D.F (nitrogen 135 kg ha^{-1}, phosphorus 90 kg ha^{-1}, potash 45 kg ha^{-1} and 10^{th} July Sowing date).

The minimum GDD at maturity of crop 1596.00 ^{0}C was found in treatment T_3, 150% of R.D.F (nitrogen 135 kg ha^{-1}, phosphorus 90 kg ha^{-1}, potash 45 kg ha^{-1} and 10^{th} July Sowing date) and minimum in D_1 (10^{th} July sowing date) was 1672.75 ^{0}C.The minimum heat use efficiency 8.85 kg ha^{-1} $^0C^{-1}$ day^{-1} was found in D_1 (10^{th} July sowing date) and minimum 7.37 kg ha^{-1} ^{0} C^{-1} day^{-1} in treatment combination T_0 (10^{th} July sowing date +Control NPK).

Help our farmer to apply balanced fertilizer application and suitable sowing time which will be synchronized with crop demand and also will reduce the cost of production.

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