Influence of Dates of Sowing and Nitrogen Levels on Growth and Yield of *Kharif* Maize under Irrigated Conditions in South Telanagana Agro-climatic Zone of Andhra Pradesh, India

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Abstract

An Experiment was carried out during *kharif* 2009 and 2010 at Agricultural Research Institute, Rajendranagar, Hyderabad, India. with four dates of sowing (7th July, 21st July, 6th and 22nd Aug in 2009 and 18th June, 02nd July, 17th July and 02nd Aug in 2010) as main plot and five nitrogen levels (N_0: 0 kg ha $^{-1}$(control), N_1:100 kg ha $^{-1}$, N_2: 200 kg ha $^{-1}$, N_3:300 kg ha $^{-1}$and N_4: 400 kg ha $^{-1}$) as sub-plot in split plot design replicated thrice. In 2009, 21-July sown crop recorded significantly higher plant height (185 cm), LAI (2.489), dry matter (103.7 g plant^{-1}), grain (6809 kg ha^{-1}) and stover yield (6590 kg ha^{-1}), harvest index (47.9), net returns (₹ 30429 ha^{-1}) and benefit cost ratio (2.08), and was on par with 7th July sown crop. On the other hand, in 2010, plant height (175 cm), LAI (2.464), dry matter (89.9 g plant^{-1}), grain yield (6605 kg ha^{-1}), stover yield (6537), harvest index (47.2), net returns (₹ 28770 ha^{-1}) and benefit cost ratio (2.01) of 18th June sown crop was on par with 2nd July sown crop. Significantly higher growth, yield, (7778 kg ha^{-1}, 7646 kg ha^{-1}), HI (51.3, 51.7), net returns (₹ 38502 and 37469) and benefit cost ratio (2.37 and 2.39) was observed with 200 kg N ha^{-1} respectively during both the years of study. Sowing beyond 21st July in 2009 and 17th July in 2010 reduced the grain yield by 23% and 14% respectively.

1. Introduction

Maize (*Zea mays* L.) is emerging as an important world cereal crop after wheat and rice, due to its high yielding ability, easy to process readily and cultivation cost less than other cereals (Jaliya et al., 2008). Among cereal food crops it has the highest potential of per day carbohydrate productivity. Because of its wider adoptability and high yield potential, it is finding place in cropping systems. The demand for maize in Asia is expected to grow in the next 20 years mainly driven by the growth of the livestock and poultry feed industry as regional income increase and Asian consumers shift towards animal-based diets. The rapid expansion of the biofuel industry in recent years and high fossil fuel energy costs also influence global maize demand and supply, pushing maize prices to a historic high. The increasing demand for maize is rapidly transforming cropping systems in certain parts of Asia. Where the biophysical and socioeconomic conditions are favorable, significant shifts from rice monoculture to more profitable rice-maize systems have either taken place or are getting impetus (IRRI and CIMMYT, 2006). Corn grain yields are influenced by a number of factors, including N fertility, growing season, water availability, and soil conditions.

In India, maize is grown under a wide range of agro-climatic environments, extending from extreme semi-arid to sub-humid and humid regions. Yield potential varies from region to region owing to variation in environmental conditions like radiation, temperature, water availability and nutrient supply systems. It is well known that planting time influences crop yields (Thompson and Heenan, 1991), principally through the effect of environmental conditions (especially temperature and day length) on canopy production function and crop development processes. Among different components of maize production, timely sowing during *kharif* season is very important. In the event of late onset of rains and insufficient rainfall during the recommended optimum sowing time, the farmers are forced to sow late i.e., beyond 15 July; under such late condition, the sowing may be extended to the end of August month There are evidences showing that delay in sowing beyond July results reduction in yield (Madhavi, 2007). Besides dates of sowing, nitrogen management plays a key role in realizing higher yields. In Andhra Pradesh the recommended dose of N is only 120 kg ha^{-1}. Due to continuous cropping of cereal based cropping systems the native soil fertility is getting exhausted, inturn the gap between crop nutrient demand and supply is widening year after year in order to achieve the target yields. Hence, there is a need to standardize the optimum level of nitrogen along with optimum time of sowing to realize the yield potential of presently available single cross hybrids under different farming systems.

By keeping above points in view, the present work was under taken to study the performance of maize hybrid sown at different times under varying nitrogen levels.

2. Materials and Methods

A field experiment was conducted during rainy season of 2009 and 2010 at Agricultural Research Institute, Rajendranagar, Hyderabad located at $17^0 19'$ N latitude, $78^0 23'$ E longitude and 542.3 m above mean sea level. The soil of the experimental site was sandy loam in texture, neutral in reaction, low in available nitrogen (163.07 kg ha^{-1}), phosphorus (10.64 kg ha^{-1}), and high in available potassium (385.28kg /ha). The experiment was laid out in split plot design with four dates of sowing (7^{th} July, 21^{st} July, 6^{th} Aug and 22^{nd} Aug in 2009 and 18^{th} June, 02^{nd} July, 17^{th} July and 02^{nd} Aug in 2010) as main plots and five nitrogen levels (N_0: 0 kg ha^{-1} (control), N_1:100 kg ha^{-1}, N_2: 200 kg ha^{-1}, N_3:300 kg $ha^{-1}$and N_4: 400 kg ha^{-1}) as sub-plot, replicated thrice. A uniform dose of 60 kg ha^{-1} P_2O_5 as single super phosphate, 60 kg ha^{-1} K_2O as muriate of potash and $ZnSO_4$ @ 50 kg ha^{-1} was applied to all the treatments. The entire P_2O_5, $ZnSO_4$ and half of K_2O were applied at the time of sowing. Nitrogen was applied as per the treatments (wherever it was required) in the form of urea (46% N) in three equal splits (1/3 each at basal, at knee-height and tasseling). The remaining potassium was applied along with urea during second top dressing at tasseling. Other cultural operations and plant protection measures were followed as per the recommendations. During the crop period 538.7 mm rainfall was received in 31 rainy days in 2009 and 943.8 mm in 56 rainy days in 2010, respectively as against the decennial average of 588.1 mm received in 37 rainy days, for the corresponding period indicating 2010 as wet year. Multiple comparisons among dates and nitrogen levels were made by employing Tukeys (HSD) test using SAS.

3. Results and Discussions

3.1. Grain yield and stover yield in relation to growth parameters and yield attributes

The response due to variation in sowing time was similar in both years of study. During 2009, 21^{st} July (D_2) sown crop recorded higher grain yield (6809 kg ha^{-1}), which was however, on par with 7^{th} July (D_1) sown crop and significantly superior to 6^{th} August (D_3) and 22^{nd} August (D_4) sown crop, which recorded the lowest yield (5272 kg ha^{-1}) over the treatments under study (Table 5). While later two dates (D_3 and D_4) differed significantly with each other. In 2010 also 18th June (D_1) sown crop recorded higher (6605 kg ha^{-1}) grain yield, which was however, on par with 2nd July (D_2) sown crop but significantly superior to 2nd August (D_4) sown crop, which recorded the lowest grain yield (5117 kg ha^{-1}) across all other sowing dates, however, 2nd July (D_2) sown crop yield was comparable with 17th July sown crop. This might be due to favourable growth attributing characters like plant height, leaf area index (LAI), dry matter production (DMP), stover yield (Table 1, 2, 3 and 5) and yield parameters particularly number of rows cob^{-1}, grains cob^{-1}, number of grains m^{-2}, test weight, grain yield and HI observed with early sown crop than the late sown in both years of the study (Table 4 and 5). More LAI under early sowing might be due to favourable temperature and better radiation use efficiency and thereby higher synthesis of metabolites leading to higher LAI (Table 2). Higher temperature during vegetative growth stage hastened growth rate in early sown crop (Van Dobben, 1962). Whereas, in delayed sowing, minimum temperatures reduced growth rate resulting in lower DM production. Increase in temperature during vegetative growth stage enhanced growth rate more than developmental rate resulting in taller plants with higher total DM (Table 3). Yield increased with optimum planting date probably resulted from improved physiological conditions during the silking period for optimum kernel set (Barbieri et al., 2000). Late sowing affected grain yield by decreasing kernel number per unit area (Table 4). The present observation confirms to that of Moentono (1989) and Mendhe et al. (1992), who reported that grain production $plant^{-1}$, test weight and grain yield increased with early sowing.

Sowing beyond 21^{st} July and 17^{th} July reduced the grain yield by 23% and 14% in 2009 and 2010 respectively. Further, reduction in yield under late sown conditions might be due to lower DM production (Table 3) during early stages as the crop experienced low temperatures, high relative humidity and excess soil moisture resulting from high rainfall which are not favorable to maize crop (Figure 1 and 2). Variation in dry matter production across the sowing dates was associated more with differences in the amount of radiation intercepted than differences in radiation use efficiency. Optimum utilization of solar radiation, higher assimilation of CO_2 and its conversion to starches resulted in higher grain number and weight which in-turn produced more biomass and seed yield (Derby et al. 2004).

Increase in yield was observed with the increase in nitrogen

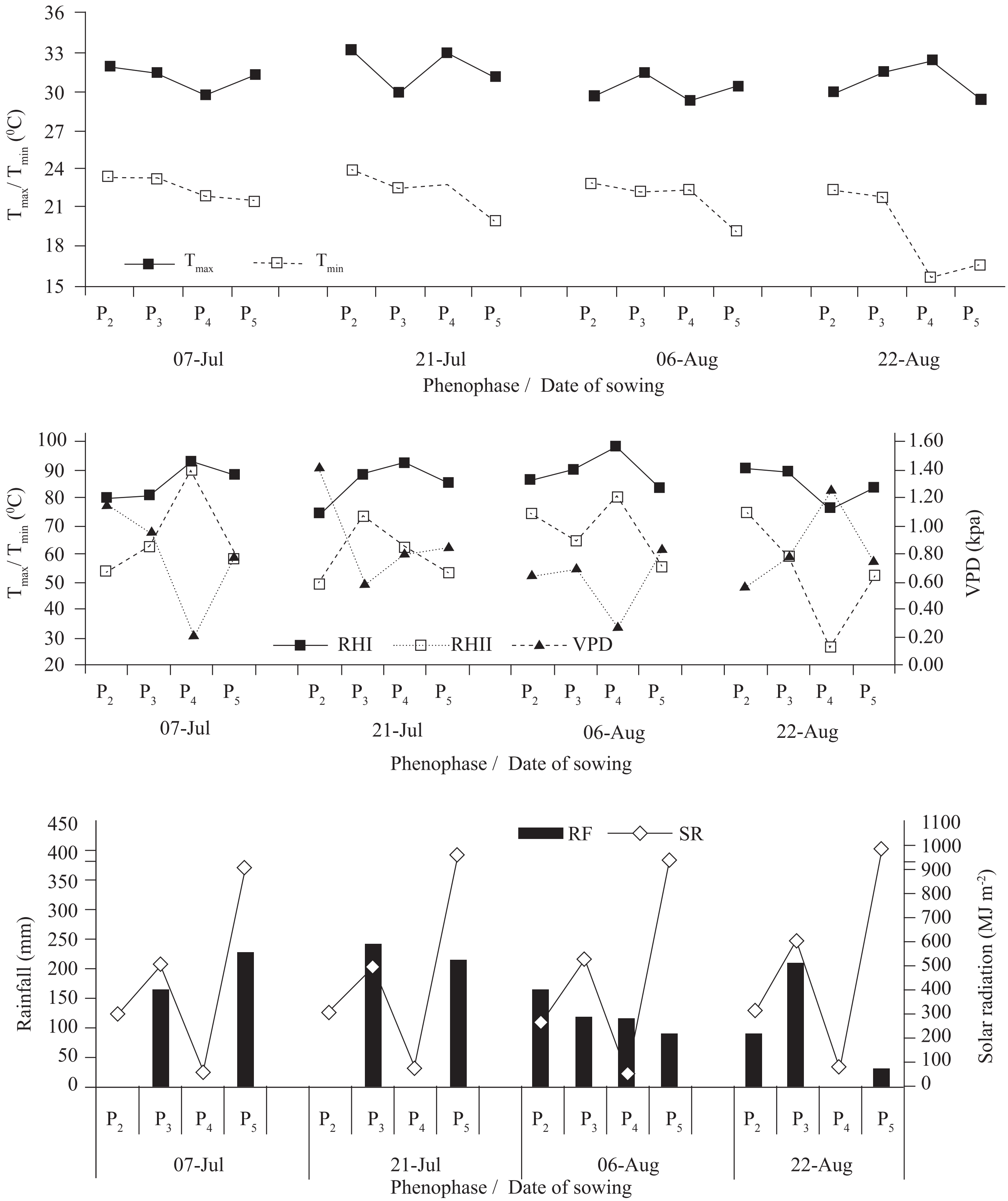

Figure 1: Mean maximum and mean minimum temperature, morning and after noon relative humidity, vapour pressure deficit, rainfall and solar radiation during different phenophases of maize under different dates of sowing during 2009.

Note: P_2=Emergence to six leaf stage; P_3=Six leaf to tasseling stage; P_4=Tasseling to silking stage; P_5=Silking to physiological maturity;

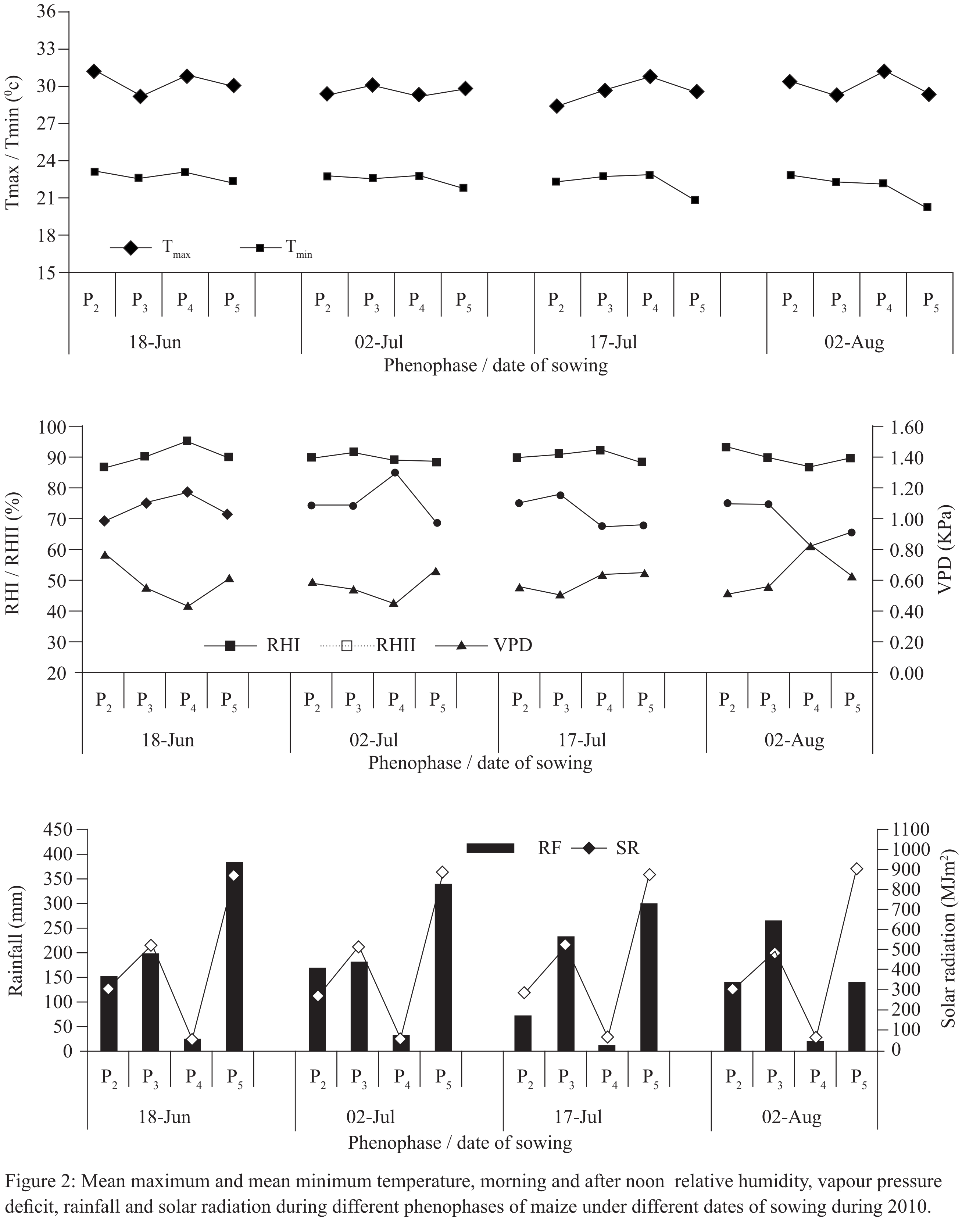

Figure 2: Mean maximum and mean minimum temperature, morning and after noon relative humidity, vapour pressure deficit, rainfall and solar radiation during different phenophases of maize under different dates of sowing during 2010.

Note: P_2=Emergence to six leaf stage; P_3=Six leaf to tasseling stage; P_4=Tasseling to silking stage; P_5=Silking to physiological maturity;

level up to 400 kg ha^{-1} (N_4) however, it was comparable with 300 kg N ha^{-1} and 200 kg N ha^{-1} (7778 kg ha^{-1} and 7646 kg ha^{-1}). Control (N_0) treatment produced the lowest yield (1276 kg ha^{-1} and 1224 kg ha^{-1}) over the different levels of nitrogen tested in 2009 and 2010 respectively. Significant improvement in growth parameters like plant height and leaf production might be attributed to the fact that, adequate supply of nitrogen helps in maintaining higher auxin levels which inturn had favorable effect on cell enlargement and division resulting in higher plant height and LAI. The increase in plant height and LAI caused better interception and utilization of radiant energy, leading to production of higher photosynthates, and ultimately resulted in higher accumulation of DM. More leaf expansion in maize was ascribed to higher rate of cell division and cell enlargement (Wright, 1982). Enhanced DM production with adequate supply of nitrogen, as evidenced in this investigation corroborates the findings of Raja (2001)). It was also observed that increase in N rate enhanced number of rows cob^{-1}, grains row^{-1}, grains cob^{-1}, grains m^{-2}, test weight and grain yield and stover yield (Table 4 and 5). These results are also in agreement with the suggestion that low N supply decreases grain weight due to low supply of the carbohydrates to the grains and amino-compounds during the lag period in which the number of storage cells and starch granules is determined

Table 1: Plant height (cm) of maize at different growth stages as influenced by dates of sowing and nitrogen levels

Treatments		Crop growth stages							
Date of sowing (D)		Six leaf stage		Tasseling stage		Silking stage		Physiological maturity	
2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
7-Jul (D_1)	18-Jun (D_1)	20^a	19^a	180^a	178^a	180^a	178^a	180^a	178^a
21-Jul (D_2)	2-Jul (D_2)	20^a	19^{ab}	185^a	175^{ab}	185^a	175^{ab}	185^a	175^{ab}
6-Aug (D_3)	17-Jul (D_3)	18^b	18^b	171^b	171^b	171^b	171^b	171^b	171^b
22-Aug (D_4)	2-Aug (D_4)	16^c	16^c	164^c	164^c	164^c	164^c	164^c	164^c
Nitrogen (N) (kg ha^{-1})									
0 (N_0)		12^c	12^c	125^c	115^c	125^c	115^c	125^c	115^c
100 (N_1)		17^b	18^b	169^b	167^b	169^b	167^b	169^b	167^b
200 (N_2)		21^a	20^a	190^a	191^a	190^a	191^a	190^a	191^a
300 (N_3)		21^a	20^a	194^a	194^a	194^a	194^a	194^a	194^a
400 (N_4)		21^a	20^a	196^a	195^a	196^a	195^a	196^a	195^a
Interaction (DxN)		NS	NS	NS	NS	NS	NS	NS	NS

Note: Means with the same letter are not significantly different

Table 2: Leaf area index (LAI) of maize at different growth stages as influenced by dates of sowing and nitrogen levels

Treatments		Crop growth stages							
Date of sowing (D)		Six leaf stage		Tasseling stage		Silking stage		Physiological maturity	
2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
7-Jul (D_1)	18-Jun (D_1)	0.193^a	0.188^a	2.413^a	2.481^a	2.452^a	2.464^a	1.007^a	1.073^a
21-Jul (D_2)	2-Jul (D_2)	0.198^a	0.184^{ab}	2.471^a	2.387^{ab}	2.489^a	2.404^{ab}	1.062^a	1.032^{ab}
6-Aug (D_3)	17-Jul (D_3)	0.184^b	0.181^b	2.202^b	2.238^b	2.285^b	2.318^c	0.898^b	0.970^b
22-Aug (D_4)	2-Aug (D_4)	0.174^c	0.162^c	1.999^c	1.953^c	2.139^c	2.175^d	0.612^c	0.866^c
Nitrogen (N) (kg ha^{-1})									
0 (N_0)		0.164^c	0.158^c	0.729^c	0.695^c	0.748^c	0.688^c	0.192^c	0.171^c
100 (N_1)		0.181^b	0.175^b	1.875^b	1.897^b	1.993^b	2.035^b	0.682^b	0.713^b
200 (N_2)		0.194^a	0.183^a	2.834^a	2.841^a	2.944^a	2.958^a	1.13^a	1.329^a
300 (N_3)		0.197^a	0.187^a	2.944^a	2.908^a	2.997^a	3.01^a	1.219^a	1.351^a
400 (N_4)		0.200^a	0.190^a	2.973^a	2.982^a	3.024^a	3.011^a	1.252^a	1.363^a
Interaction (DxN)		NS	NS	NS	NS	NS	NS	NS	NS

Note: Means with the same letter are not significantly different

Table 3: Dry matter (g $plant^{-1}$) production of maize at different growth stages as influenced by dates of sowing and nitrogen levels

Treatments		Crop growth stages									
Date of sowing (D)		Emergence		Six leaf stage		Tasseling stage		Silking stage		Physiological maturity	
2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
7-Jul (D_1)	18-Jun (D_1)	0.4^a	0.4^a	9.9^a	9.8^a	93.8^a	83.3^a	100.1^a	89.9^a	202.7_a	203.2_a
21-Jul (D_2)	2-Jul (D_2)	0.4^a	0.4^a	10.3^a	9.2^{ab}	98.6^{ab}	78.5^{ab}	103.7^a	87.1^{ab}	208.9_a	196.9_{ab}
6-Aug (D_3)	17-Jul (D_3)	0.4^a	0.4^a	8.9^b	8.8^b	76.7^b	74.4^b	83.9^b	82.9^b	186_b	188.1_b
22-Aug (D_4)	2-Aug (D_4)	0.4^a	0.4^a	7.9^c	7.4^c	67^c	64.8^c	72.1^c	70.4^c	167.4_c	166.9_c
Nitrogen (N) (kg ha^{-1})											
0 (N_0)		0.4^a	0.4^a	7.5^c	6.6^c	31.6^c	30.7^c	33.1^c	33.2^c	71.3^c	68.9^c
100 (N_1)		0.4^a	0.4^a	8.8^b	8.1^b	77.0^b	74.0^b	84.2^b	78.5^b	165.2^b	163.1^b
200 (N_2)		0.4^a	0.4^a	9.6^a	9.4^a	100^a	88.3^a	105.4^a	97.6^a	234.1^a	232.2^a
300 (N_3)		0.4^a	0.4^a	10.0^a	9.8^a	103.6^a	90.8^a	111.7^a	100.3^a	239.5^a	237.0^a
400 (N_4)		0.4^a	0.4	10.3^a	10^a	108^a	92.4^a	115.2^a	103.2^a	246.2^a	242.8^a
Interaction (DxN)		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: Means with the same letter are not significantly different

Table 4: Yield attributes of maize as influenced by dates of sowing and nitrogen levels

Treatments		Yield attributing characters									
Date of sowing (D)		Number of rows cob^{-1}		Number of grains row^{-1}		Number of grains cob^{-1}		Number of grains m^{-2}		Test weight (g)	
2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
7-Jul (D_1)	18-Jun (D_1)	15.3^a	15.6^a	23.8^a	24.5^a	376^a	390^a	2367^a	2484^a	296.6^a	294.8^a
21-Jul (D_2)	2-Jul (D_2)	15.5^a	15.4^{ab}	24.3^a	23.1^{ab}	387^a	364^{ab}	2453^a	2310^{ab}	298.5^a	290.6^{ab}
6-Aug (D_3)	17-Jul (D_3)	14.9^b	15.2^b	22.5^b	21.7^b	348^b	338^b	2200^b	2156^b	293.2^b	293.2^b
22-Aug (D_4)	2-Aug (D_4)	14.5^c	14.7^c	21.2^c	20.0^c	317^c	301^c	2010^c	1920^c	295.9_+	296.1^c
Nitrogen (N) (kg ha^{-1})											
0 (N_0)		11.8^c	13.3^c	9.6^c	8.4^c	113^c	112^c	712^c	709^c	244.6^c	234^c
100 (N_1)		15.1^b	14.9^b	22.2^b	21.9^b	337^b	327^b	2130^b	2085^b	292.4^b	298.1^b
200 (N_2)		15.9^a	15.9^a	27.3^a	26.5^a	434^a	422^a	2745^a	2682^a	312.5^a	311.2^a
300 (N_3)		16.1^a	16^a	27.8^a	27.2^a	446^a	435^a	2827^a	2770^a	314.4^a	312.4^a
400 (N_4)		16.2^a	16^a	28.3^a	27.8^a	453^a	446^a	2874^a	2841^a	316.4^a	312.8^a
Interaction (D X N)		NS	NS	NS	NS	NS	NS	NS	NS	Sig	Sig
SEm±		0.3	0.3	1	1.34	21	26	134	164	2.1	2.3
CD (*p*=0.05)		NS	NS	NS	NS	NS	NS	NS	NS	4.2	4.6

Note: Means with the same letter are not significantly different

in the endosperm of maize kernels (Jones et al*.,* 1996). Higher the efficiency of converting DM into economic yield, higher would be the value of harvest index (HI). Akmal et al. (2010) observed the highest HI (48%) with 150 kg N ha^{-1} and lowest (41.8%) for 90 kg N ha^{-1}.

3.2. Interaction effect of dates of sowing and nitrogen management

Dates of sowing did not show any significant influence on nitrogen management except on test weight. Crop sown on 2nd July recorded significantly lowest test weight at all levels of nitrogen, however 21st July (D_2), 7th July (D_1) and 22nd August sown crop produced comparable test weight at 300 and 400kg N ha^{-1} application in 2009 and was significantly superior to 6th August (D_3) sown crop. The early sown crop associated with higher DM contributed more carbohydrates during grain filling stage thus resulted in higher test weight of grains (Table 4) which is in consistent with findings of Cirilo and Andrade

Table 5: Grain yield, stover yield and harvest index of maize as influenced by dates of sowing and nitrogen levels

Date of sowing (D)		Grain yield (kg ha^{-1})		Stover yield (kg ha^{-1})		Harvest Index (%)	
2009	2010	2009	2010	2009	2010	2009	2010
7-Jul (D_1)	18-Jun (D_1)	6588^a	6605^a	6376^a	6537^a	47.7^a	47.2^a
21-Jul (D_2)	2-Jul (D_2)	6809^a	6301^{ab}	6590^a	6315^{ab}	47.9^a	47.2^{ab}
6-Aug (D_3)	17-Jul (D_3)	5968^b	5953^b	5894^b	6077^b	47.2^b	46.2^b
22-Aug (D_4)	2-Aug (D_4)	5272^c	5117^c	5413^c	5508^c	46.8^c	45.1^c
Nitrogen (N) (kg ha^{-1})							
0 (N_0)		1276^c	1224^c	2968^c	2956^c	30.3^c	28.6^c
100 (N_1)		5383^b	5274^b	5160^b	5334^b	50.8^b	49.5^b
200 (N_2)		7778^a	7646^a	7220^a	7272^a	51.8^a	51.3^a
300 (N_3)		8110^a	7873^a	7422^a	7467^a	52.1^a	51.3^a
400 (N_4)		8249^a	7951^a	7571^a	7517^a	52.0^a	51.4^a
Interaction (DxN)		NS	NS	NS	NS	-	-

Note: Means with the same letter are not significantly different

(1996) and Law-Ogbomo and Remison (2009).

The highest test weight (316.4 g and 312.8 g) of maize was recorded with N_4 (400 kg ha^{-1}), which was however, comparable with N_3 (300 kg ha^{-1}) and N_2 (200 kg ha^{-1}) and significantly higher than N_1 (100 kg ha^{-1}) and control (N_0). The lowest test weight (244.6 g and 234.0 g) of maize was recorded with control (N_0), during 2009 and 2010 respectively.

In 2010, 18th June sown crop produced significantly higher test weight (314.3 g) with application of 400, 300 and 200 kg N ha^{-1}, which was comparable with 2nd July, 17th July and 2nd August sown crop (Table 6 and 7).

Table 6: Test weight (g) of maize as influenced by interaction effect of dates of sowing and nitrogen levels during 2009

Nitrogen (N) (kg ha^{-1})	Dates of sowing				
	7-Jul	21-Jul	6-Aug	22-Aug	Mean
0	243.4^f	252.6^e	240.5^f	241.7^f	244.6
100	292.2^d	290.4^d	290.7^d	296.3^d	292.4
200	314.2^{abc}	314.5^{abc}	310.1^c	311.1^c	312.5
300	315.7^{abc}	316.1^{abc}	312.2^{bc}	313.6^{abc}	314.4
400	317.7^{ab}	318.9^a	312.5^{bc}	316.6^{abc}	316.4
Mean	296.6	298.5	293.2	295.9	296.1

Table 7: Test weight (g) of maize as influenced by interaction effect of dates of sowing and nitrogen levels during 2010

Nitrogen (N) (kg ha^{-1})	Dates of sowing				
	18-Jun	2-Jul	17-Jul	2-Aug	Mean
0	233.3^d	224.3^e	238.0^d	240.3^d	234.0
100	299.3^{bc}	298.2^c	296.0^c	298.7^{bc}	298.1
200	313.3^a	308.3^{ab}	309.6^a	313.7^a	311.2
300	313.9^a	310.7^a	311.0^a	313.9^a	312.4
400	314.3^a	311.3^a	311.7^a	314.0^a	312.8
Mean	294.8	290.6	293.2	296.1	293.7

Note: Means with the same letter are not significantly different

4. Economics

Gross returns, net returns and benefit cost ratio decreased consistently with subsequent delay in sowing in both the years of study as that of grain yield (Table 8). In 2009, highest net returns (₹ 30429 ha^{-1}) and benefit cost ratio (2.08) was recorded with 21st July (D_2) sown crop, which was however, comparable with 7th July (D_1) sown crop and significantly superior to 6th August (D_3) and 22nd August (D_4) sown crop, which recorded the lowest net returns (₹ 17552 ha^{-1}) and benefit cost ratio (1.61) over other dates tested.

During 2010 also, maize sown on 18th June (D_1) produced significantly high net returns (₹ 28770 ha^{-1}) and benefit cost ratio (2.01), which was however, on par with 2nd July (D_2) sown crop, and in turn comparable with 17th July (D_3) sown crop and was significantly superior to 2nd August (D_4) sown crop, which produced the lowest net returns (₹ 16353 ha^{-1}) and benefit cost ratio (1.57) during the period of study.

During both the years of study, increase in nitrogen from 0 to 400 kg ha^{-1} increased the net returns and benefit cost ratio. In 2009, highest gross returns (₹ 69778 ha^{-1}) and net returns (₹ 40183 ha^{-1}) were recorded with N_4 (400 kg N ha^{-1}) which was however, comparable with N_3 (300 kg N ha^{-1}) and N_2 (200 kg N ha^{-1}) but significantly superior to N_1 (100 kg N ha^{-1}) and control, which registered the lowest gross returns (₹ 11691 ha^{-1}), net returns (₹ 13384 ha^{-1}) and benefit-cost ratio (0.47). Application of 200 kg N ha^{-1}resulted in higher benefit cost ratio

Table 8: Gross returns, net returns and B:C ratio of maize as influenced by dates of sowing and nitrogen levels

Date of sowing (D)		Gross returns (₹ ha^{-1})		Net returns (₹ ha^{-1})		B:C	
2009	2010	55888[a]	56105[a]	28553[a]	28770[a]	2.01[a]	2.01[a]
7-Jul (D_1)	18-Jun (D_1)	57764[a]	53564[ab]	30429[a]	26229[ab]	2.08[a]	1.92[ab]
21-Jul (D_2)	2-Jul (D_2)	50690[b]	50661[b]	23355[b]	23326[c]	1.81[b]	1.82[b]
6-Aug (D_3)	17-Jul (D_3)	44887[c]	43688[c]	17552[c]	16353[d]	1.61[c]	1.57[c]
22-Aug (D_4)	2-Aug (D_4)	5272[c]	5117[c]	5413[c]	5508[c]	46.8[c]	45.1[c]
Nitrogen (N) (kg ha^{-1})							
0 (N_0)		11691[c]	11273[c]	-13384[c]	-13802[c]	0.47[c]	0.45[c]
100 (N_1)		45640[b]	44857[a]	19435[b]	18652[b]	1.74[b]	1.71[b]
200 (N_2)		65837[a]	64804[a]	38502[a]	37469[a]	2.41[a]	2.37[a]
300 (N_3)		68592[a]	66721[a]	40127[a]	38256[a]	2.41[a]	2.34[a]
400 (N_4)		69778[a]	67368[a]	40183[a]	37773[a]	2.36[a]	2.28[a]
Interaction (D X N)		NS	NS	NS	NS	-	-

Note: Means with the same letter are not significantly different

(2.41 and 2.37) during 2009 as well as 2010.

Higher level of dry matter accumulation and efficient translocation to the reproductive parts owing to adequate supply of nitrogen might be responsible for the production of higher yield which resulted in higher net returns and benefit cost ratio. Similar results were also reported by Ramu and Reddy (2007), Jadhav and Shelke (2009) and (Neduncheziyan, (2010) with higher levels of nitrogen application.

5. Conclusion

Based on the experimental results, it is concluded that, higher grain yield of maize can be obtained by sowing the crop from 18[th] June to 21[st] July with application of 200 kg N ha^{-1} under irrigated conditions with higher net returns and benefit cost ratio, and further delay in sowing beyond 21[st] July and 17[th] July reduced the grain yield by 23% and 14% respectively, in 2009 and 2010.

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