Original Research Article

CROP WEATHER RELATION ON YIELD OF GROUNDNUT GENOTYPES UNDER EXTENDED SOWING WINDOW DURING *KHARIF* SEASON

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ABSTRACT

A field experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during 2018. The experiment was laid out in split plot design consist of four sowing window as main plots *i.e.*, June 1st Fortnight, June 2nd Fortnight, July 1st Fortnight and July 2nd Fortnight and four groundnut genotypes as sub plots *i.e.*, GPBD-4, G2-52, Dh-245 and JL-1085 with three replications. The groundnut crop sown during first fortnight of June recorded significantly higher pod yield (3,551 kg ha^{-1}) and haulm yield (4,477 kg ha^{-1}) compared to second fortnight of July and was at par with first fortnight of July and second fortnight of June. Among groundnut genotypes, G2-52 recorded significantly higher pod yield (3,364 kg ha^{-1}) and haulm yield (4,239 kg ha^{-1}) over JL-1085 and was on far with Dh-245 and GPBD-4. The groundnut genotype, G2-52 sown during first fortnight of June recorded higher pod yield (3,841 kg ha^{-1}) and haulm yield (4,840 kg ha^{-1}) compared to JL-1085 sown during second fortnight of July.

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***Key words**: Sowing window, Date of sowing, Genotypes, weather etc.*

1. INTRODUCTION

In the economy of Indian agricultural, oilseeds are important crops and next to food grains in terms of place, value and production. Groundnut shall remain an essential oilseed crop for the semi-arid regions if the projected demand for oils and fat needs to be met with sustainability. Groundnut plays an important role in the Indian rural economy, which constitute

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the important element of Indian diet. Groundnut kernel contains edible oil (48-50 %), protein (25 %) and carbohydrates (20 %). **It is rich source of phosphorus and minerals, out of the 20 essential minerals for normal human body, seven essential minerals are present in groundnut. Among the 13 vitamins necessary for normal human body growth, nearly eight vitamins are present in groundnut (Vitamin-B, tocopherol (Vitamin-E) etc.)**

In the world, the groundnut is cultivated on large scale in almost all the tropical and sub-tropical countries and is commercially cultivated between 40° N and 40° S latitude. Globally, the crop is cultivated in an area of 25.92 million hectares with a total production of 44.64 million metric tonnes of nut shell (pod). The average productivity is 1,730 kg per hectare. In India, during 2017-18 the crop is cultivated in an area of 4.90 million hectares with total production of 8.21 million tonnes and the average productivity is 1,674 kg per hectare. However, in Karnataka during *kharif* season (2017-18), 3.75 lakh hectare area, 2.32 lakh tonnes production and 619 kg per hectare average productivity. Whereas, in *rabi* - summer season (2017-18), 2.05 lakh hectare area, 1.91 lakh tonnes production and 932 kg per hectare average productivity. In total, annual record of 5.80 lakh hectare area, 4.23 lakh hectare production and 729 kg per hectare productivity [1].

Growth and yield of crop depend on more than a few factor, but the most significant role is played by climate. The function of solar radiation, temperature, moisture and precipitation can be very important. The oilseed crops, particularly peanut is very much sensitive to climatic factors like radiation and temperature [2]. Groundnut can be grown under wide range of climatic condition however, it is growing best in temperature range between 22 °C and 37 °C. Yield variation can be depending upon the variability of rainfall *i.e.*, distribution and amount of rainfall. The effectiveness of rainfall in production of crop as influenced by the commencement of sowing rains as well as distribution and amount of rainfall in the course of the season [3].

Groundnut production and productivity is being reduced day by day in the country, particularly in Karnataka and cannot possible to meet the requirement of growing population, which may be due to non-availability of good quality seed of improved genotypes, improper sowing time and establishment methods etc. In dryland agriculture, farmers have limited choice for sowing time, however in irrigated situation sowing time is one of the crucial non-economic

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input affecting the crop yield [4]. Being a tropical crop, groundnut requires warm climate and can be grown in *kharif* season due to congenial climate. Therefore, proper sowing time of groundnut in *kharif* is important for enhancing yield. The improved groundnut genotypes increase 25-28 per cent of yield, while 30-32 per cent by improved management practices[5].

Crop management practices such as time of sowing and duration of genotype may also influence growth, yield and quality parameters of groundnut. The real impact of seed maturity is dependent on genotype, climatic conditions and interaction of genotype between climate. Out of several above factors responsible for its low productivity, proper time of sowing under good rainfall situation with high yielding genotypes is considered as a prime constraint. Hence, the present investigation was carried out on **"Crop weather relation on yield of groundnut genotypes under extended sowing window during *kharif* season"** with the objective to study the effect of sowing dates on growth and yield of groundnut genotypes.

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2. MATERIAL AND METHODS

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The experiment was laid out in split plot design consist of four date of sowing as main plots *i.e*., D_1: First fortnight of June (14-06-2018), D_2: Second fortnight of June (25-06-2018), D_3: First fortnight of July (06-07-2018) and D_4: Second fortnight of July (19-07-2018) and four groundnut genotypes as sub plots *i.e*., G_1: GPBD-4, G_2: G2-52, G_3: Dh-245 and G_4: JL-1085 with three replications and total 16 treatment combination. The experiment was conducted in medium to deep black soils *i.e*., *Vertisols*. The soil type of the experimental site was clay loam. The pH of the soil was neutral with 7.62. The soil was low in available nitrogen content (262 kg N ha^{-1}) and medium in available phosphorous (33 kg P_2O_5 ha^{-1}) and high in available potassium (389 kg K_2O ha^{-1}).

The all management practices are followed according to the UAS Dharwad package of practice. Seeds were weighed separately for each plot at the rate of 125 kg ha^{-1}. Groundnut seeds were treated with (Carboxin 37.5% + Thiram 37.5%) *i.e*., Vitavax power followed by *Rhizobium* and phosphate solubilizing bacteria. By following 30 cm×10 cm spacing (Row to row: 30 cm and plant to plant: 10 cm) the lines were opened with the help of marker and the seeds were hand dibbled and covered with soil. Basal application of farm yard manure @ 7.5 t ha^{-1}, nitrogen @ 18 kg N ha^{-1}, phosphorus @ 46 kg P_2O_5 ha^{-1} and potassium @ 25 kg K_2O ha^{-1} were applied in the

UNDER PEER REVIEW

form of diammonium phosphate and muriate of potash along with this $FeSO_4$ and $ZnSO_4$ each @ 25 kg ha^{-1} and gypsum at 500 kg ha^{-1} during peg initiation stage. According to the date of sowing and duration of the genotypes when crop attains maturity *i.e.*, the inside of the shell turns dark and the kernels reach maximum growth accompanied by good colouration of the seed coat, the crop was harvested.

Pods from the plot area were cleaned to remove the soil adhering to the pods, impurities and immature pods. The developed pods were sun dried completely and weighed. Pod yield per hectare was calculated and expressed in kilogram per hectare. After separating the pods from harvested groundnut plants, the remaining produce was sun dried and haulm yield per hectare was calculated and expressed in kilogram per hectare.

3. RESULTS AND DISCUSSION

3.1. EFFECT OF WEATHER PARAMETERS ON PERFORMANCE OF *KHARIF* GROUNDNUT

The average rainfall recorded during the months of June to October (1950 to 2017) was 555.08 mm. However, the rainfall received during the crop growth period *i.e.*, June to October, 2018 was as 462.8 mm. During the experimental year 2018, a rainfall of 892.2 mm was received which was 172.6 mm higher than the normal (1950-2017). Out of 892.2 mm rainfall, 462.8 mm was received during the crop growth period for all date of sowing (June to October, 2018) (Table 1 and Fig. 1). The groundnut crop requires 400-500 mm rainfall, Whereas, different sowing window observed different amount and distribution of rainfall. First, second, third and four sowing window recorded 302, 288, 344 and 255 mm rainfall, respectively (Table 2 and Fig. 2).

The crop sown during first fortnight of June recorded 302 mm rainfall in 34 rainy days, which was well distributed *i.e.*, 71 mm (10 days) between 0-30 days, 106.4 mm (15 days) between 30-60 days, 56.6 mm (5 days) between 60-90 days and 68.4 mm (4 days) between 90 to harvest. Almost similar rainfall distribution was experienced during first fortnight of July and second fortnight of June.

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Table 1: Monthly mean meteorological data during crop growth period (2018) and the average of past 68 years (1950-2017) at the Main Agricultural Research Station, UAS, Dharwad

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Month	Rainfall (mm)		Rainy days	Temperature (^{o}C)				Relative humidity (%)	
	1950-2017	2018		Maximum		Minimum		1950-2017	2018
				1950-2017	2018	1950-2017	2018		
January	0.77	0.0	0	28.84	29.8	14.66	13.9	52.96	66.3
February	10.84	1.0	0	31.66	32.1	16.11	15.7	44.88	46.3
March	3.65	72.4	3	34.89	34.9	18.64	19.3	42.42	46.6
April	38.43	32.8	3	36.52	36.2	20.16	21.1	58.61	58.2
May	71.92	250.4	10	35.19	34.7	21.23	21.3	64.28	66.7
June	107.59	115.4	9	29.60	28.8	21.12	21.0	79.69	80.5
July	134.47	128.8	19	27.21	25.8	20.71	20.6	86.25	87.5
August	103.98	72.2	7	26.85	25.9	20.41	20.2	86.09	87.2
September	103.29	69.6	4	28.40	29.6	20.02	18.9	81.81	75.7
October	105.75	76.8	6	29.72	31.6	19.40	18.3	75.20	65.5
November	31.49	34.4	2	29.71	30.5	16.46	16.3	69.67	54.8
December	7.45	38.4	1	28.83	28.8	14.04	14.6	67.40	60.6
Total/mean	**719.6***	**892.2***	**64***	**30.6**	**30.7**	**18.6**	**18.4**	**67.4**	**66.3**

***Total**

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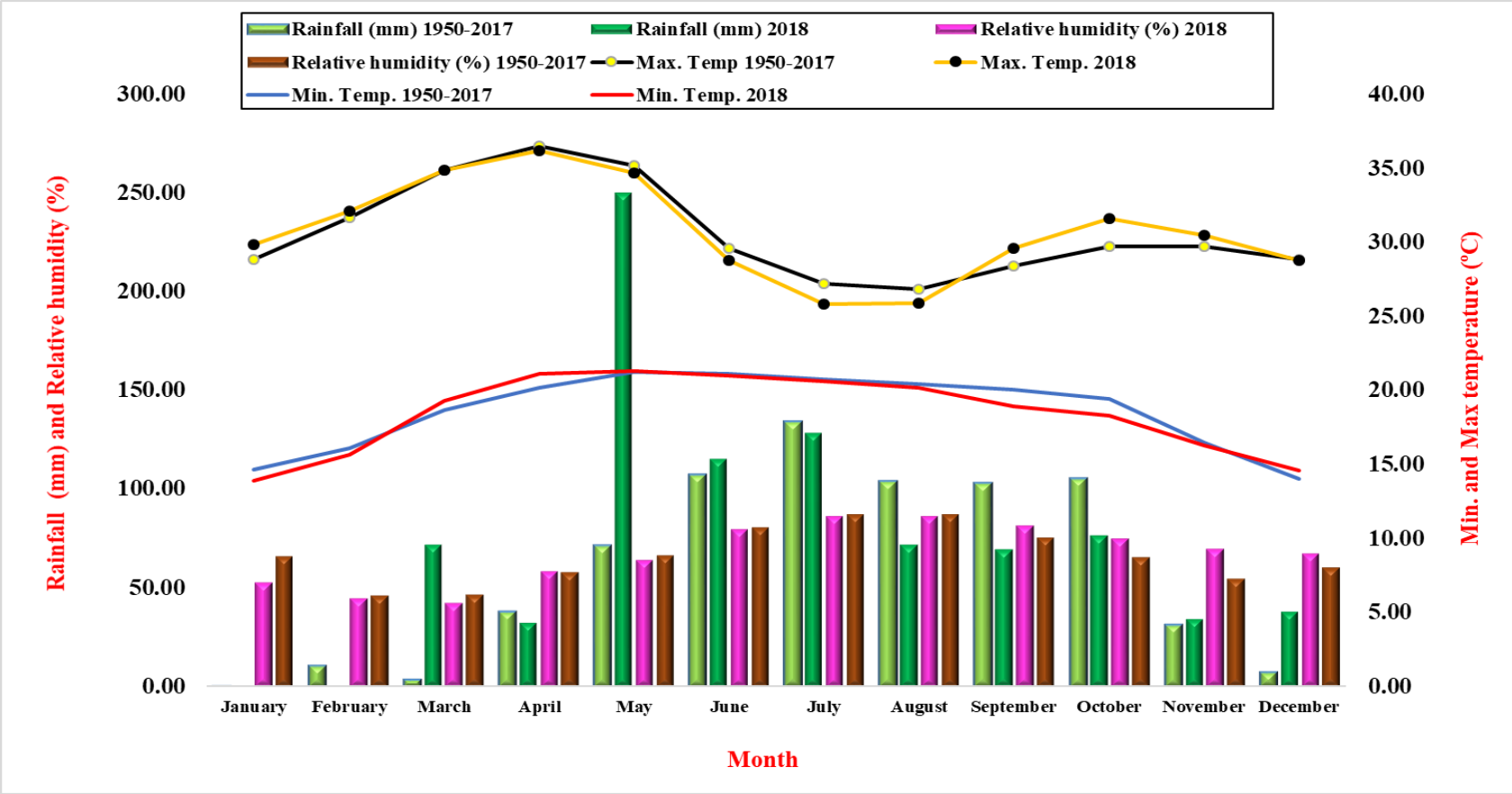

Figure 1: Monthly meteorological data during crop growth period (2018) and the average of past 68 years (1950-2017) at the Main Agricultural Research Station, UAS, Dharwad

Table 2: Meteorological data during crop growth stages for all four sowing window during *kharif* 2018 at the Main Agricultural Research Station, UAS, Dharwad

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Sowing window	Growth stage	Max. Temp. (^{o}C)	Min. Temp. (^{o}C)	RH Max. (%)	RH Min. (%)	Mean RH (%)	Rainfall (mm)	Rainy days
D_1: June 1st Fortnight	**0-30**	27.42	20.60	88.20	77.33	82.77	71	10
	31-60	25.67	20.64	90.03	86.13	88.08	106.4	15
	61-90	26.52	19.58	89.03	79.23	84.13	56.6	5
	91-Harvest	30.57	19.10	81.40	65.45	73.43	68.4	4
	Mean /Total	**27.55**	**19.98**	**87.17**	**77.04**	**82.10**	**302.4***	**34***
D_2: June 2nd Fortnight	**0-30**	26.21	20.69	89.30	83.30	86.30	118.8	18
	31-60	25.70	20.41	90.37	85.60	87.98	78.6	9
	61-90	28.53	19.03	85.23	70.07	77.65	39.4	2
	91-Harvest	31.66	19.61	80.35	63.15	71.75	51	5
	Mean /Total	**28.03**	**19.94**	**86.31**	**75.53**	**80.92**	**287.8***	**34***
D_3: July 1st Fortnight	**0-30**	25.61	20.65	90.07	85.93	88.00	129.2	18
	31-60	25.90	20.12	89.87	84.80	87.33	75.2	8
	61-90	30.11	18.95	83.03	66.77	74.90	76.2	6
	91-Harvest	31.68	19.27	78.95	57.85	68.40	63	3
	Mean /Total	**28.33**	**19.75**	**85.48**	**73.84**	**79.66**	**343.6***	**35***
D_4: July 2nd Fortnight	**0-30**	25.61	20.53	90.50	86.17	88.33	91.4	13
	31-60	27.63	19.20	86.80	73.20	80.00	25.8	2
	61-90	31.50	19.65	81.53	61.43	71.48	75.2	6
	91-Harvest	30.70	17.01	66.15	56.50	61.33	62.6	3
	Mean /Total	**28.86**	**19.01**	**81.26**	**69.33**	**75.29**	**255***	**24***

***Total**

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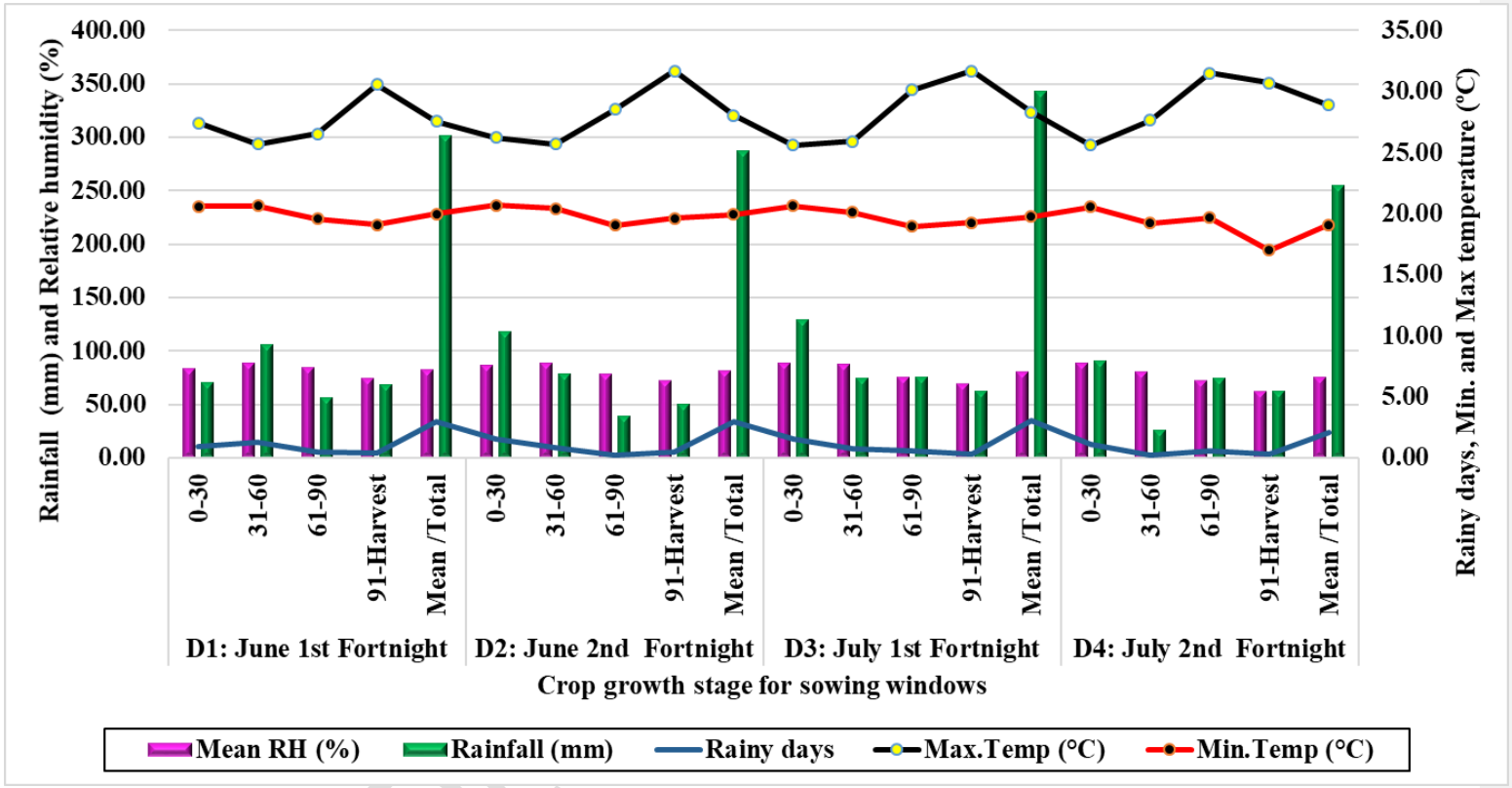

Figure 2: Meteorological data during crop growth stage for all four sowing window during *kharif* 2018 at the Main Agricultural Research Station, UAS, Dharwad

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Differences in the pod yield are mainly influenced by the variation in the distribution of rainfall. The higher pod yield was obtained when the crop was sown during first fortnight of June as the crop experienced good distribution of rainfall throughout the cropping period. The crop sown during first fortnight of July and second fortnight June received more rainfall at early stage of crop then, optimum distribution during rest of the crop period. Whereas, the crop sown during second fortnight of July experienced limited water supply resulting in moisture stress periods during the crop growth and development stages which has resulted in significantly lower pod yield. This sowing window received only 255 mm rainfall in 24 rainy days. Moisture stress between 30-60 days of the crop growth which affected the peak flowering, peg initiation and pod development.

The highest and the lowest mean maximum temperature were 36.2 ºC (April) and 25.8 ºC (July), respectively while the respective highest and the lowest minimum temperature were 21.3 ºC (May) and 13.9 ºC (January), respectively. During crop growth period the maximum and minimum temperature was observed equally in all sowing windows (Max. temp. 28.19 ºC ± 0.40 and Min. temp. 19.67 ºC ± 0.32). During the experimental year, the mean relative humidity ranged from 46.3 per cent in February to 87.5 per cent in July. The mean relative humidity decreased from first date of sowing (77.04 %) to fourth date of sowing (69.33 %). Whereas, 73.94 ± 2.35 per cent deviation from the mean relative humidity was observed for all date of sowing (Table 1 and Fig. 2).

3.2. ACCUMULATED GROWING DEGREE DAYS AND ASSESSING THE MATURITY OF THE GROUNDNUT CROP

Growth and development of groundnut are affected by different uncontrollable environmental conditions such as effect of different planting dates, growing degree days and agronomic traits of genotypes. The currently available methods used to predict groundnut maturity are based on hull colour determination and are somewhat labour-intensive and subject to the observer's ability to finely discriminate colour classes. In addition, an over-mature crop may lead to increased mechanical losses during the process of digging due to deteriorating peg strength with age. This mechanical loss, termed digging loss, is the retention of pods in the soil during the digging process due to separation of the pod from the stem attachment at the plant. Typical digging losses have been estimated to be 8% of the total yield but can reach 40 % at dates beyond optimal maturity [6&7]. Therefore, correctly assessing groundnut maturity prior to

UNDER PEER REVIEW

digging is essential to the economic viability of groundnut production. Further, Ketring and Wheless (1989) found accumulated degree days to range between 1450 and 1670 at final harvest in case of groundnut [8]. In the present study, among the dates of sowing, growing degree days were found to be similar (Table 3). The range is from 1448 to 1485, indicating temperature condition prevailed during different sowing windows was uniform from sowing to maturity. Among, different genotypes under the study, higher growing degree days was observed with genotypes G2-52, GPBD-4 and Dh-245 as compared to JL-1085 indicating JL-1085 consumed less heat units to reach maturity. It may be attributed to the genotype JL-1085 being of relatively of shorter duration and had optimum maturity duration of 100 to 105 days as compared to other genotypes which are having optimum maturity of 105 to 110 days. These results show that overall groundnut plant development appears to be highly correlated with growing degree days of 1448 to 1485 under semi arid climate like Dharwad to determine the maturity of the crop. So in absence of the previous studies on this aspect in the study area, accumulated degree days between 1448 to 1485 could be used to judge the maturity of the groundnut crop.

3.3. SOIL MOISTURE CONTENT IN RELATION TO SOWING WINDOWS

Soil moisture content from 0-30 cm depth at 10 days interval after sowing to harvest was recorded and presented in Graph No. 3. During crop period of first date of sowing (14.06.2018) highest soil moisture was observed in 24.07.2018, which coincides with the flowering to peg initiation stage (30-40 DAS) crop. Whereas, lowest moisture was recorded in 80-90 DAS *i.e.*, kernel development to maturity stage at 12.09.2018. In second date of sowing (25.06.2018) highest soil moisture was observed in 24.07.2018 which coincides with the emergence to flowering stage (20-30 DAS) crop. Whereas, lowest moisture was recorded in 70-80 DAS *i.e.*, pod formation to kernel development stage at 12.09.2018. During crop period of third date of sowing (06.07.2018) highest soil moisture was observed in 24.07.2018 which coincides with the germination to emergence stage (10-20 DAS) crop. Whereas, lowest moisture was recorded in 60-70 DAS *i.e.*, pod initiation to pod formation stage at 12.09.2018. In fourth date of sowing (19.07.2018) highest soil moisture was observed in 24.07.2018 which coincides with the sowing to germination stage (0-10 DAS) crop. Whereas, lowest moisture was recorded in 50-60 DAS *i.e.*, pegging stage to pod initiation stage at 12.09.2018 (Figure 3).

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Table: 3 Accumulated growing degree days under different date of sowing during *kharif*-2018

Accumulated GDD					
Date of sowing / Genotypes	**14th June**	**25th June**	**6th July**	**19th July**	**Mean**
GPBD-4	1503	1521	1530	1539	**1523**
G2-52	1503	1521	1530	1539	**1523**
Dh-245	1472	1490	1500	1509	**1493**
JL-1085	1427	1442	1458	1467	**1448**
Mean	**1476**	**1494**	**1504**	**1514**	

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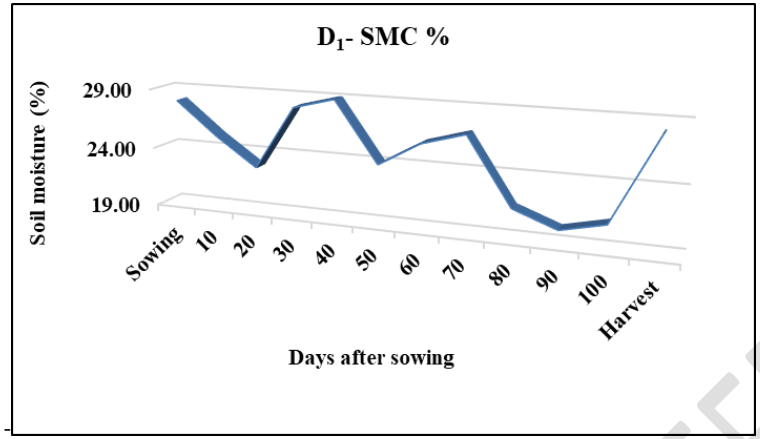

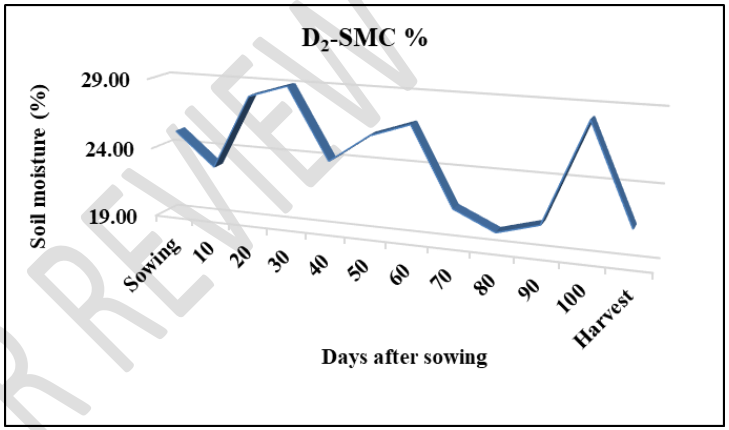

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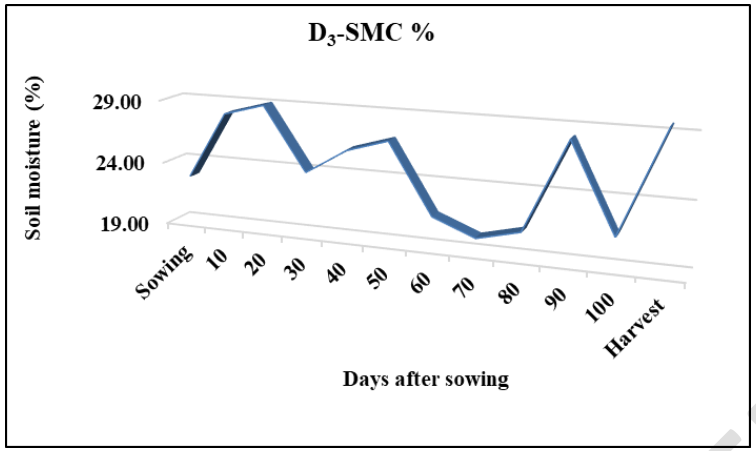

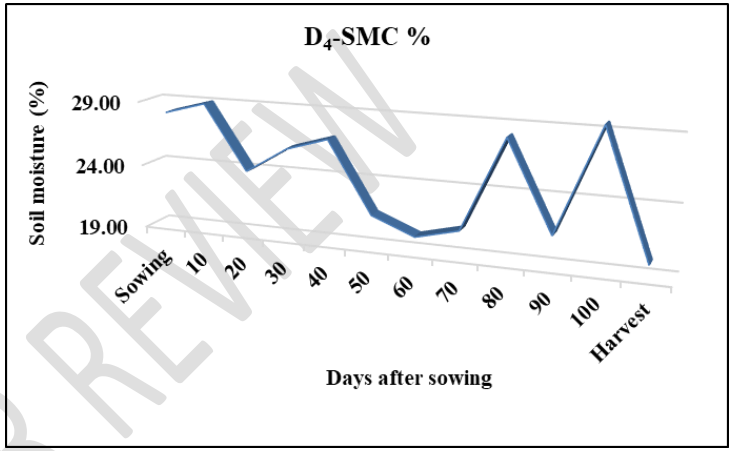

Figure 3: Graphical representation of soil moisture content from 0 to 30 cm depth at 10 days interval after sowing to harvest under different dates of sowing during *kharif*.

UNDER PEER REVIEW

3.4. EFFECT OF SOWING WINDOW ON POD AND HAULM YIELD *KHARIF* GROUNDNUT

Among the sowing windows, the crop sown during first fortnight of June recorded significantly higher pod yield (3,551 kg ha^{-1}) and haulm yield (4,477 kg ha^{-1}) and other yield attributes (Table 4) and was at par with the crop sown during first fortnight of July (3,372 and 4,222 kg ha^{-1}, respectively) and second fortnight of June (3,163 and 4,056 kg ha^{-1}, respectively). This might be due to better performance of yield attributes *viz.*, number of pods, pod weight. Similarly, higher leaf area at 60 DAS and at harvest and higher leaf area index, which resulted in higher leaf surface area for assimilation of photosynthates. The crop sown early during first fortnight June might have been exposed to better climatic condition resulting in higher photosynthetic rate and consequently increased leaf area. Higher dry matter production per plant at 60 DAS and at harvest was observed with early sown crop. Similar findings were observed by Guled (2013); Patel and Vaishnav (2003) in Gujarat [9&10].

Comment [u21]: and pod weight

The pod yield decreased by 29.30 per cent (2,509 kg ha^{-1}) with delayed sowing *i.e.*, second fortnight of July over the first fortnight of June (Table 4). It might be due to insufficient availability soil moisture at reproductive stages, like peak flowering, peg initiation and pod filling wherein, these are the critical stages of crop for moisture leading to stress reduced dry matter production and there by the translocation of photosynthates from leaves (source) to fruiting parts (sink). Hence there was lower number of pods and pod weight. Effect of rainfall had greater influence on vegetative growth of the crop under delayed sowing. Which ultimately reduced dry matter production, leaf area and leaf area index in second fortnight of July sowing window. Similar kind of results was observed by Sahu *et al.* (2004) and Thiyagrajan *et al.* (2010) at Saurashtra region, Gujarat [3&11].

3.5. PERFORMANCE OF GROUNDNUT GENOTYPES UNDER DIFFERENT SOWING WINDOW

It is necessary to grow the groundnut genotypes which can withstand weather aberrations by adapting to varied sowing window. Nageswar Rao (1992) revealed that, improved genotypes contribute 25-28 per cent to the yield increase while improved management practices contribute

UNDER PEER REVIEW

30-32 per cent [5]. Hence, it is an important factor to assess the performance of groundnut genotypes under varied sowing windows.

Among the different genotypes of groundnut, the genotype G2-52 recorded significantly superior pod yield (3,364 kg ha^{-1}) and haulm yield (4,239 kg ha^{-1}) over JL-1085 (2,868 kg ha^{-1} & 3,639 kg ha^{-1}, respectively) and was statistically on par with Dh-245 (3,209 kg ha^{-1} & 4,044 kg ha^{-1}, respectively) and GPBD-4 (3,154 kg ha^{-1} & 3,975 kg ha^{-1}, respectively). Similar findings were observed by Bharatha Lakshmi and Sambasiva Reddy, (2001) at Tirupati, Andhra Pradesh [12].

3.6. INTERACTION EFFECT OF SOWING WINDOW AND GENOTYPES ON YIELD OF *KHARIF* GROUNDNUT

The interaction effect was found not significant between sowing window and genotypes for growth and yield parameters of groundnut. The groundnut genotype, G2-52 sown during first fortnight of June recorded higher pod yield (3,841 kg ha^{-1}) and haulm yield (4,840 kg ha^{-1}) compared to JL-1085 sown during second fortnight of July.This was also due to combination of genetic characters and also the optimum weather parameters during crop period.

Lower pod yield was recorded with second fortnight July with JL-1085 genotype (2,267 kg ha^{-1}). Delay in sowing resulted in reduced pod yield (2868 kg ha^{-1}) and haulm yield (3639 kg ha^{-1}). This might be due to stress condition prevailed to the crop with delayed sowing due to lack of rainfall (255 mm) and rainy days (24). These results are in accordance with Kanade *et al.* (2016) at Pune and Mohite *et al.* (2017) at Kolhapur [13&14].

4. CONCLUSION

Sowing of groundnut with normal onset monsoon *i.e*., during first fortnight of June was highly productive (3,551 kg ha^{-1}) and remunerative. But under delayed onset of monsoon, sowing could be extended up to second fortnight of July. The groundnut genotype, G2-52 was superior and was on par with Dh-245 and GPBD-4. The groundnut genotype, G2-52 sown during first fortnight of June resulted in higher pod yield and haulm yield.

UNDER PEER REVIEW

Table 4: Effect of different sowing window on pod yield and kernel yield of groundnut genotypes

	Pod yield (kg ha^{-1})					Haulm yield (kg ha^{-1})				
Sowing window / Genotype	**14th June**	**25th June**	**6th July**	**19th July**	**Mean**	**14th June**	**25th June**	**6th July**	**19th July**	**Mean**
GPBD-4	3,517	3,215	3,421	2,464	**3,154**	4,432	4,115	4,276	3,079	**3,975**
G2-52	3,841	3,324	3,558	2,731	**3,364**	4,840	4,255	4,447	3,414	**4,239**
Dh-245	3,556	3,217	3,488	2,576	**3,209**	4,480	4,118	4,360	3,220	**4,044**
JL-1085	3,288	2,898	3,019	2,267	**2,868**	4,156	3,738	3,805	2,856	**3,639**
Mean	**3,551**	**3,163**	**3,372**	**2,509**		**4,477**	**4,056**	**4,222**	**3,142**	

Source of variation	**S.Em. ±**	**CD (P=0.05)**	**S.Em. ±**	**CD (P=0.05)**
Sowing window (D)	122	422	153	530
Genotype (G)	105	307	134	390
Two genotype means at same sowing window	211	NS	267	NS
Two sowing window means at same or diff. genotype	219	NS	277	NS

NS: Non significant

UNDER PEER REVIEW

5. REFERENCE

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