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# Effect of Rainfall and Percent Available Soil Moisture on Groundnut Yield in Middle Gujarat

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ABSTRACT

A field experiment on effect of per cent available soil moisture and rainfall on rainfed groundnut yield under middle Gujarat was conducted at agronomy farm, Anand Agricultural University, Anand during the year 2019 and year 2020. Results showed that first date of sowing (onset of monsoon) was significantly superior for growth and yield character due to well distributed rainfall and per cent available soil moisture. Significantly higher pod yield (2176 kg ha$^{-1}$ and 1862 kg ha$^{-1}$) was recorded during both years of the experiment under first date of sowing which was statistically at par with second date of sowing (1937 kg ha$^{-1}$ and 1592 kg ha$^{-1}$) and significantly higher than the third date of sowing (1614 kg ha$^{-1}$ and 1369 kg ha$^{-1}$). The higher rainfall and more per cent of available soil moisture content was recorded in first date of sowing during 2019 and 2020. The result also showed that the final yield of groundnut crop was greater during 2019 as compared to 2020 due to higher per cent available soil moisture and rainfall. Among the varieties, GG 20 recorded significantly higher pod yield (2043 and 1701 kg ha$^{-1}$) over other varieties (GJG 34 and TAG 3A). Hence, variety GG 20 is promising under onset of monsoon (first date of sowing) in terms of pod yield in middle Gujarat agro climatic zone.

*Keywords* : Groundnut, Middle Gujarat, Per cent available soil moisture, Rainfall, Yield

GROUNDNUT (*Arachis hypogaea* L.) is an important oilseed crop of tropical and subtropical regions of the world. In India, it is one of the most important cash crop. The well-distributed rainfall of at least 500 mm during crop growth period and abundance bright sunshine hours with relatively warm temperature favours the crop. Sowing, emergence, germination, flowering, vegetative and pod development of groundnut requires good rainfall distribution and soil moisture. Moisture stress affect flowering, pod setting and resulting in lower yield. In India, groundnut occupies an area of 5.5 m ha producing 9.6 m.t. with a productivity of 1750 kg ha$^{-1}$ (Shwetha *et al*., 2017).

The principal groundnut growing states are Gujarat, Andhra Pradesh, Karnataka, Tamil Nadu, Maharashtra, Rajasthan, Madhya Pradesh, Orissa and Uttar Pradesh which accounts for more than 80 per cent of the Indian production as well as area. Variation and unequal distribution of monsoon is main cause of fluctuations in groundnut yield in India (Basu and Ghosh, 1995). Gujarat stands first in area and production. It occupies 1.95 m. ha., 28.93 per cent of the total area of the country producing 3.39 m.t. (42.43 %) with a productivity of 1777 kg ha$^{-1}$. In Gujarat, Anand district occupies area about 7000 ha, producing 1200 m.t. with averge yield of 1701 kg ha$^{-1}$ ( Anonymous, 2011).

Optimum sowing time of groundnut depends upon the type of variety and growing season due to variation in agro ecological conditions. Sowing date is most important factor influencing the growth and yield of groundnut. Late or delayed sowing results in declining crop yield. Also, the soil moisture during different growth stages *viz*., emergence, branching, flowering, pod initiation and pod development, etc. are equally important. Kulkarni *et al.* (1988) observed that water deficit reduced the pod yields of Spanish type groundnut (cv. JG 11 and GG 2) at all the stages (vegetative, flowering and pod development). Thus, soil moisture being one of the most precious inputs and balanced with due consideration to the growth, development and yield of groundnut (Lal *et al.* (2013). Keeping in view the above, the present investigation

was carried out to study the effect of rainfall and per cent available soil moisture and to identify the suitable date of sowing for rainfed groundnut in middle Gujarat region.

## Material and Methods

The field experiment was conducted during *kharif* season 2019 and 2020 at Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India. Anand is located at the latitude of 22° 35' N and longitude of 72° 55' E and at an altitude of 45.1 m above the mean sea level. The treatments consisted of three dates of sowing *viz*., first date of sowing - onset of monsoon, second date of sowing - 10 days after onset of monsoon and third date of sowing - 20 days after onset of monsoon with three varieties GG 20, GJG 34 and TAG 37A. The experiment replicated with four times in randomized block design (factorial). The crop was sown at a distance of 30 cm x 10 cm. The soil at the experiment site is sandy loam in texture with water table deeper than 10 m (Lakkad, 1993). The experimental field can be characterized as a gentle slope and good drainage as well as fair moisture retentive capacity. All the package of practices was followed as per recommendation of AAU, Anand. Approximately 60 mm at sowing time as heavy irrigation during 2020 and 40 at initial flowering mm for light irrigation during 2019 in second date of sowing was given to the each plot as a life saving irrigations. The meteorological data were collected from the Agrometeorological observatory which is adjacent to the experimental site.

### Soil Moisture Content

The soil moisture content at different soil depths (0-15, 15-30 and 30-45 cm) was determined by gravimetric method at alternate day from sowing to harvesting of the crop. The soil samples were collected from experimental field with the help of soil auger. The collected soil samples were weighed and placed in an oven drying at 105°C for 24 hours, to constant weight. The difference in weight of wet and dry soil samples was considered as moisture present in soil sample. The soil moisture percentage calculated using following formula.

$$\text{Soil moisture (\%)} = \frac{W_1 - W_2}{W_2} \times 100$$

Where,

$W_1$ = Weight of wet soil sample (g)

$W_2$ = Weight of oven dry soil sample (g)

The conversion of soil moisture into volumetric content was calculated by using the following bulk density.

$$\text{Volumetric soil moisture} = \text{Soil moisture (\%)} \times BD$$

Where,

BD = Bulk density (g $cm^{-3}$)

### Depth of Water

The depth of water was obtained as under (Dastane, 1967)

$$Pv = \frac{Pw \times BD \times d}{100}$$

Where,

Pv = Depth of water in cm

Pw = Percent moisture on weight basis

BD = Bulk density

d = Depth of soil in cm

### Per cent Available Soil Moisture (PASM)

PASM is based on daily water balance and is defined as the ratio of the difference between the current soil moisture and the permanent wilting point to the field capacity and the permanent wilting point. The index values range from 0 to 100 with 0 indicating extreme dry condition and 100 wet condition (Saxena *et. al.,* 2019).

### Meteorological Observations

The daily observations of weather parameters such as maximum and minimum temperatures, rainfall, bright sunshine hours, wind speed, pan evaporation, relative humidity (I and II) and vapour pressure were recorded twice daily at 0738h (morning) and 1438h (afternoon) IST at Agro meteorological observatory, which is situated adjacent to the site of the experimental field.

## Results and Discussion

### Rainfall and Percent Available Soil Moisture (PASM)

The rainfall and per cent available soil moisture (PASM) to attain different crop growth stage under different dates of sowing during 2019 and 2020 were worked out and are graphically presented in Fig.1. The results revealed that rainfall receipt during crop growth period was more than the normal rainfall during both years. The higher rainfall and more soil moisture content was recorded from emergence to pod filling crop stage for all dates of sowing during 2019. During 2019, rainfall quantum and distribution were good. Per cent of available soil moisture status were improved in dates of sowing. While, during 2020, just after onset of monsoon, due to dry spell resulted in depletion in per cent available soil moisture at time of sowing. Also, there was depletion soil moisture from peak leaf area stage to maturity had moisture stress condition because of low rainfall. The first date of sowing recorded higher groundnut yield due to higher rainfall and more per cent of available soil moisture. The result also showed that the final yield of the groundnut crop was more 2019 as compared to the 2020 due to higher per cent of available soil moisture and higher rainfall during 2019.

Daily observed and simulated soil moisture for the entire growing season during 2019 and 2020 are graphically presented in Fig. 2. It showed that during 2019, there was good amount of soil moisture from flowering initiation to physiological maturity stage of the first and second dates of sowing. Whereas, in the third date of sowing, higher moisture from sowing to peak leaf index was observed. During 2020, except first date of sowing there was decreasing trend was noticed from

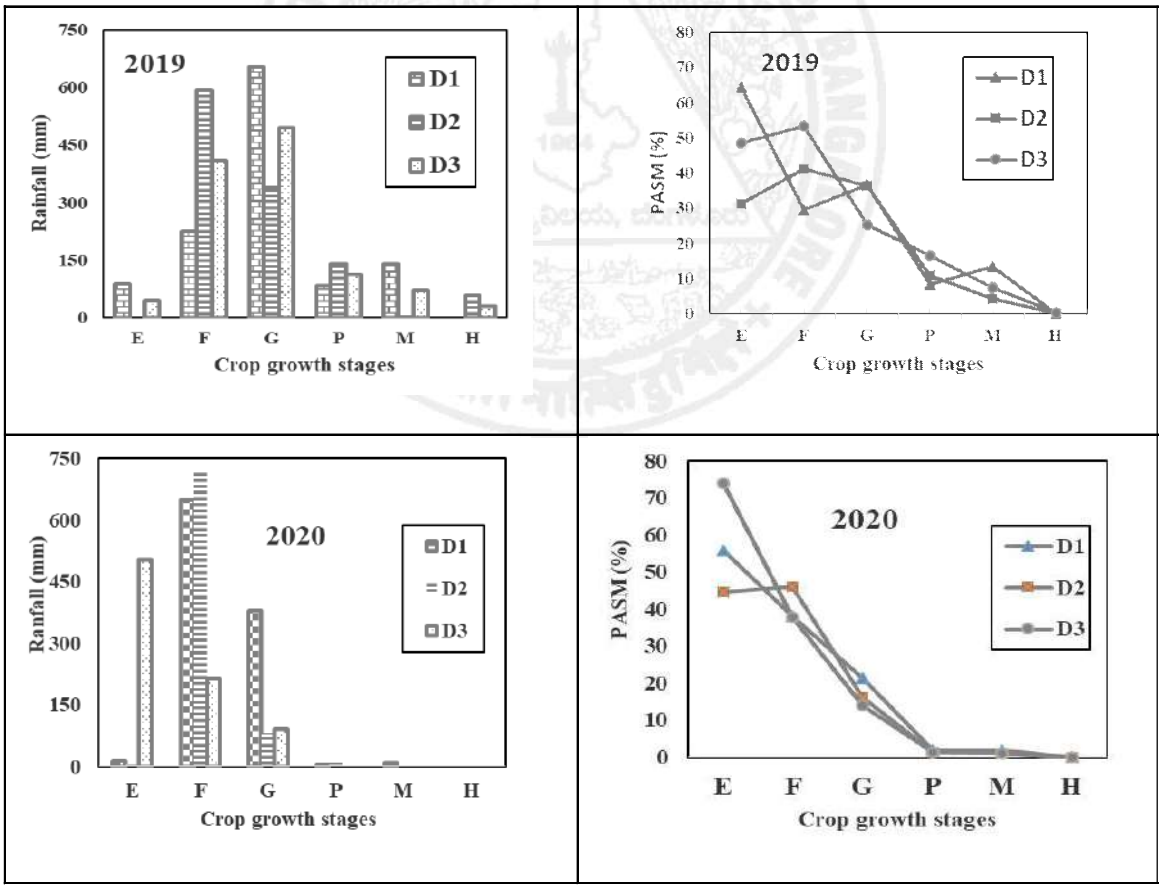


Fig. 1: Rainfall and per cent available soil moisture at different crop growth stages during 2019 and 2020
(*E: Emergence, F: Flowering, G: Pod initiation, P: Peak leaf area, M: Maturity and H: Harvesting)



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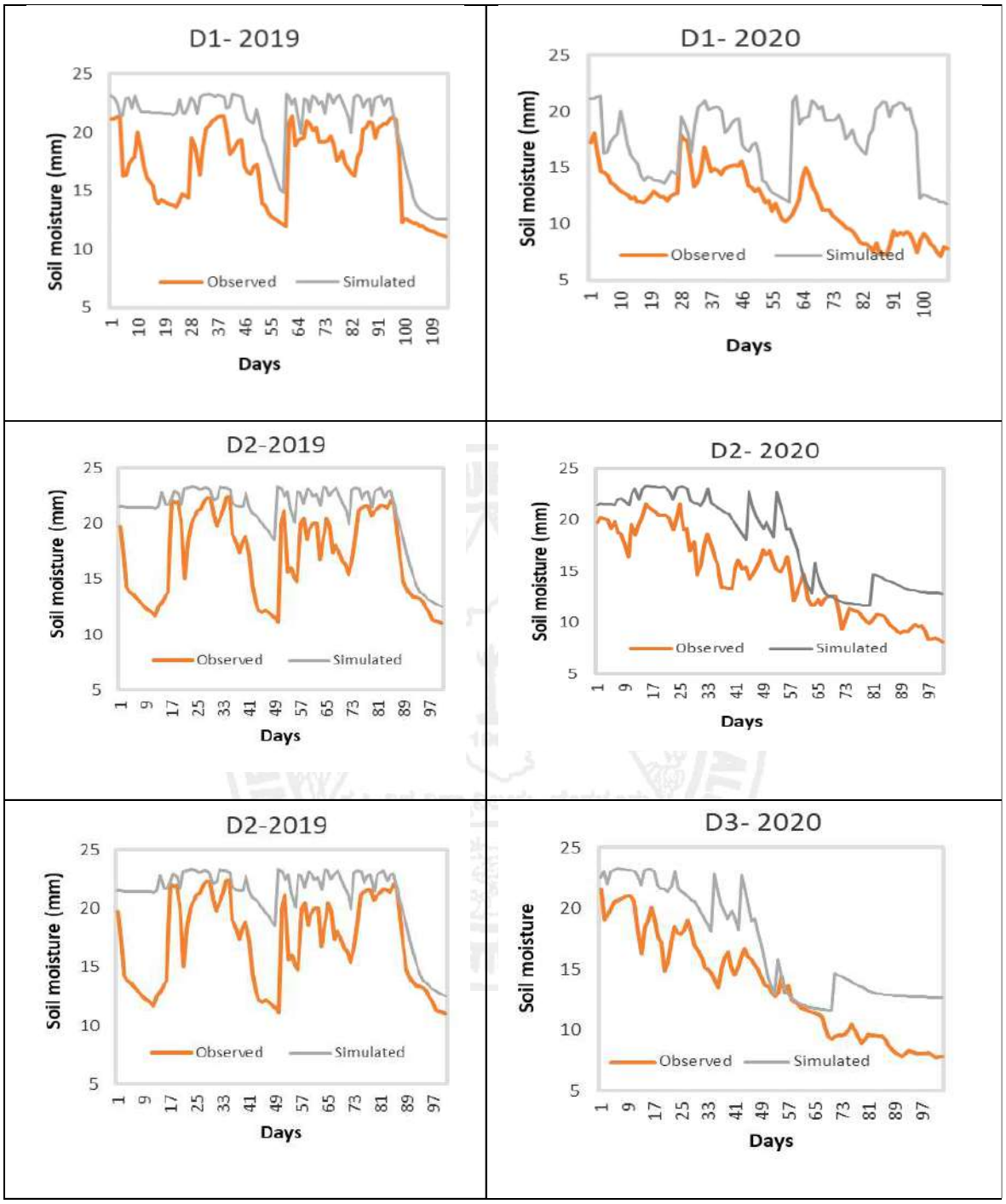


Fig. 2: Observed and simulated soil moisture in groundnut growth period during 2019 and 2020

sowing to harvesting of crop but soil moisture was sufficient during crop growing period. The result revealed that maximum soil moisture and higher pod yield was recorded in the first date of sowing during both the seasons.

**Evapotranspiration (ET), Rainfall and Irrigation of Groundnut at Crop Growth Stages**

The ET, rainfall, irrigation and PASM of groundnut as influenced by different dates of sowing and varieties

TABLE 1

Evapotranspiration, rainfall and irrigation of groundnut for different crop growth stages by different dates of sowing and varieties during 2019

| Crop growth stages | Evapotranspiration (mm) | | | Rainfall (mm) | | | Irrigation (mm) | | |
|---|---|---|---|---|---|---|---|---|---|
| | $V_1$ | $V_2$ | $V_3$ | $V_1$ | $V_2$ | $V_3$ | $V_1$ | $V_2$ | $V_3$ |
| *First Date of sowing* | | | | | | | | | |
| Emergence | 20.1 | 22.2 | 20.1 | 70.4 | 119.6 | 70.4 | — | — | — |
| Flowering | 39.8 | 42.2 | 41.9 | 208.2 | 213.0 | 250.2 | — | — | — |
| Grain filling | 104.8 | 100.3 | 100.6 | 686.6 | 632.6 | 644.6 | — | — | — |
| Peak LAI | 20.2 | 20.2 | 22.4 | 83.0 | 83.0 | 83.0 | — | — | — |
| Maturity | 59.3 | 59.3 | 59.3 | 140.0 | 140.0 | 140.0 | — | — | — |
| *Second Date of sowing* | | | | | | | | | |
| Emergence | 2.0 | 2.0 | 2.0 | 0.0 | 0.0 | 0.0 | — | — | — |
| Flowering | 52.1 | 52.1 | 50.1 | 573.8 | 573.8 | 409.4 | 40.0 | 40.0 | 40.0 |
| Grain filling | 100.4 | 100.4 | 99.0 | 362.4 | 362.4 | 519.2 | — | — | — |
| Peak LAI | 29.4 | 29.4 | 32.8 | 131.8 | 131.8 | 139.4 | — | — | — |
| Maturity | 35.4 | 35.4 | 35.4 | 64.0 | 64.0 | 64.0 | — | — | — |
| *Third Date of sowing* | | | | | | | | | |
| Emergence | 17.0 | 19.7 | 17.0 | 38.4 | 47.0 | 38.4 | — | — | — |
| Flowering | 53.4 | 51.1 | 53.4 | 563.6 | 555.0 | 563.6 | — | — | — |
| Grain filling | 63.1 | 67.0 | 63.1 | 266.6 | 326.6 | 266.6 | — | — | — |
| Peak LAI | 66.1 | 61.8 | 66.1 | 200.0 | 140.0 | 200.0 | — | — | — |
| Maturity | 21.3 | 21.3 | 21.3 | 63.4 | 63.4 | 63.4 | — | — | — |

during 2019 and 2020 are given in Table 1 to 2. Crop phenology was divided into five growth stages during both the seasons as a function of days after sowing (DAS). The maximum ET (mm) and rainfall (mm) were recorded in grain filling stage of the crop, whereas, it was minimum at harvesting stage during first date of sowing. The irrigation was applied 40.0 mm at flowering stage in second date of sowing during 2019 (Table 1). In 2020, ET (mm) and rainfall (mm) were higher in grain filling stage (first date of sowing) and flowering stage (second date of sowing), respectively. The irrigation was applied 60.0 mm immediately after each date of sowing during 2020 to facilitate better establishment (Table 2).

The ET and PASM were 225.7 mm and 51.2 per cent respectively, during 2019 while, 171.2 mm and 32.2 per cent during 2020 respectively. The total water, drainage and water entering soil were increased with delayed sowing during both the years. Higher rainfall, maximum PASM and ET were observed in both the year. Results showed that amount of rainfall, water entering soil and PASM were well distribution in the first date of sowing. Also, during flowering stage, the amount of rainfall and drainage was higher. Hence, the pod yield of groundnut was higher in first sowing date as compared to other sowings. Less amount of rainfall, soil moisture as well as PASM was noticed in pod formation during second and third sowing.



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TABLE 2

Evapotranspiration, rainfall and irrigation of groundnut for different crop growth stages by different dates of sowing and varieties during 2020

| Crop growth stages | Evapotranspiration (mm) | | | Rainfall (mm) | | | Irrigation (mm) | | |
|---|---|---|---|---|---|---|---|---|---|
| | $V_1$ | $V_2$ | $V_3$ | $V_1$ | $V_2$ | $V_3$ | $V_1$ | $V_2$ | $V_3$ |
| *First Date of sowing* | | | | | | | | | |
| Emergence | 14.0 | 14.0 | 14.0 | 15.4 | 15.4 | 15.4 | 60.0 | 60.0 | 60.0 |
| Flowering | 50.1 | 50.1 | 48.0 | 663.2 | 663.2 | 622.6 | -- | -- | -- |
| Grain filling | 112.2 | 112.2 | 110.8 | 147.0 | 147.0 | 174.4 | -- | -- | -- |
| Peak LAI | 19.5 | 19.5 | 23.0 | 0.0 | 0.0 | 13.2 | -- | -- | -- |
| Maturity | 7.0 | 7.0 | 7.0 | 10.4 | 10.4 | 10.4 | -- | -- | -- |
| Second Date of sowing | | | | | | | | | |
| Emergence | 5.6 | 5.6 | 7.9 | 7.0 | 7.0 | 9.8 | 60.0 | 60.0 | 60.0 |
| Flowering | 67.5 | 67.5 | 63.2 | 718.2 | 718.2 | 715.4 | -- | -- | -- |
| Grain filling | 99.5 | 99.5 | 101.0 | 82.4 | 82.4 | 82.4 | -- | -- | -- |
| Peak LAI | 3.6 | 3.6 | 4.1 | 10.4 | 10.4 | 10.4 | -- | -- | -- |
| Maturity | 3.6 | 3.6 | 3.6 | 0.0 | 0.0 | 0.0 | -- | -- | -- |
| Third Date of sowing | | | | | | | | | |
| Emergence | 17.6 | 17.6 | 17.6 | 502.6 | 502.6 | 502.6 | 60.0 | 60.0 | 60.0 |
| Flowering | 43.1 | 43.1 | 42.6 | 212.4 | 212.4 | 212.4 | -- | -- | -- |
| Grain filling | 77.7 | 78.3 | 77.6 | 90.8 | 90.8 | 90.8 | -- | -- | -- |
| Peak LAI | 4.2 | 3.6 | 4.8 | 0.0 | 0.0 | 0.0 | -- | -- | -- |
| Maturity | 0.7 | 0.7 | 0.7 | 0.0 | 0.0 | 0.0 | -- | -- | -- |

**Pod Yield**

The individual as well as pooled statistical results of pod yield of groundnut as influenced by different dates of sowing and varieties are presented in Table 3.

Significantly high pod yield (2176 kg $ha^{-1}$ and 1862 kg $ha^{-1}$) was recorded during both years of the experiment under first date of sowing onset of monsoon which was statistically at par with second date of sowing (10 days after onset of monsoon) and significantly higher than the third date of sowing (20 days after onset of monsoon). The higher pod yield was recorded during 2019 compared to 2020. Similar trends were observed in pooled over years. The present study revealed that onset of monsoon is the better time for obtaining higher pod yield of groundnut during *kharif* season under middle Gujarat agroclimatic condition. In early sowing, there was a sufficient time to exploit the soil and environmental resources such as rainfall and availability of soil moisture for growth, development compared to delay sowing. Hence, result showed that the first date of sowing realizing higher pod yield than the other dates of sowing in middle Gujarat. Shah *et al.,* (1999) was found similar results. Similar results were also reported by Sogut *et al*., (2016), Canavar and Kaynak (2008) and Munda and Patel (1998). Guled *et. al.,* (2013) recorded the higher yield (2244 kg $ha^{-1}$) in first date of sowing (onset of monsoon) as compared to other sowing dates.

TABLE 3
Pod yield of groundnut as influenced by sowing dates and varieties during 2019 an 2020

| Treatments | Pod yield (kg ha$^{-1}$) | | |
|---|---|---|---|
| | 2019 | 2020 | Pooled |
| *Date of sowing* | | | |
| $D_1$ (Onset of monsoon ) | 2176 | 1862 | 2019 |
| $D_2$ (10 days after onset of monsoon) | 1937 | 1592 | 1764 |
| $D_3$ (20 days after onset of monsoon) | 1614 | 1369 | 1492 |
| SEm± | 46.7 | 47.9 | 33.4 |
| CD at 5% | 135.3 | 138.7 | 95.1 |
| CV% | 8.5 | 10.3 | 9.3 |
| *Variety* | | | |
| $V_1$ (GG 20) | 2043 | 1701 | 1872 |
| $V_2$ (GJG 34) | 1915 | 1612 | 1763 |
| $V_3$ (TG 37A) | 1769 | 1511 | 1640 |
| SEm± | 46.7 | 47.9 | 33.4 |
| CD at 5% | 135.3 | 138.7 | 95.1 |
| CV% | 8.5 | 10.3 | 9.3 |
| Interaction effect | NS | NS | NS |

Effect of varieties on pod yield was found significantly during both years and pooled results of field experiment. Significantly higher pod yield (2043 kg ha$^{-1}$ and 1701 kg ha$^{-1}$) under GG 20 over other varieties GJG 34 and TAG 37A. Hence, variety GG 20 is the promising one in terms of growth and yield in middle Gujarat agro climatic zone. Variety GG 20 was well respond to soil moisture at crop growth stages of groundnut crop. Guled *et.al.,* (2013) was observed more yield (1969 kg ha$^{-1}$) in the variety M 335 than the other two varieties GG 20 and GG5.

It could be concluded from these results that the varieties and sowing dates had significant influence on yield of groundnut. Thus, to obtain higher pod yield of groundnut GG 20 variety should be sown earlier at onset of monsoon particularly in middle Gujarat agro climatic zone.

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