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Response of Maize Hybrids to Sowing Dates in Northern Trazitional Zone of Karnataka

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ABSTRACT

A field experiment was conducted during the rainy (Kharif) seasons of 2015 and 2016 at the Main Agricultural Research Station (MARS), University of Agricultural Sciences Dharwad, Karnataka, India. The treatments were laid out in a split plot design wherein three dates of sowing i.e., I-FN June, II-FN June, and I-FN July (DS_1, DS_2, and DS_3) with four improved but currently cultivated with a medium maturity group of maize hybrids (Nithyashree, NK-6240, GH-0727, and 900-M-Gold) i.e. (H_1, H_2, H_3, and H_4) were included. Date of sowing (DS) and hybrids (H) were allotted to main and sub plot, respectively. The soil of the experimental plot was clay in texture. Crop phenology, growth and yield component data were collected, and analysed using SAS version 9.3. The highest plant height (192.9 cm) at harvest was recorded by NK-6240. The highest LAI of 4.53 was recorded during DS_2, but was on par with DS_3. The highest grain number per cob of 354.8 was recorded by DS_2 followed by DS_2 which recorded 347 grain per cob. The highest total shoot biomass (187.9q ha^{-1}) and grain yield (94.8 q ha^{-1}) were recorded by DS_2. But almost similar total shoot biomass (TSB) values were recorded by DS_1 and DS_3 as well. Among the tested hybrids the highest grains per cob (367.7) was recorded by 900-M-Gold. With respect to hybrids the highest TSBH total shoot biomass per hectare (194. 8 q ha^{-1}) and grain yield (96.8 q ha^{-1}) were recorded by NK-6240 and 900-M-Gold, respectively, but the total shoot biomass was on par with 900-M-Gold.

Key words: *Date of sowing, Hybrids, LAI, Biomas, Grain yield.*

INTRODUCTION

Maize is the third most important cereal crop after rice and wheat in India. In India maize accounts for 9 % of the total food grain production, whereas in Karnataka, the leading state in India, its grown on an area of 1.34 m ha and with a production and productivity of 4.4 m. t. and 2921 kg ha^{-1}, respectively. However, the productivity of the maize in India is by far lower compared to the global average (5500 kg ha^{-1}). This may further be adversely affected by changing climatic conditions[2]. Climate change and climate variability has a direct influence on the quantity and quality of maize production as water shortage combined with thermal stress adversely affect maize productivity.

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To deal with the impact of climate change, the potential adaptation strategies are identifying stress and drought resistant varieties, changing sowing dates; crop diversification, integrated farming system, *etc*[16]. One of the most limiting factors in crop growth and to get attainable and optimum yield is moisture stress, which is further aggravated by rising temperature due to climate change; therefore, sowing date is important to mitigate climate change[13]. Successful maize production requires an understanding of various management practices as well as environmental conditions that affect crop performance[9]. Selection of appropriate cultivars, planting dates and plant densities are the cultural practices that have been shown to affect maize yield potential and stability. Therefore, a field experiment was carried out to screen suitability of maize hybrids and optimise sowing time for Northern Transition Zone of Karnataka, India.

MATERIAL AND METHODS

A field experiment was conducted during the rainy (*Kharif*) seasons of 2015 and 2016 at the Main Agricultural Research Station (MARS) University of Agricultural Sciences Dharwad Karnataka, India. The treatments were laid out in a split plot design wherein three dates of sowing I-FN June, II-FN June, and I-FN July i.e (DS_1, DS_2, and DS_3) with four improved but currently cultivated maize hybrids (Nithyashree, NK-6240, GH-0727, and 900-M-Gold) i.e. (H_1, H_2, H_3, and H_4) were included with the date of sowing (DS) as a main plot and hybrids (H) as sub plot. The soil of the experimental plot was clay in texture with the average bulk density of 1.33 g/cm^3, neutral in pH (7.6), low in organic carbon (0.34 %) and available nitrogen (175.6 and 168 kg N ha^{-1}); medium in available phosphorus (11.9 and 11.3 kg P ha^{-1}) and high in available potassium (388.6 and 425 kg K ha^{-1}), respectively during the first and second years.

Fertilizer was applied according to the recommended package of practice of UAS, Dharwad at 100:50:25 kg N: P: K/ha. Nitrogen was applied in the form of urea; half applied at the time of planting and the rest at the grand growth stages of the plant (60 dates after sowing). All the dose of phosphorus and potassium was applied at the time of sowing. The mean growing season T_{max} (May to Nov) was 0.8 ^{0}C higher during 2015 and 0.2 ^{0}C lower during 2016 than long-term average. Whereas the mean T_{min} (May to Nov) was 0.6 ^{0}C higher during 2015 and 0.1 ^{0}C lower during 2016 than long-term average. The growing season rainfall (May to Nov) during 2015 and 2016 was 45 % and 50 % le6ss, respectively, over the long-term average. The crop was given a irrigation four times during the first season and three times during the second season based up on the needs of the crop

Data Collection and Analysis

The data on growth parameters, *viz*. leaf area index (LAI), plant height, and phenology were collected from three randomly selected plants from each plot following standard methodology. The yield attributes, *viz*. No. rows per cob, No. of grains per row, and grain no. per cob were measured from 10 randomly selected plants per plot, the grain yield per hectare, total shoot biomass (TSB) per hectare were estimated using the standard methodology.

Data were subjected to ANOVA by using SAS package (version 9.3, USA). Means were separated by the least significant difference (LSD) test at the probability level of $P \leq 0.05$. The significant treatment and interactions for most of the variables evaluated, the treatment effects were discussed for each year, pooled, and interaction.

RESULT AND DISCUSSION

Crop phenology as affected by DS and H

The phenology of a crop showed a significant difference among the different DS and H. (fig. 1). The longest time to reach tasseling stage (62.1 days) was recorded by DS_1, but the shortest time (60.0 days) was recorded by DS_3. Among the hybrids the longest time taken to reach the same stage (62.3 days) was recorded by Nithyashree, but similar value were recorded by NK-6240 and 900-M-Gold as well, whereas the shortest (58.5 days) was recorded by GH-0727. Similar trend was followed by DS and H at dough, physiological, and harvest maturity stages. The longest date to reach physiological (114.5 days) and harvest maturity (119.3 days) was recorded by NK-6240 but it was on par with 900-M-Gold with respect to harvest maturity.

Interaction of the DS and H showed a significant effect on the phenology of the crop (data not shown). In general any of the hybrids in combination with the DS_1 showed the longest date to reach at each of the phenological stages mentioned above followed by the $DS_{2;}$ whereas the shortest time to reach any of the mentioned phenological stage was recorded when hybrids were sown during $DS_{3.}$ From this result we can understand that planting of anyone of the tested four hybrids after DS_2 do not have a growth resource advantage compared to the early sowing.

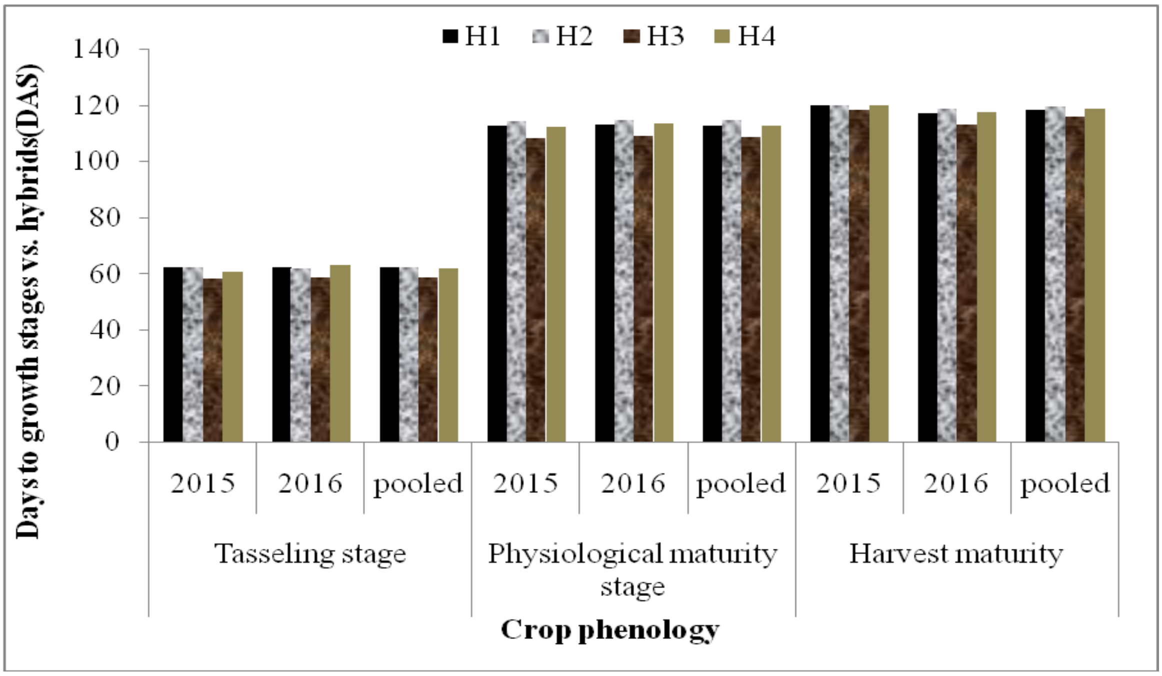


Fig. 1: Crop phenology as affected by hybrids during 2015, 2016, and pooled

Plant height as affected by dates of sowing and hybrids

The plant height at different growth stages of maize was affected by DS and H as presented in table 1. The plant height at the tasseling stage was significantly affected by the DS; the highest values (187.9 cm) was recorded on DS_3 compared to the others, the lowest plant height (176.7 cm) was recorded on DS_1; but it was on par with $DS_{2.}$

Plant height was significantly affected by DS at dough, physiological maturity, and harvest maturity stages of the crop growth. The highest plant height value at dough (192.4 cm), at physiological maturity (198.0 cm), and at harvest maturity stage (198.0 cm), respectively were recorded during DS_3 compared to the others. Whereas the lowest values were recorded at the same phenology stages (181.2 cm), (184.9 cm), and (184.9 cm) were by DS_1, but these values were on par with DS_2. In contrast to our findings Jasemi *et al*[12]., reported that the highest plant height was recorded when crop was planted early May than late July, but the climatic conditions were different to the NTZ of Karnataka.

The tested four hybrids showed a slight difference in plant height at different growth stages of the crop. At tasseling, dough and physiological maturity stage the highest plant height (184.9, 189.4, and 192.9 cm) respectively were recorded by NK-6240, but it was on par with 900-M-Gold and Nithyashree; whereas the lowest plant height was recorded by GH-0727 at all the stages mentioned.

Table 1: Plant height (cm) of maize hybrids as affected by date of sowing

Treatments	Tasseling stage			Dough stage			Physiological maturity stage		
	Date of sowing								
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
DS_1	187.7	165.7^c	176.7^b	191.7	170.7^c	181.2^b	193.7	176.1^c	184.9^b
DS_2	183.8	176.3^b	180.0^b	187.8	181.3^b	184.5^b	189.8	188.8^b	189.3^b
DS_3	188.8	187.0^a	187.9^a	192.8	192.0^a	192.4^a	194.8	201.3^a	198.0^a
SEm$\pm$	4.47	2.53	2.79	4.47	2.53	2.79	4.47	1.89	2.57
LSD ($P\leq0.05$)	NS	10.0	5.7	NS	9.95	5.66	NS	7.41	5.22
	Hybrids								
H_1	185.0	181.4	183.2^{ab}	189.0	186.4	187.7^{ab}	191.0	192.0^a	191.4^{ab}
H_2	188.9	181.0	184.9^a	192.9	186.0	189.4^a	194.9	191.0^a	192.9^a
H_3	184.6	170.7	177.6^b	188.6	175.7	182.1^b	190.6	180.7b	185.6^b
H_4	188.5	172.1	180.3^{ab}	192.5	177.1	184.8^{ab}	194.5	191.2^a	192.9^a
SEm$\pm$	2.37	3.86	3.22	2.37	3.86	3.22	2.37	3.44	2.97
LSD ($P\leq0.05$)	NS	NS	6.5	NS	NS	6.5	NS	10.2	6.0

Means followed by the same letter (s) within a column are not statistically significant.

Where: DS_1 =Ist FN June; DS_2= IInd FN June; DS_3= Ist FN July; H_1= Nithyashree; H_2= NK-6240; H_3 = GH-0727 and H_4 = 900-M-Gold.

The interaction between date of sowing (DS) and hybrids (H) showed a significant difference in the plant height (Table 2). At tasseling stage the plant height did not show a significant difference with the interaction of DS and H for DS_1 and DS_2, but during DS_3 hybrids showed a significant difference. The highest plant height (202.3 cm) was recorded by DS_3H_2; the lowest value (181.8 cm) was recorded by DS_3H_4, however it was on par with DS_3H_1 and DS_3H_3. Whereas a slight difference in plant height at dough, physiological, and harvest maturity stages were observed. The highest plant height at the dough stage (206.8 cm), at physiological maturity (210.3 cm), and at harvest maturity (210.3 cm) was recorded by DS_3H_2, but the lowest plant height (179.0 cm) at dough, (182.5 cm) equally at physiological and harvest maturity stages was recorded by DS_1H_2. Other combinations of DS and H did not show a significant difference in plant height.

Table 2: Interaction effects of treatments on plant height

Treatments	Plant height (cm)								
	Tasseling			Dough stage			Physiological maturity		
	2015	2016	pooled	2015	2016	pooled	2015	2016	pooled
DS_1H_1	189.1^{bc}	173.3^{bc}	181.2^b	193.1^{bc}	178.3^b	185.7^b	195.1^{bc}	182.3^{bc}	188.7^{bc}
DS_1H_2	186.6^{bc}	162.3^c	174.5^b	190.6^{bc}	167.3^b	179.0^b	192.6^{bc}	172.3^c	182.5^c
DS_1H_3	187.2^{bc}	163.0^{bc}	175.0^b	191.2^{bc}	168.0^b	179.5^b	193.2^{bc}	173.0^c	183.0^c
DS_1H_4	187.9^{bc}	164.0^{bc}	176.0^b	191.9^{bc}	169.0^b	180.5^b	193.9^{bc}	176.7^{bc}	185.3^c
DS_2H_1	187.7^{bc}	180.7^{bc}	184.2^b	191.7^{bc}	185.7^b	188.7^b	193.7^{bc}	190.7^{bc}	192.2^{bc}
DS_2H_2	177.5^c	178.7^{bc}	178.0^b	181.5^c	183.7^b	182.5^b	183.5^c	188.7^{bc}	186.0^c
DS_2H_3	182.2^{bc}	167.0^{bc}	174.5^b	186.2^{bc}	172.0^b	179.0^b	188.2^{bc}	177.0b^c	182.5^c
DS_2H_4	187.7^{bc}	178.7^{bc}	183.2^b	191.7^{bc}	183.7^b	187.7^b	193.7^{bc}	199.0^{ab}	196.3^{bc}
DS_3H_1	178.2^{bc}	190.3^{ab}	184.2^b	182.2^{bc}	195.3^{ab}	188.7^b	184.2^{bc}	203.0^{ab}	193.5^{bc}
DS_3H_2	202.5^a	202.0^a	202.3^a	206.5^a	207.0^a	206.8^a	208.5^a	212.0^a	210.3^a
DS_3H_3	184.4^{bc}	182.0^b	183.2^b	188.4^{bc}	187.0^b	187.7^b	190.4^{bc}	192.0^b	191.2^{bc}
DS_3H_4	189.8^b	173.7^{bc}	181.8^b	193.8^b	178.7^b	186.3^b	195.83^b	198.0^{ab}	197.0^b
SEm$\pm$	4.11	6.69	5.58	4.11	6.69	5.58	4.11	5.95	5.14
LSD ($P\leq0.05$)	12.2	19.9	11.3	12.2	19.9	11.3	12.2	17.7	10.4

Means followed by the same letter (s) within a column are not statistically significant

Where: DS_1 =Ist FN June; DS_2= IInd FN June; DS_3= Ist FN July; H_1= Nithyashree; H_2= NK-6240; H_3 = GH-0727 and H_4 = 900-M-Gold.

Leaf area index (LAI) as affected by date of sowing and hybrids

In both the seasons and pooled values the LAI was significantly affected by the DS and H (Table 3a). Among all the growth stages the highest LAI was recorded at tasseling stage, and the highest LAI (4.74) was recorded by DS_2; the lowest LAI (4.46) was recorded by DS_1; this was in agreement with D' Andrea et *al*[8]., who reported that the highest LAI in maize was observed at 55 DAS when tasseling started thereafter LAI declines.

Sulochana *et.al*[19]., conducted an experiment to study the - "effect of sowing dates on growth, phenology and agro-meteorological indices for maize varieties" during Kharif season 2013 in Rajasthan reported that the higher leaf area development, which is the potential site of photosynthesis, was largely responsible for increased biomass production in the crop sown on June 30. This might have been resulted in more synthesis of photosynthates, major portion of which was utilized for increasing leaf area and ultimately dry matter accumulation. This result was in conformity with Cooper and Law[7] who conducted a physiological study in Kenya indicated that crop growth rate progressively declined with delay in sowing, which resulted in smaller plants and strong relationship between the leaf size of plant at tasseling and final grain yield was observed.

Table 3a: Leaf area index (LAI) as affected by date of sowing and hybrids

Treatments	LAI								
	Tasseling stage			Dough stage			Physiological maturity		
	2015	2016	pooled	2015	2016	pooled	2015	2016	pooled
Date of sowing									
DS_1	4.46^{b}	3.97^{b}	4.22^{b}	3.94^{a}	3.97^{a}	3.95^{a}	3.31	3.12	3.22^{a}
DS_2	4.74^{a}	4.33^{a}	4.53^{a}	3.72^{a}	3.59^{b}	3.66^{b}	2.91	3.07	2.99^{b}
DS_3	4.64^{a}	4.33^{a}	4.48^{a}	3.15^{b}	4.13^{a}	3.63^{b}	3.07	3.28	3.17^{ab}
SEm±	0.03	0.02	0.03	0.12	0.05	0.14	0.13	0.06	0.11
LSD ($P \leq 0.05$)	0.12	0.07	0.06	0.45	0.21	0.29	NS	NS	0.22
Hybrids									
H_1	4.55^{c}	4.03^{b}	4.29^{b}	3.65^{ab}	3.71^{b}	3.69^{b}	3.22^{ab}	2.84^{b}	3.03^{bc}
H_2	4.93^{a}	4.47^{a}	4.70^{a}	3.42^{ab}	3.98^{ab}	3.52^{b}	3.05^{b}	3.41^{a}	3.24^{ab}
H_3	4.16^{d}	3.80^{c}	3.98^{c}	3.40^{b}	3.64^{b}	3.68^{b}	2.75^{c}	3.14^{ab}	2.94^{c}
H_4	4.81^{b}	4.53^{a}	4.67^{a}	3.94^{a}	4.24^{a}	4.10^{a}	3.37^{a}	3.21^{ab}	3.29^{a}
SEm±	0.03	0.04	0.03	0.18	0.15	0.16	0.09	0.15	0.13
LSD ($P \leq 0.05$)	0.08	0.11	0.07	0.53	0.44	0.33	0.26	0.45	0.26

Means followed by the same letter (s) within a column are not statistically significant.

Where: DS_1 = Ist FN June; DS_2 = IInd FN June; DS_3 = Ist FN July; H_1= Nithyashree; H_2= NK-6240; H_3 = GH-0727 and H_4 = 900-M-Gold.

Increased LAI in early sowing was in agreement with other earlier workers also where[10]. This increased LAI with early sowing might be due to increase in leaf production and leaf area duration due to more solar light and thermal units available for the growing period.

At dough stage the highest LAI (3.95) was recorded by DS_1. But the lowest LAI values were recorded by both DS_2 and DS_3. At physiological maturity LAI was significantly affected by DS and the highest LAI (3.22) was recorded by DS_1 which was on par with DS_3

whereas the lowest LAl value was recorded by DS_2 (Fig 2).

The tested hybrids showed a significant difference in LAI in both the seasons and pooled value (Table 3). At tasseling stage the highest LAI (4.70) was recorded by NK-6240; however it was on par with 900-M-Gold; the lowest LAI value (3.98) was recorded by GH-0727. At dough stage and physiological maturity stage the highest LAI (4.10) and (3.29), respectively were recorded by 900-M-Gold; but at physiological maturity stage it was on par with NK-6240. The lowest LAI (3.52 and 2.94) during these phenological stages were recorded by NK-6240 and GH-0727.

At tasseling stage the interaction of DS and H also showed a significant difference on LAI among the different combinations of DS and H (Table 3b). At early sowing the highest LAI (4.4) was recorded by DS_1H_4 followed by DS_2H_2. With (DS_2) the highest LAI (4.8) was recorded by DS_2H_2 but it was on par with DS_2H_4, whereas the lowest LAI (4.1) was recorded by DS_2H_3. With further delaying of DS the highest LAI (5.0) was recorded by NK-6240 followed by 900-M-Gold, but the lowest LAI (3.9) at the same DS was recorded by GH-0727. At dough stage interaction of DS and H showed a significant difference on LAI. With early DS the highest LAI (4.45) was recorded by DS_1H_4, but it was on par with DS_1H_1. But the lowest LAI (3.51) was recorded by DS_1H_3 which was on par itself with DS_1H_2. With increasing of the time of DS, interaction effect was not significant on LAI, but the mean value showed that the highest LAI (4.11) was recorded by DS_2H_4. With further increasing the time of DS, H showed a significant difference on LAI; the highest LAI value (3.89) was recorded by DS_3H_2, which was on par with DS_3H_1 and DS_3H_4 as well; whereas the lowest LAI value (3.30) was recorded by DS_3H_3.

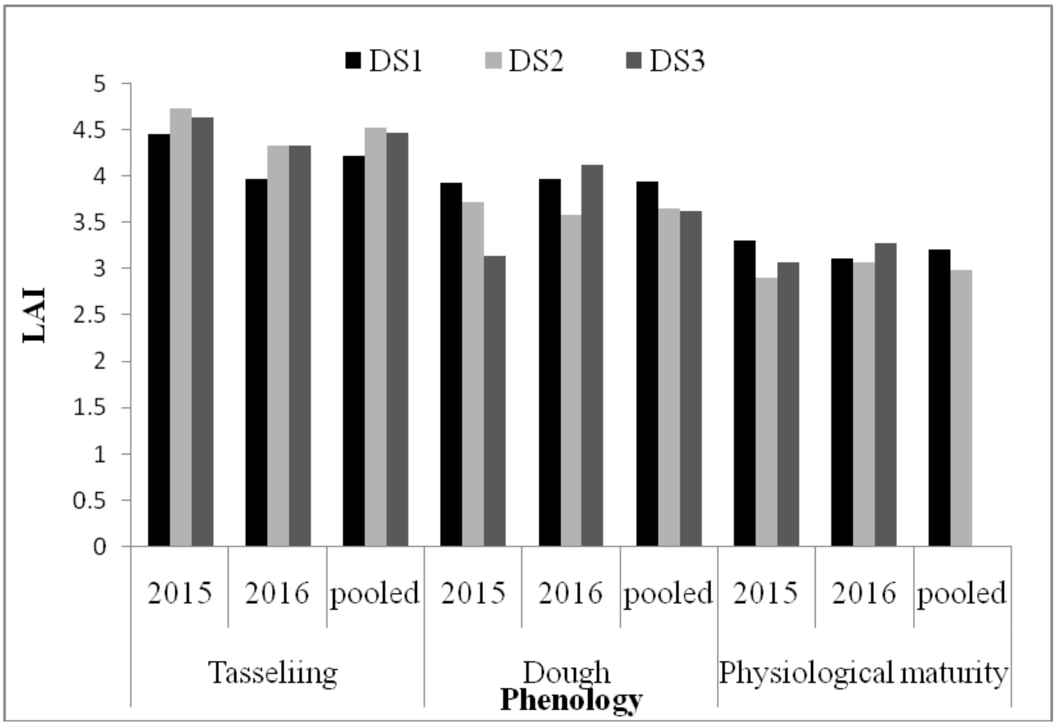


Fig. 2: Leaf area index (LAI) as affected by DS and H during 2015 and 2016

Interaction effect of DS and H on LAI - at physiological maturity stage showed similar response of hybrids when sown during DS_1; but with delaying the time of DS however, they showed a difference. The highest LAI value (3.13) was recorded by DS_2H_4, but it was on par with DS_2H_1 as well. With further delaying the time of DS the highest LAI (3.41) was recorded by DS_3H_4, but it was on par with DS_3H_2. The lowest LAI value (2.93) was recorded by DS_3H_3, but it was on par with DS_3H_1 as well. In general delaying in sowing of the crop leads to fast growing which results in shortening of time for growth of the crop eventually resulting - in lower leaf area and other yield parameters.

Table 3b: Interaction effects of dates of sowing and hybrids on LAI

Treatments	LAI								
	Tasseling stage			Dough stage			Physiological maturity		
	2015	2016	pooled	2015	2016	pooled	2015	2016	pooled
DS_1H_1	4.5^{c}	3.9^{de}	4.2^{e}	4.35^{a}	3.80^{b}	4.07^{ab}	3.42^{ab}	2.67^{b}	3.04^{ab}
DS_1H_2	4.6^{c}	4.0^{d}	4.3^{d}	3.84^{ab}	3.77^{b}	3.79^{b}	3.21^{ab}	3.30^{ab}	3.25^{ab}
DS_1H_3	4.2^{d}	3.8^{e}	4.0^{g}	3.23^{b}	3.77^{b}	3.51^{b}	3.15^{ab}	3.30^{ab}	3.23^{ab}
DS_1H_4	4.6^{c}	4.2^{c}	4.4^{c}	4.34^{a}	4.53^{ab}	4.45^{a}	3.47^{a}	3.20^{ab}	3.35^{ab}
DS_2H_1	4.6^{c}	4.2^{c}	4.4^{c}	3.35^{b}	3.40^{b}	3.38^{b}	3.29^{ab}	2.90^{b}	3.09^{ab}
DS_2H_2	5.0^{b}	4.6^{b}	4.8^{b}	3.25^{b}	3.53^{b}	3.40^{b}	2.99^{b}	3.10^{b}	3.06^{ab}
DS_2H_3	4.3^{d}	3.9^{de}	4.1^{f}	4.04^{ab}	3.50^{b}	3.75^{b}	2.25^{c}	3.10^{b}	2.68^{b}
DS_2H_4	5.0^{b}	4.6^{b}	4.8^{b}	4.25^{ab}	3.93^{ab}	4.11^{ab}	3.11^{ab}	3.17^{ab}	3.13^{a}
DS_3H_1	4.5^{c}	4.0^{d}	4.3^{d}	3.24^{b}	3.93^{ab}	3.59^{b}	2.95^{b}	2.97^{b}	2.95^{b}
DS_3H_2	5.2^{a}	4.8^{a}	5.0^{a}	3.18^{b}	4.63^{a}	3.89^{ab}	2.96^{b}	3.83^{a}	3.40^{a}
DS_3H_3	4.0^{e}	3.7^{e}	3.9^{h}	2.93^{b}	3.67^{b}	3.30^{b}	2.85^{b}	3.03^{b}	2.93^{b}
DS_3H_4	4.9^{b}	4.8^{a}	4.8^{b}	3.23^{b}	4.27^{ab}	3.76^{b}	3.52^{a}	3.27^{ab}	3.41^{a}
SEm±	0.05	0.07	0.05	0.31	0.26	0.28	0.15	0.26	0.22
LSD ($P \leq 0.05$)	0.14	0.20	0.10	0.93	0.76	0.57	0.46	0.79	0.45

Means followed by the same letter (s) within a column are not statistically significant.

Where: DS_1 = Ist FN June; DS_2= IInd FN June; DS_3= Ist FN July; H_1= Nithyashree; H_2= NK-6240; H_3 = GH-0727 and H_4 = 900-M-Gold.

Yield components as affected by dates of sowing and hybrids

The yield component of the crop was significantly affected by DS and H (Table 4). Total shoot biomass per hectare (TSBH),was not significantly affected during first season and pooled value, however it did show a significant difference among the DS during the second season; the highest TSBH (187.9 q) was recorded by DS_2, but it was on par with the value recorded by DS_3 as well. Whereas the lowest TSBH (181.6 q) was recorded by DS_1, which was lower by 3.35 % compared to the highest. This result was in comparison with the works of Ahmad *et al*[1] who reported that DS has significant effects on biomass production. Biomass yield decreased consistently with subsequent delays in sowing. For instance, the highest biomass yield of 206.9 q ha^{-1} was recorded with early planting on June 16, while the lowest biomass yield of 184.5 q ha^{-1} was obtained with late sowing (August 01).

Ahmed *et al*. have also reported that, significant difference on biomass yield was also observed among the maize genotypes. Highest biomass yield of 215.4 q ha^{-1} was obtained for cultivar Ehsan, while cultivar Pahari gave the lowest biomass yield (168.3 q ha^{-1}). Interaction between planting date and cultivar was also significant ($P<0.01$). Highest biomass yield of 234.2 q ha^{-1} was produced with sowing on June 16 for cultivar Ehsan and the lowest biomass yield was recorded for cultivar Pahari with late planting on August 01.

Hybrids also showed a significant difference in both the seasons and pooled values on the yield components of the crop. The highest TBMH (194.8 q) was recorded by NK-6240; however it was on par with 900-M-Gold. The lowest TSBH value (162.4 q), was recorded by GH-0727 which was lower by 16.6 %, compared to the highest recorded values.

The data showed that grain yield per hectare, and harvest index also showed a significant difference among the DS (Table 4a). The highest grain yield per hectare (94.8 q), and harvest index (50 %), respectively, were recorded by DS_2 which was followed by

DS_3, whereas the lowest grain yield per hectare (87.9 q), and harvest index (49 %), respectively were recorded by DS_1 which was lower by 7.3 % for grain yield per hectare, and 2.0 % harvest index, but it was on par with DS_3 as well which was in agreement with Aziz, *et al*[3]., who reported that planting date was reported to affect the growth and yield of maize significantly. To date, the challenge for maize growers is finding the narrow window between planting too early and planting too late. Either early planting or late planting can result in lower yield because the probability exists that unfavorable climatic conditions can occur after planting or during the growing season; and also late sowing of maize manifested significant reduction in grain yield.

Our finding was in agreement with the works of Zhou *et. al*[20]., in China who studied maize kernel weight responses to sowing date associated variation in weather conditions in their two-year experiment. Sowing was performed every 15–20 days from mid-March to mid-July, such that the earliest and latest dates suitable for sowing maize at the test sites were included. According to these authors variation in sowing date strongly affected maize grain yield, with a delay in sowing date, maize yield increased first and then decreased, ranging from 8117 to 11,364 kg ha^{-1} in 2012 and 7955 to 11,272 kg ha^{-1} in 2013. In their work the highest grain yield was obtained with the sixth sowing date (June12).

In Hai-dong *et. al*., who worked on the efficacy of planting date adjustment as a cultivation strategy to cope with drought stress and increase rainfed maize yield and water-use efficiency used six planting dates (April 10, 16, 22, and 28 and May 4 and 10) designated as A, B, C, D, E, and F, correspondingly. They reported that, the maize yields in 2012–2014 were significantly higher ($P < 0.05$) in treatments B, C and D than those in treatments A, E, and F. The yield in treatment F was the lowest among the other treatments. The grain yields of treatments B, C and D were 2.3%–8.7% and 20.2%–24.7% higher than those sown early (treatment A) and sown late (treatment F), respectively.

Table 4a: Yield and yield components as affected by date of sowing and hybrids

Treatments	Total shoot biomass q/ha			Grain yield q/ha			Harvest index		
	2015	2016	pooled	2015	2016	pooled	2015	2016	pooled
Date of sowing									
DS_1	190.0	173.3^b	181.6^b	87.3^c	88.6^b	87.9^c	0.46^b	0.51^a	0.49^b
DS_2	187.8	187.9^a	187.9^a	94.8^a	94.7^a	94.8^a	0.51^a	0.50^b	0.50^a
DS_3	179.3	189.0^a	184.1^b	88.4^b	90.3^b	89.4^b	0.50^a	0.48^c	0.49^b
SEM±	2.87	1.80	1.66	0.12	0.63	0.58	0.01	0.001	0.003
LSD (P=0.05)	NS	7.08	3.38	0.46	2.5	1.18	0.03	0.004	0.007
Hybrids									
H_1	188.6^b	188.3^b	188.4^b	90.8^c	92.2^b	91.5^c	0.48^b	0.49^c	0.48^c
H_2	201.9^a	187.7^b	194.8^a	94.9^b	94.3^b	94.6^b	0.47^b	0.50^a	0.49^{bc}
H_3	162.7^c	162.2^c	162.4^c	79.0^d	80.6^c	79.8^d	0.49^b	0.50^b	0.49^b
H_4	189.7^b	195.3^a	192.5^a	96.0^a	97.7^a	96.8^a	0.51^a	0.50^{ab}	0.50^a
SEM±	2.03	1.81	1.92	0.15	0.94	0.67	0.01	0.001	0.004
LSD (P=0.05)	6.03	5.37	3.9	0.46	2.78	1.36	0.02	0.003	0.08

Means followed by the same letter (s) within a column are not statistically significant.

Where: DS_1 = I^{st} FN June; DS_2= II^{nd} FN June; DS_3= I^{st} FN July; H_1= Nithyashree; H_2= NK-6240; H_3 = GH-0727 and H_4 = 900-M-Gold.

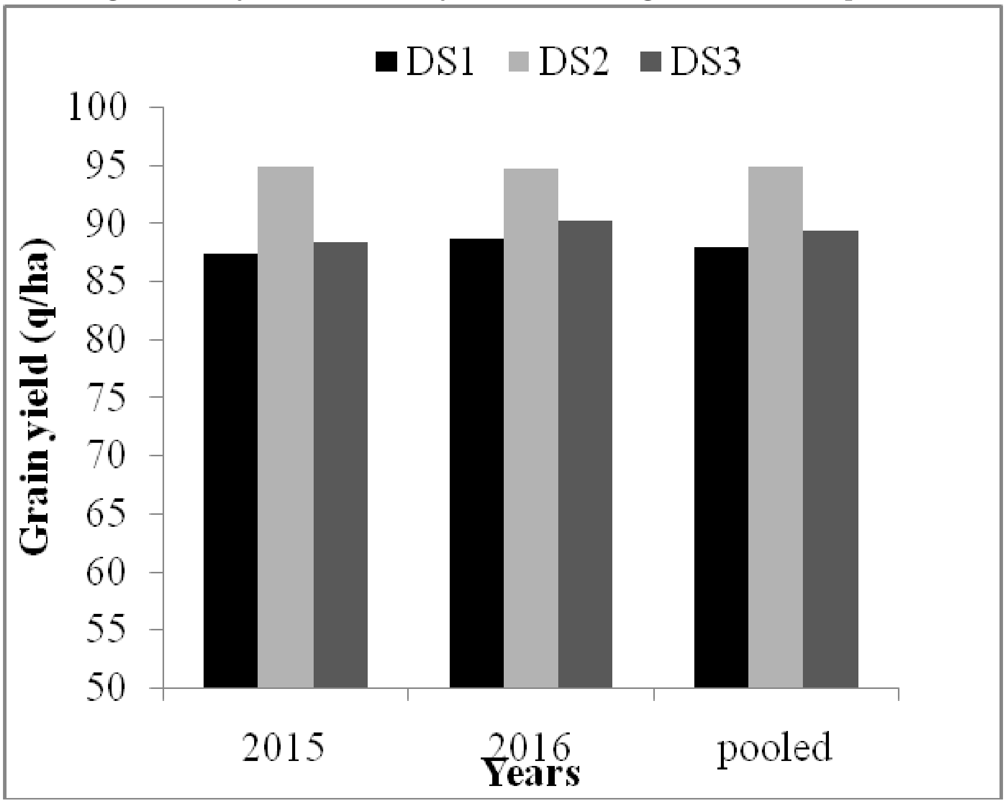
Stabbenborg *et al*[18]., also reported that low growth rate in the late sown crop is mainly due to unfavorable environmental effects encountered during the reproductive phase and due to the low net assimilation rate. Grj[11], studied the effect of sowing date on corn yield during the years 1985-1983 in Arlington in Mexico and found out that the performance decreases in late sowing.

The data showed that grain yield was significantly affected among the tested hybrids (fig. 3). The highest grain yield per hectare

(96.8q) was recorded by 900-M-Gold followed by NK-6240 with a yield (94.6q). The lowest grain yield per hectare (79.8q) was recorded by GH-0727. Compared to the highest recorded value it was lower by (17.6 %).

The interaction effects of DS and H showed that, the highest TSBH (201.0 q) was recorded by DS_1H_2, but it was on par with DS_1H_1, but the lowest TSBH (161.0q) was recorded by DS_1H_3. With delaying the time of DS the highest TSBH (199.0 q) was recorded by DS_2H_4, but it was on par with the other two hybrids except GH-0727, which recorded the lowest value during the same DS (Table 4). Similar trend was followed with further delaying the time of DS the highest TSBH (199.4 q) was recorded by DS_3H_4, but it was on par with the other two hybrids except GH-0727 which gave the lowest TSBH during the same DS.

Fig. 3: Grain yield as affected by DS and H during 2015, 2016, and pooled



Interaction of DS and hybrids significantly affected the grain yield per hectare (Table 4a). At the earliest DS the highest grain yield per hectare (92.0q) was recorded by DS_1H_4 but it was on par with DS_1H_2. The lowest grain yield per hectare (79.0 q) was recorded DS_1H_3. With Medium date of sowing (DS_2) the highest grain yield per hectare (103.0q) was recorded by DS_2H_4; followed by DS_2H_2 and DS_2H_1 well. The lowest value (81.0q) was recorded by DS_2H_3. With further delay the time of DS the highest grain yield per hectare (96.0q) was recorded by DS_3H_4, but it was on par with DS_3H_2 as well. The lowest grain yield (80.0q) was recorded by DS_3H_3. The lower value recorded was lesser by (23.3 %) compared to the highest.

With respect to the harvest index the interaction of DS and H showed a significant difference (Table 4b). The highest harvest index (51 %) was recorded by DS_1H_4, whereas the lowest value was (46.0 %) was recorded by DS_1H_2 which was lower by (8.0 %) compared to the highest value. During DS_2 similarly the highest HI value (52.0 %) was recorded by DS_2H_4, where as the lowest value (49.0 %) recorded by DS_2H_3 which was lower by (6.0 %) compared to the highest value.

Table 4b: Interaction effects of DS and H on yield and yield components of maize

	Total shoot biomass q/ha			Grain yield q/ha			Harvest index		
Treatments	2015	2016	pooled	2015	2016	pooled	2015	2016	pooled
DS_1H_1	196^{ab}	173^{bc}	184^{ab}	90^{b}	90^{c}	90^{d}	0.46^{b}	0.52^{a}	0.49^{b}
DS_1H_2	222^{a}	180^{b}	201^{a}	91^{b}	91^{b}	91^{cd}	0.41^{c}	0.51^{b}	0.46^{c}
DS_1H_3	162^{b}	160^{c}	161^{b}	76^{e}	81^{d}	79^{e}	0.47^{b}	0.51^{b}	0.49^{b}
DS_1H_4	180^{b}	180^{b}	180^{b}	92^{b}	92^{b}	92^{cd}	0.51^{a}	0.51	0.51^{a}
DS_2H_1	192^{ab}	192^{ab}	192^{ab}	97^{b}	97^{b}	97^{b}	0.51^{a}	0.50^{b}	0.51^{a}
DS_2H_2	197^{ab}	194^{ab}	196^{ab}	100^{a}	97^{b}	99^{b}	0.51^{a}	0.50^{b}	0.51^{a}
DS_2H_3	165^{b}	165^{bc}	165^{b}	81^{cd}	80^{d}	81^{e}	0.49^{ab}	0.49^{c}	0.49^{b}
DS_2H_4	197^{ab}	201^{a}	199^{ab}	101^{a}	105^{a}	103^{a}	0.51^{a}	0.52^{a}	0.52^{a}
DS_3H_1	178^{b}	200^{a}	189^{ab}	86^{c}	90^{c}	88^{d}	0.48^{b}	0.44^{e}	0.46^{c}
DS_3H_2	186^{ab}	189^{ab}	188^{ab}	93^{b}	95^{b}	94^{c}	0.50^{a}	0.50^{b}	0.50^{b}
DS_3H_3	161^{b}	162^{c}	161^{b}	80^{d}	80^{d}	80^{e}	0.50^{a}	0.50^{b}	0.50^{b}
DS_3H_4	192^{ba}	205^{a}	199^{ab}	95^{b}	96^{b}	96^{bc}	0.50^{a}	0.47^{d}	0.49^{b}
SEM$\pm$	13.27	5.79	10.24	2.11	2.43	2.27	2.82	0.57	1.78
LSD ($P\leq 0.05$)	39.4	17.2	20.8	6.3	7.2	4.6	0.03	0.004	0.014

Means followed by the same letter (s) within a column are not statistically significant.

Where: DS_1 = I[st] FN June; DS_2= II[nd] FN June; DS_3= I[st] FN July; H_1= Nithyashree; H_2= NK-6240; H_3 = GH-0727 and H_4 = 900-M-Gold.

With further delay in the DS the highest HI value (50.0 %) was recorded by DS_3H_2, but similar value was recorded by the other two hybrids during the same DS except Nithyashree which gave the lowest value (46.0%) and it was lower by 8.0% . In general early and late sowing combined with in any one of the tested hybrids showed a lesser harvest index compared to the optimum planting time, which was DS_2.

Except No. of rows per cob the data showed that No. of grain per row, No. of grain per cob, test weight were significantly affected by the DS (Table 4c). This was in agreement with Shah *et al*[17]., who reported that grain rows per cob did not show any significant changes (p<0.05) in maize when planted between June 08 to July 24 with a ten days interval in the season. However, Ahmed *et al*[1]., reported that higher thousand grains weight (235 g) was attained by the early sowing (6th June) while lower thousand grains weight (153 g) was recorded from the late sown crop (26th July). According to the same author early sown crop had produced bold and plump grains, it may be due to the reason that it had prolong period for growth and development and grain filling period and faster growth of late sown crop has affected the grain size and produced lighter grains.

The highest No. of rows per cob (14.8) and No. of grains per cob (354.8), respectively were recorded by DS_2, but the lowest No. of rows per cob (14.3), and No. of grains per cob (337.0) were recorded by DS_1 which was on par with DS_3. The lowest values were lesser No. of rows per cob (3.4 %), and No. of grains per cob (4.8 %), compared to the highest recorded values. And these values were in agreement with Aziz, *et al*[3]., who reported that late sowing of maize manifested significant reduction in grain yield; and Jasemi[12] indicated that maximum No. of kernel per row (51.2) was observed May 22 sown and minimum value (42.0) was observed on July 13 sown date. They further stated that the mean comparison on the No. of grain per cob was higher (712.6) in May sown but it was lower (574.5) on July sown.

And also Ahmed *et.al*[1]., in Peshawar Khyber Pakhtunkhwa, conducted a research on Yield and yield components of maize as affected by sowing dates and sowing methods and reported that, higher number of grains per cob (503.86) were produced by the early sowing on 26[th] June while lower number of grains per cob (287.39) were recorded from the late sown crop on 26th July.

Cirilo and Andrade[6] reported that, grain yield reduction association with delayed sowing was probably due to reduction in 1000-grain weight. According to Jasemi *et.al*[12]., the delay in sowing date on 13 July leads to reduced grain weight to (228.1g) further they suggest that because of shortening the growth period, corn was affected by the short days of late growth period, low sun radiation, low air temperature, and the opportunity for transfer of photosynthesis materials and seed filling was not provided. The highest test weight of 33.4 g also recorded by DS_2 that the rest but the lowest test weight (32.1g) was recorded by $DS_{1.}$

The analysed values showed that traits like No. of rows per cob, No. grains per row, and No. of grains per cob were significantly differed among the tested hybrids. The highest No. of rows per cob (15.0),recorded by Nithyashree but was on par with 900-M-Gold, No. of grains per row (24.9)was recorded by 900-M-Gold similar values were recorded by other hybrids except GH-0727 and No. of grains per cob (367.7) were recorded by 900-M-Gold followed by Nithyashree; but the lowest No. of rows per cob (14.2), No. of grains per row (21.6), and No. of grains per cob (305.6) were recorded by GH-0727. (33.8g) was recorded by NK-6240 followed by 900-M-Gold. Whereas the lowest test weight (32.3g) was recorded by H-0727. Compared to the highest value these lowest corresponding values were lower in No. of rows per cob by (5.4 %), No. of grains per row by (13.3 %), and No. of grains per cob by (16.9 %), and test weight (4.4%), respectively.

The data showed that the interaction effects of DS and H was significant on the No. of rows per cob, No. of grains per row, and No. of grains per cob. The highest No. of rows per cob (15.0) was recorded by DS_1H_1, but it was on par with the other hybrids with the same DS. With increasing the time of DS the highest No. of rows per cob (15.5) was recorded by DS_2H_4, but it was on par with other hybrids within the same DS as well. At delayed sowing (DS_3) however, the lowest No. of rows per cob (13.7) was recorded by DS_3H_3, whereas the highest value (15.3) was recorded by DS_3H_1 which was on par with the other two hybrids (H_2 and H_4) as well.

The result on No. of grains per row showed that interaction of DS and H affect it significantly, the highest No. of grains per row (24.9) was recorded by DS_1H_4, whereas the lowest value (29.0 grains per row) was recorded by DS_1H_3. With increasing the time of DS the highest No. of grains per row (24.9) was recorded by DS_2H_4, which was on par with other hybrids within the same DS except H3 which gave lowest value (21.4 grains per row). With delayed date of sowing (DS_3) the highest No. of grains per row (37.0) was recorded by DS_3H_4, but the lowest No. of grains per row of all the combinations (25.0) was recorded by DS_3H_4 but the lowest values (22.1 grains) were recorded by $DS_3H_{1.}$ The highest number of grains per cob (371.7) was recorded by DS_1H_1 followed by DS_1H_4 which gave 348.3 but lowest value (288.5 grains per cob) was recorded by DS_1H_3; With increasing the time of DS the highest number of grains per cob (384.2) was recorded by DS_2H_4; in which the lowest number of grains per cob (309.8) were recorded by DS_2H_3. With delayed sowing the highest number of grains per cob (370.5) was recorded by DS_3H_4, but the lowest number of grains per cob (318.5) was recorded by DS_3H_3. In general interaction effect showed a better performance on the number of grains per cob when hybrids were planted with DS_2 than early as well as late sowing. This result was in agreement with Otegui *et. al*[15]., reported that optimum planting date resulted in higher grain yield than early and late planting dates because of higher cob numbers and greater kernel numbers per plant.

In contrast to our result Osang *et.al*[14]., worked on "Influence of date of planting and time of introduction of maize on the agronomic performance of soybean-maize intercrop in Nigerian Southern-Guinea Savanna" showed that date of planting had significant effects (P<0.05) on 100 seed weight of maize and there were significant differences between the two dates of planting (June 27th and July 27th) (seed weight decreased with delayed planting). The highest test weight of (33.8 g) was recorded by NK-

6240 wherein it was on par with GH-0727, whereas the lowest test weight values (30.0, 30.4 g) were recorded by 900-M-Gold and Nithyashree, respectively.

The data on the yield components *viz.* test weight showed that, date of sowing influence significantly in both the seasons and pooled (Table 4d). At the early sowing the highest test weight of (33.0 g) was recorded by DS_1H_3 but the lowest value (31.0g) was recorded by $DS_1H_{1.}$ With increasing the time of DS the highest test weight (34.6g) was recorded by DS2H2 but was on par with other hybrids too except H3 which recorded the lowest value (32.5g) within the same DS. With delaying the DS the highest test weight (34.7g) was recorded by DS_3H_2 whereas the lowest value (31.5g) was recorded $DS_3H_{3.}$

Bhusal *et.al*[4]., reported that a highly significant difference was observed in test weight between the genotypes considering the planting dates. Highest test weight was observed when the genotypes were planted in September 12 followed by those planted during September 22 while the lowest was in September 2 planted crop. The heavier grains with earlier planting might be due to prolonged growing and grain filling period which enabled the plants to produce bold and plump grains. These results are in conformity with findings of Cha and Chol[5], who reported reduction in 1000 grain weight with delay in sowing date.

Beiragi *et. al.,* studies in Iran on Effects of planting dates (5 and 20 June) on growth and yield of 18 maize hybrids reported that, there have been significant differences among hybrids for all the traits at both sowing date (P≤0.01). This study showed that yield component such as kernel weight, kernel no. per row, kernel depth and cob length were adversely affected in delay planting condition.

They further stated that, delay on planting reduced cob percentage (-1.73 %), physiological maturity (-2.96 %), total leaf number (-6.79 %), 300 kernel weight (-18.94 %), kernel no. per row (-1.63 %), kernel depth (-15.21 %) and cob length (-0.12 %). Delayed planting also affected plant height (20.79 %), cob height (11.80 %), stem diameter (12.40 %), and total yield (3.23 %), positively. The percent reduction in total yield with early planting was only 3.12 %.

Table 4c: Yield components as affected by date of sowing and hybrids

Treatments	Yield components											
	No. of rows/cob			No. of grain /row			No. of grain/cob			Test weight (g)		
	2015	2016	pooled	2015	2016	pooled	2015	2016	pooled	2015	2016	Pooled
Date of sowing												
DS_1	14.6	14.1	14.3^b	23.6	23.5	24.0	344^{ab}	330.2^b	337.0^b	31.6^b	32.6^b	32.1^b
DS_2	15.3	14.4	14.8^a	23.8	24.2	24.0	362^a	347.2^a	354.8^a	32.7^{ab}	34.0^a	33.4^a
DS_3	14.8	14.3	14.6^{ab}	23.0	24.1	24.0	337^b	345.4^a	341.3^b	33.3^a	32.8^b	33.1^a
SEm$\pm$	0.2	0.2	0.2	0.51	0.30	0.37	5.86	1.43	2.65	0.41	0.28	0.32
LSD (P$\leq$0.05)	NS	NS	0.5	NS	NS	NS	23.0	5.6	5.38	1.63	1.11	0.65
H_1	15.7^a	14.3^{ab}	15.0^a	23.2^b	24.7^a	24.0^b	362.3^b	352.6^b	357.4^b	32.1^b	32.7^b	32.4^b
H_2	14.5^b	14.0^b	14.3^b	24.2^{ab}	24.5^a	24.4^{ab}	350.6^b	343.0^c	346.8^c	33.5^a	34.1^a	33.8^a
H_3	14.4^b	14.1^{ab}	14.2^b	21.2^c	21.9^b	21.6^c	303.2^c	308.0^d	305.6^d	32.6^{ab}	32.0^b	32.3^b
H_4	14.9^{ab}	14.7^a	14.8^{ab}	25.3^a	24.6^a	24.9^a	375.2^a	360.1^a	367.7^a	32.0^b	33.8^a	32.9^b
SEm$\pm$	0.32	0.21	0.27	0.47	0.33	0.45	4.12	1.34	3.06	0.43	0.3	0.37
LSD (P$\leq$0.05)	0.95	0.6	0.6	1.6	0.98	0.9	12.2	3.98	6.21	1.26	0.9	0.75

Means followed by the same letter (s) within a column are not statistically significant.

Where: DS_1 = I^{st} FN June; $DS_{2=}$ II^{nd} FN June; $DS_{3=}$ I^{st} FN July; H_1= Nithyashree; H_2= NK-6240; H_3 = GH- 0727 and H_4 = 900-M-Gold.

Table 4d: Interaction effects of date of sowing and hybrids on yield components

Treatment	Yield components											
	No. of rows/ear			No. of grain /row			No. of grain/ear			Test weight (g)		
	2015	2016	Pooled	2015	2016	pooled	2015	2016	Pooled	2015	2016	pooled
DS_1H_1	15.5^{ab}	14.5^{ab}	15.0^{ab}	25.4^{a}	24.2^{a}	24.8^{ab}	392.0^{a}	351.3^{b}	371.7^{b}	30.1^{c}	32.0^{b}	31.0^{c}
DS_1H_2	14.3^{b}	13.5^{b}	13.9^{b}	24.1^{a}	25.0^{a}	24.5^{ab}	343.3^{c}	336.0^{c}	339.7^{d}	30.3^{c}	34.0^{ab}	32.1^{bc}
DS_1H_3	14.7^{ab}	14.3^{ab}	14.5^{b}	19.1	20.9^{c}	20.0^{c}	280.0^{e}	297.0^{e}	288.5^{f}	34.0^{ab}	32.0^{b}	33.0^{b}
DS_1H_4	14.0^{b}	14.0^{b}	14.0^{b}	25.8^{a}	24.1^{ab}	24.9^{ab}	360.3^{bc}	336.3^{c}	348.3^{cd}	31.9^{bc}	32.4^{b}	32.2^{bc}
DS_2H_1	15.6^{ab}	14.0^{b}	14.8^{ab}	24.5^{ab}	25.4^{a}	24.9^{ab}	381.0^{ab}	354.7^{b}	367.8^{bc}	31.9^{bc}	34.0^{ab}	33.0^{b}
DS_2H_2	14.4^{b}	14.4^{ab}	14.4^{b}	25.6^{a}	24.0^{a}	24.8^{ab}	368.3^{b}	346.0^{b}	357.2^{c}	34.1^{ab}	35.0^{a}	34.6^{a}
DS_2H_3	15.1^{ab}	14.1^{ab}	14.6^{ab}	20.4	22.3^{b}	21.4^{c}	306.7^{d}	313.0^{d}	309.8^{e}	32.9^{b}	32.0^{b}	32.5^{b}
DS_2H_4	16.0^{ab}	14.9^{ab}	15.5^{a}	24.6^{ab}	25.1^{a}	24.9^{ab}	393.3^{a}	375.0a	384.2^{a}	32.0^{bc}	35.0^{a}	33.5^{ab}
DS_3H_1	16.1^{a}	14.3^{ab}	15.2^{ab}	19.6	24.7^{a}	22.1^{c}	314.0^{d}	351.7^{b}	332.8^{d}	34.2^{ab}	32.0^{b}	33.1^{b}
DS_3H_2	14.9^{ab}	14.1^{ab}	14.5^{ab}	22.8^{b}	24.6^{a}	23.7^{b}	340.0^{cd}	347.0^{b}	343.5^{d}	36.1^{a}	33.2^{b}	34.7^{a}
DS_3H_3	13.5^{b}	13.9^{b}	13.7^{b}	24.0^{ab}	22.7^{b}	23.4^{b}	323.0^{d}	314.0^{d}	318.5^{e}	31.0^{bc}	32.0^{b}	31.5^{c}
DS_3H_4	14.7^{ab}	15.1^{a}	14.9^{ab}	25.5^{a}	24.5^{a}	25.0^{a}	372.0^{b}	369.0^{ab}	370.5^{b}	32.0^{bc}	34.0^{ab}	33.0^{b}
SEm$\pm$	0.56	0.36	0.47	0.81	0.57	0.78	7.14	2.32	5.30	0.74	0.52	0.64
LSD ($P \le 0.05$)	1.7	1.1	1.0	2.27	1.60	1.63	19.92	6.48	11.06	2.08	1.45	1.34

Means followed by the same letter (s) within a column are not statistically significant.
Where: DS_1 = I^{st} FN June; DS_2 = II^{nd} FN June; DS_3 = I^{st} FN July; H_1= Nithyashree; H_2= NK-6240; H_3 = GH-0727 and H_4 = 900-M-Gold.

SUMMARY

Based up on the findings of our work the longer crop growth duration was recorded when hybrids were planted with DS_1 followed by DS_2 any delay than DS_2 was found to be not advantageous. The highest plant height (198.0 cm) at pooled analysis was recorded by DS_3 which was followed by DS_2 with plant height value of (189.0 cm). Among the hybrids the pooled value showed that highest plant height (192.9 cm) at harvest was recorded by NK-6240, but it was on par with 900-M-Gold. The highest LAI of 4.53 was recorded during DS_2, but was on par with DS_3. The highest grain number per cob of 354.8 was recorded by DS_2 followed by DS_2 which recorded 347 grain per cob. The highest total shoot biomass (187.9q ha^{-1}) and grain yield (94.8 q ha^{-1}) were recorded by DS_2. But similar total shoot biomass values were recorded by DS_1 and DS_3 as well. Among the tested hybrids the highest grains per cob (367.7) was recorded by 900-M-Gold. With respect to hybrids the highest TSB (194. 8 ha^{-1}) and grain yield (96.8 q ha^{-1}) were recorded by NK-6240 and 900-M-Gold, respectively, but the total shoot biomass was on par with 900-M-Gold. Therefore, DS_2 among the DS and NK-6240 and 900-M-Gold among the tested hybrids can be recommended as the best sowing window and best hybrids for the study area.

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