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# Impact on Yield Attributes and Yields of Groundnut Varieties under Different Sowing Windows in Western Maharashtra, India

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

Present experiment was undertaken to study the "Impact of yield attributes and yields of groundnut varieties under different sowing windows in Western Maharashtra Plain Zone" at Department of Agricultural Meteorology Farm, Centre of Advanced Faculty Training (CAFT) in Agricultural Meteorology, College of Agriculture, Pune, Maharashtra State (India). The experiment was laid out in split plot design comprised of four varieties *viz.,* $V_1$: JL-501, $V_2$: RHRG-6083 (*Phule Unnati*), $V_3$: TAG-24 and $V_4$: JL-776 (*Phule Bharati*) as main plot and four sowing windows *viz*., $S_1$: 25$^{rd}$ MW (18$^{th}$ to 24$^{th}$ June), $S_2$: 26$^{th}$ MW (25$^{th}$ June to 01$^{st}$ July), $S_3$: 27$^{th}$ MW (2$^{nd}$ to 8$^{th}$ July) and $S_4$: 28$^{th}$ MW (09$^{th}$ to 15$^{th}$ July) as sub plot treatments. The number of pods plant$^{-1}$, weight of pods plant$^{-1}$, 100 kernel weight (g), shelling (%) and yields as influenced by the different treatments were recorded at harvest. Yield contributing characters *viz.,* number of pods$^{-1}$ (45.25 and 43.29) and weight of pods$^{-1}$ (12.99 and 13.82) were found significantly higher in variety JL-776 over RHRG-6083, JL-501 and TAG-24, whereas shelling percentage (75.12 and 76.60) were found significantly higher in variety TAG-24 followed by JL-501, JL-776 and RHRG-6083. Pod yield (26.59 and 28.14 q ha$^{-1}$) and haulm yield (39.61 and 36.7 q ha$^{-1}$) were significantly higher in JL-776 followed by RHRG-6083, JL-501 and TAG-24. Amongst all the groundnut varieties, JL-776 (*Phule Bharati*) is significantly superior under extended sowing windows followed by varieties RHRG-6083, TAG-24 and JL-501. Sowing during 26$^{th}$ MW was observed to be most suitable and optimum for groundnut considering the growth and yield attributes. This sowing window was at par with 27$^{th}$ MW sowing window.

*Keywords: Crop weather relationship; groundnut; sowing window; varieties; yield; yield contributing character.*

## 1. INTRODUCTION

"Groundnut (*Arachis hypogaea* L.) is an annual legume which is also known as peanut, earthnut, monkey nut and goobers. Groundnut seeds (kernels) contain 40-50 % fat, 20-50 % protein and 10-20 % carbohydrates. It is essentially a tropical plant and requires a long and warm growing season. The favorable climate for groundnut is a well distributed rainfall of at least 500 mm during the crop growing season with abundance of sunshine and relatively warm temperature, which is essential for maximum yield and quality of groundnut. Long days promote vegetative growth at the expense of reproductive growth and increased crop growth rate resulting in decreased partitioning of photosynthesis to pods and decreased duration of effective pod filling phase" [1]. "Groundnut covers 295 lakh hectares with the production of 487 lakh tonnes with the productivity of 1647 kg per hectare" (FAOSTAT, 2019) [2]. "With annual all-season coverage of 55.6 lakh hectares, globally, India ranks first in Groundnut acreage and is the second largest producer of Groundnut in the world with 101 lakh tonnes with a productivity of 1816 kg per hectare in 2020-21 (agricoop.nic.in)" [3]. "Sowing of rainfed and irrigated crop early in the season provide favorable weather conditions for proper growth and yield of groundnut. Delay in sowing by one-week results in linear decrease in pod yield of groundnut. In normal-sown crop, the pattern of flowering is regular with two distinct peaks, whereas in late-sown crop erratic pattern of flowering occurs" [4]. "The choice of a groundnut variety for any particular area depends on matching the variety with the length of the growing season". [1] Therefore, the investigation is carried out to study the impact of yield attributes and yields of groundnut varieties under different sowing windows in Western Maharashtra Plain Zone.

## 2. MATERIALS AND METHODS

### 2.1 Location of the Experimental Site, Soil and Climatic Condition

The field experiment was conducted by two consecutive years at Department of Agricultural Meteorology farm, College of Agriculture, Pune during *kharif,* 2017 and 2018. The geographical location of the site (Pune) was 18° 32'N, latitude; 73°51E, longitude and 557.7 m above mean sea level (MSL). The soil is medium black having depth of about 1m. The experimental site is situated in the sub-tropical region (Plain Zone) on the latitude 18$^0$ 22' N and longitude 73$^0$ 51' E and having an altitude of 557.7 m above the mean sea level. The average annual rainfall of Pune is 675 mm, which is distributed from second fortnight of June to second fortnight of October. Out of total rainfall, about 75 per cent is received from June to September from south-west monsoon, while remaining is received from north-east monsoon during October and November.

## 2.2 Nature of Season during Experimental Period

Daily and weekly mean meteorological data during the crop growth period (25th to 45th MW) of *kharif* 2017 and 2018 recorded in class 'A' observatory situated at college of agriculture, campus. The daily maximum and minimum temperature during the crop growth period ranged from 34.4 and 12.7 $^{o}$C during *kharif* 2017 and 34.7 and 13.3 $^{o}$C during *kharif* 2018. During crop period, the weekly maximum and minimum temperatures varied from 27.1 to 33.4 $^{o}$C and 14.1 to 23.9 $^{o}$C, respectively, during 2017. It was varied from 24.2 to 37.7 $^{o}$C and 13.3 to 24.6 $^{o}$C respectively, during *kharif* 2017. Weekly relative humidity during morning (07.20 hrs LMT) and afternoon (14.20 hrs LMT) was 93.7 and 31.1 % in 2017, whereas it was 97 and 16 % in *kharif* 2018, respectively. The daily range of relative humidity during morning was 75-97 % and 72-97 % during the respective years while during afternoon was in the range of 26-98 %, while, it was between 16-92 % during two years of experimentation, respectively. The weekly wind velocity during the period ranged from 1.6 to 10.3 and 1.1 to 11.6 kmph during 2017 and 2018, respectively. The bright sunshine hour's day$^{-1}$ during crop growing period were 9.3 and 10.5 during 2017 and 2018, respectively. The weekly evaporation ranged from 2.2 to 6.7 and 2.2 to 5.3 mm per day in 2017 and 2018, respectively. The weekly photoperiod *i.e.* maximum possible sunshine hours which were fixed for the particular day in a year ranged from 10.38 to 13.87.

## 2.3 Experimental Details

The experiment was laid out in split plot design with three replications. The treatment comprised of four varieties *viz.,* $V_1$: JL-501, $V_2$: RHRG-6083 (*Phule Unnati*), $V_3$: TAG-24 and $V_4$: JL-776 (*Phule Bharati*) as main plot and four sowing windows *viz*., $S_1$: 25rd MW (18th to 24th June), $S_2$: 26th MW (25th June to 01st July), $S_3$: 27th MW (2nd to 8th July) and $S_4$: 28th MW (09th to 15th July) as sub plot treatments. "The gross and net plot size was 4.5 x 4.5 m$^2$ and 3.6 x 3.6 m$^2$, respectively. The allocation of treatments was done with random method. The certified seed of all the groundnut variety JL-501, RHRG-6083, TAG-24 and JL-776 was procured from the Groundnut Breeder, Oilseed Research Station, Jalgaon, MPKV, Rahuri". [1] Sowing was done as per the treatments by dibbling one kernel at each hill with 30 cm inter-row and 7.5 cm intra-row distance keeping a seed rate of 100 kgha$^{-1}$. The requisite plant population was maintained by thinning and gap filling. Urea and single super phosphate were used as source of N and P and applied as per recommended dose *i.e.*25 kg N and 50 kg $P_2O_5$. Seed of groundnut was inoculated with *Rhizobium* culture @ 250 g 10 kg$^{-1}$ seed.

## 2.4 Post Harvest Studies

### 2.4.1 Number and weight of pods plant$^{-1}$ (g)

"Number of pods of five observational plants was counted and number of pods plant$^{-1}$ was calculated. The weight of all the pods were taken on electronic balance and mean weight of pods per plant was recorded" [1].

### 2.4.2 100 kernel weight (g)

"Random sample of 100 kernels was taken from total kernels produced in each net plot, and its weight was recorded" [1].

### 2.4.3 Shelling percentage

200 g pods from each treatment were shelled and kernel weight was recorded. Shelling percentage obtained by using following formula.

$$\text{Shelling per cent} = \frac{\text{Weight of kernels}}{\text{Weight of pods}} \times 100$$

## 2.5 Yields

### 2.5.1 Pod yield (q ha$^{-1}$)

Pods from net plot were stripped after uprooting and dried in sunlight. The pod yield obtained was recorded as per treatments and pod yield per ha was calculated.

### 2.5.2 Haulm yield (q ha$^{-1}$)

After stripping pods, haulms from net plot area of each treatment were sun dried and expressed quintal per ha.

## 3. RESULTS AND DISCUSSION

The mean yield contributing characters of groundnut varieties *viz.,* number of pods plant$^{-1}$, weight of pods plant$^{-1}$, 100 kernel weight (g) and shelling (%), pod and haulm yields kgha$^{-1}$ as influenced by the different treatments were recorded at harvest and reported here and data presented in Table 1.

## 3.1 Number of Pods Plant$^{-1}$

The mean number of pods plant$^{-1}$ was 35.23 and 32.33, during 2017 and 2018 respectively.

### 3.1.1 Effect of varieties

The number of pods plant$^{-1}$ was significantly higher (45.25 and 43.29) in JL-776 ($V_4$) which was superior over RHRG-6083 ($V_2$) (38.42 and 35.21) and JL-501 ($V_1$) (29.75 and 26.54). The variety TAG-24 recorded significantly lower number of pods plant$^{-1}$ (27.5 and 24.29) the difference in number of pods plant$^{-1}$ of groundnut variety might be due to inherent genetically potential of groundnut varieties.

### 3.1.2 Effect of sowing windows

"The number of pods plant$^{-1}$ was maximum at 26$^{th}$ MW ($S_2$) sowing window (41.42 and 38.21) which was at par with 27$^{th}$ MW sowing window (37.83 and 34.62). This was followed by 25$^{th}$ MW sowing window (32.42 and 29.21). The least number of pods plant$^{-1}$ of groundnut was observed in 28$^{th}$ MW sowing window (29.25 and 27.29)". [1] Similar results were observed by Murthy and Rao [4] who reported that in India, sowing of rainfed and irrigated crop early in the season provided favorable weather conditions for proper growth and yield of groundnut. Delay in sowing by one week from 17$^{th}$ July to 24$^{th}$ August resulted in linear decrease in pod yield of groundnut and number of mature pods plant$^{-1}$.

### 3.1.3 Effects of interaction

The number of pods plant$^{-1}$ of groundnut was significantly influenced by interaction between varieties and sowing windows during the year 2017 and 2018. Sowing at 26$^{th}$ MW sowing window ($S_2$) recorded maximum number of pods plant$^{-1}$ of groundnut (52.46 and 55.67) in variety JL-776 ($V_4$). This was followed by variety RHRG-6083 ($V_2$) (42.46 and 45.67 cm), JL-501 ($V_1$) (30.79 and 34.00), and TAG-24 ($V_3$) (27.12 and 30.33) during the year 2017 and 2018, respectively.

## 3.2 Weight of Pods Plant$^{-1}$ (g)

The mean weight of pods plant$^{-1}$ was 12.11 and 12.92 g during the year 2017 and 2018 respectively.

### 3.2.1 Effect of varieties

The weight of pods plant$^{-1}$ of groundnut was significantly higher (12.99 and 13.82) in JL-776 ($V_4$) which was superior over rest of all varieties, followed by RHRG-6083 ($V_2$) (12.61 and 13.44) and JL-501 ($V_1$) (11.54 and 12.28). The variety TAG-24 recorded significantly lower weight of pods plant$^{-1}$ (11.32 and 12.15) the difference in weight of pods plant$^{-1}$of groundnut variety might be due to inherent genetical potential varieties.

### 3.2.2 Effect of sowing windows

The weight of pods plant$^{-1}$ of groundnut was recorded highest at 26$^{th}$ MW ($S_2$) sowing window (12.95 and 13.78) which was at par with 27$^{th}$ MW sowing window (12.45 and 13.28). This was followed by 25$^{rd}$ MW sowing window (11.98 and 12.72). The lower weight of pods plant$^{-1}$ of groundnut was observed in 28$^{th}$ MW sowing window (11.17 and 11.91). Similar results were observed by [2] who reported that in India, sowing of rainfed and irrigated crop early in the season provided favorable weather conditions for proper growth and yield of groundnut. Delay in sowing by one week from 17$^{th}$ July to 24$^{th}$ August resulted in linear decrease in pod yield of groundnut and number of mature pods plant$^{-1}$. Present findings agreed with Shantimalliah et al. [5] who showed that "pod yield of groundnut from early sowings was higher, and that groundnut could be sown up to the first fortnight of July without much reduction in yield". Similar results were reported by Lewin et al. [6]. "They concluded that the crop sown on second fortnight of June gave the highest yield followed by the crop sown on July 7".

### 3.2.3 Effects of interaction

The weight of pods plant$^{-1}$ of groundnut was significantly influenced by interaction between varieties and sowing windows during the year 2017 and 2018. Sowing at 26$^{th}$ MW sowing window ($S_2$) recorded maximum weight of pods plant$^{-1}$ (14.91 and 14.08) in variety JL-776 ($V_4$). This was followed by variety RHRG-6083 ($V_2$) (14.27 and 13.44), JL-501 ($V_1$) (13.08 and 12.25), and TAG-24 ($V_3$) (12.86 and 12.03) during the 2017 and 2018, respectively.

## 3.3 100-Kernel Weight (g)

The mean 100 kernel weight (g) was 35.23 and 32.33 g during the year 2017 and 2018 respectively.

**Table 1. Mean yield contributing characters of kharif groundnut as influenced by different treatments**

| Treatment | Number of pods plant$^{-1}$ | | | Weight of pods per plant$^{-1}$ | | | 100 kernel weight (g) | | | Shelling (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2017 | 2018 | Pooled | 2017 | 2018 | Pooled | 2017 | 2018 | Pooled | 2017 | 2018 | Pooled |
| **A) Main plot: Varieties** | | | | | | | | | | | | |
| $V_1$: JL-501 | 29.75$^{c}$ | 26.54$^{c}$ | 28.15$^{c}$ | 11.54$^{c}$ | 12.28$^{c}$ | 11.91$^{c}$ | 37.92$^{b}$ | 35.64$^{b}$ | 36.78$^{b}$ | 72.04$^{b}$ | 73.52$^{b}$ | 72.78$^{b}$ |
| $V_2$: RHRG-6083 | 38.42$^{b}$ | 35.21$^{b}$ | 36.81$^{b}$ | 12.61$^{b}$ | 13.44$^{b}$ | 13.02$^{b}$ | 31.92$^{c}$ | 29.64$^{c}$ | 30.78$^{c}$ | 69.83$^{c}$ | 71.31$^{c}$ | 70.57$^{c}$ |
| $V_3$: TAG-24 | 27.50$^{d}$ | 24.29$^{d}$ | 25.90$^{d}$ | 11.32$^{c}$ | 12.15$^{c}$ | 11.73$^{c}$ | 40.17$^{a}$ | 37.89$^{a}$ | 39.03$^{a}$ | 75.12$^{a}$ | 76.60$^{a}$ | 75.86$^{a}$ |
| $V_4$: JL-776 | 45.25$^{a}$ | 43.29$^{a}$ | 44.27$^{a}$ | 12.99$^{a}$ | 13.82$^{a}$ | 13.41$^{a}$ | 29.50$^{d}$ | 27.39$^{d}$ | 28.44$^{d}$ | 68.17$^{d}$ | 69.40$^{d}$ | 68.78$^{d}$ |
| S. E.± | 0.40 | 0.93 | 0.53 | 0.09 | 0.06 | 0.06 | 0.21 | 0.13 | 0.12 | 0.32 | 0.27 | 0.21 |
| C. D. at 5 % | 1.39 | 3.2 | 1.63 | 0.33 | 0.19 | 0.17 | 0.72 | 0.43 | 0.38 | 1.12 | 0.94 | 0.66 |
| **B) Sub plot: Sowing windows** | | | | | | | | | | | | |
| $S_1$: 25$^{th}$ MW | 32.42$^{c}$ | 29.21$^{c}$ | 30.81$^{c}$ | 11.89$^{c}$ | 12.72$^{c}$ | 12.30$^{c}$ | 33.73$^{c}$ | 31.45$^{c}$ | 32.59$^{c}$ | 70.63$^{c}$ | 72.11$^{c}$ | 71.37$^{c}$ |
| $S_2$: 26$^{th}$ MW | 41.42$^{a}$ | 38.21$^{a}$ | 39.81$^{a}$ | 12.95$^{a}$ | 13.78$^{a}$ | 13.36$^{a}$ | 38.98$^{a}$ | 36.70$^{a}$ | 37.84$^{a}$ | 73.40$^{a}$ | 74.88$^{a}$ | 74.14$^{a}$ |
| $S_3$: 27$^{th}$ MW | 37.83$^{b}$ | 34.62$^{b}$ | 36.23$^{b}$ | 12.45$^{b}$ | 13.28$^{b}$ | 12.86$^{b}$ | 35.98$^{b}$ | 33.70$^{b}$ | 34.84$^{b}$ | 71.62$^{b}$ | 73.10$^{b}$ | 72.36$^{b}$ |
| $S_4$: 28$^{th}$ MW | 29.25$^{d}$ | 27.29$^{d}$ | 28.27$^{d}$ | 11.17$^{d}$ | 11.91$^{d}$ | 11.54$^{d}$ | 30.81$^{d}$ | 28.70$^{d}$ | 29.76$^{d}$ | 69.50$^{d}$ | 70.73$^{d}$ | 70.12$^{d}$ |
| S. E.± | 0.41 | 0.79 | 0.43 | 0.08 | 0.06 | 0.05 | 0.41 | 0.79 | 0.43 | 0.08 | 0.06 | 0.05 |
| C. D. at 5 % | 1.2 | 2.31 | 1.23 | 0.24 | 0.17 | 0.14 | 1.2 | 2.31 | 1.23 | 0.24 | 0.17 | 0.14 |
| **C) Interaction (A×B)** | | | | | | | | | | | | |
| $S_1V_1$ | 25.12$^{gh}$ | 28.33$^{gh}$ | 26.73$^{gh}$ | 11.71$^{i}$ | 10.88$^{i}$ | 11.30$^{i}$ | 34.39$^{d}$ | 36.67$^{d}$ | 35.53$^{d}$ | 73.35$^{def}$ | 71.87$^{def}$ | 72.61$^{def}$ |
| $S_2V_1$ | 30.79$^{e}$ | 34.00$^{e}$ | 32.40$^{e}$ | 13.08$^{de}$ | 12.25$^{de}$ | 12.66$^{de}$ | 40.05$^{b}$ | 42.33$^{b}$ | 41.19$^{b}$ | 74.76$^{cd}$ | 73.28$^{cd}$ | 74.02$^{cd}$ |
| $S_3V_1$ | 27.79$^{f}$ | 31.00$^{f}$ | 29.40$^{f}$ | 12.35$^{gh}$ | 11.52$^{gh}$ | 11.94$^{gh}$ | 36.72$^{c}$ | 39.00$^{c}$ | 37.86$^{c}$ | 73.81$^{cde}$ | 72.33$^{cde}$ | 73.07$^{cde}$ |
| $S_4V_1$ | 22.46$^{i}$ | 25.67$^{i}$ | 24.06$^{i}$ | 11.45$^{i}$ | 10.62$^{i}$ | 11.04$^{i}$ | 31.39$^{e}$ | 33.67$^{e}$ | 32.53$^{e}$ | 72.15$^{fg}$ | 70.67$^{fg}$ | 71.41$^{fg}$ |
| $S_1V_2$ | 31.79$^{e}$ | 35.00$^{e}$ | 33.40$^{e}$ | 13.25$^{d}$ | 12.42$^{d}$ | 12.83$^{d}$ | 28.39$^{f}$ | 30.67$^{f}$ | 29.53$^{f}$ | 70.81$^{gh}$ | 69.33$^{gh}$ | 70.07$^{gh}$ |
| $S_2V_2$ | 42.46$^{c}$ | 45.67$^{c}$ | 44.06$^{c}$ | 14.27$^{b}$ | 13.44$^{b}$ | 13.86$^{b}$ | 34.05$^{d}$ | 36.33$^{d}$ | 35.19$^{d}$ | 72.48$^{efg}$ | 71.00$^{efg}$ | 71.74$^{efg}$ |
| $S_3V_2$ | 39.12$^{d}$ | 42.33$^{d}$ | 40.73$^{d}$ | 13.89$^{c}$ | 13.06$^{c}$ | 13.47$^{c}$ | 30.72$^{e}$ | 33.00$^{e}$ | 31.86$^{e}$ | 72.15$^{fg}$ | 70.67$^{fg}$ | 71.41$^{fg}$ |
| $S_4V_2$ | 27.46$^{fg}$ | 30.67$^{fg}$ | 29.06$^{fg}$ | 12.35$^{gh}$ | 11.52$^{gh}$ | 11.94$^{gh}$ | 25.39$^{gh}$ | 27.67$^{gh}$ | 26.53$^{gh}$ | 69.81$^{hi}$ | 68.33$^{hi}$ | 69.07$^{hi}$ |
| $S_1V_3$ | 22.79$^{hi}$ | 26.00$^{hi}$ | 24.40$^{hi}$ | 12.16$^{h}$ | 11.33$^{h}$ | 11.74$^{h}$ | 36.64$^{c}$ | 38.92$^{c}$ | 37.78$^{c}$ | 75.15$^{bc}$ | 73.67$^{bc}$ | 74.41$^{bc}$ |
| $S_2V_3$ | 27.12$^{fg}$ | 30.33$^{fg}$ | 28.73$^{fg}$ | 12.86$^{ef}$ | 12.03$^{ef}$ | 12.45$^{ef}$ | 42.30$^{a}$ | 44.58$^{a}$ | 43.44$^{a}$ | 80.48$^{a}$ | 79.00$^{a}$ | 79.74$^{a}$ |
| $S_3V_3$ | 25.12$^{gh}$ | 28.33$^{gh}$ | 26.73$^{gh}$ | 12.61$^{fg}$ | 11.78$^{fg}$ | 12.19$^{fg}$ | 38.97$^{b}$ | 41.25$^{b}$ | 40.11$^{b}$ | 76.64$^{b}$ | 75.16$^{b}$ | 75.90$^{b}$ |

| **Treatment** | **Number of pods plant$^{-1}$** | | | **Weight of pods per plant$^{-1}$** | | | **100 kernel weight (g)** | | | **Shelling (%)** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2017** | **2018** | **Pooled** | **2017** | **2018** | **Pooled** | **2017** | **2018** | **Pooled** | **2017** | **2018** | **Pooled** |
| $S_4V_3$ | 22.12$^{i}$ | 25.33$^{i}$ | 23.73$^{i}$ | 11.49$^{i}$ | 11.01$^{i}$ | 11.25$^{i}$ | 33.64$^{d}$ | 35.92$^{d}$ | 34.78$^{d}$ | 74.15$^{cd}$ | 72.67$^{cd}$ | 73.41$^{cd}$ |
| $S_1V_4$ | 37.12$^{d}$ | 40.33$^{d}$ | 38.73$^{d}$ | 13.76$^{c}$ | 12.93$^{c}$ | 13.34$^{c}$ | 26.39$^{g}$ | 28.67$^{g}$ | 27.53$^{g}$ | 69.15$^{i}$ | 67.67$^{i}$ | 68.41$^{i}$ |
| $S_2V_4$ | 52.46$^{a}$ | 55.67$^{a}$ | 54.06$^{a}$ | 14.91$^{a}$ | 14.08$^{a}$ | 14.50$^{a}$ | 30.39$^{e}$ | 32.67$^{e}$ | 31.53$^{e}$ | 71.81$^{fg}$ | 70.33$^{fg}$ | 71.07$^{fg}$ |
| $S_3V_4$ | 46.46$^{b}$ | 49.67$^{b}$ | 48.06$^{b}$ | 14.27$^{b}$ | 13.44$^{b}$ | 13.86$^{b}$ | 28.39$^{f}$ | 30.67$^{f}$ | 29.53$^{f}$ | 69.81$^{hi}$ | 68.33$^{hi}$ | 69.07$^{hi}$ |
| **$S_4V_4$** | 37.12$^{d}$ | 35.33$^{e}$ | 36.23$^{d}$ | 12.35$^{gh}$ | 11.52$^{gh}$ | 11.94$^{gh}$ | 24.39$^{h}$ | 26.00$^{h}$ | 25.19$^{h}$ | 66.81$^{j}$ | 66.33$^{j}$ | 66.57$^{j}$ |
| S. E.± | 0.82 | 1.58 | 0.86 | 0.17 | 0.12 | 0.10 | 0.82 | 1.58 | 0.86 | 0.17 | 0.12 | 0.10 |
| C. D. at 5% | 2.39 | 4.63 | 2.46 | 0.49 | 0.34 | 0.29 | 2.39 | 4.63 | 2.46 | 0.49 | 0.34 | 0.29 |
| General Mean | 35.23 | 32.33 | 33.78 | 12.11 | 12.92 | 12.52 | 35.23 | 32.33 | 33.78 | 71.76 | 72.00 | 71.76 |

*Note: Observations with same superscript are at par and with different superscript are significantly different*

#### 3.3.1 Effect of varieties

The 100-kernel weight (g) of groundnut was significantly higher (40.17 and 37.89) in TAG-24 ($V_3$) which was superior over rest of all varieties, followed by JL-501 ($V_1$) (37.92 and 35.64) and RHRG-6083 ($V_2$) (31.92 and 29.64). The variety JL-776 recorded significantly lower 100 kernel weight (g) (29.5 and 27.39). The difference in 100 kernel weight (g) of groundnut variety might be due to inherent genetical potential varieties.

#### 3.3.2 Effect of sowing windows

The 100-kernel weight (g) of groundnut was recorded highest at 26$^{th}$ MW sowing window (38.98 and 36.70) which was at par with 27$^{th}$ MW sowing window (35.98 and 33.70). This was followed by 25$^{rd}$ MW sowing window (33.73 and 31.45). The least 100 kernel weight (g) of groundnut was observed in 28$^{th}$ MW sowing window (30.81 and 28.70). Similar results were reported by Mane et al. [7] and Datke et al. [8].

#### 3.3.3 Effects of interaction

The 100-kernel weight (g) of groundnut was significantly influenced by interaction between varieties and sowing windows during the 2017 and 2018. Sowing at 26$^{th}$ MW sowing window ($S_2$) recorded maximum 100 kernel weight (g) of groundnut (42.30and 44.58) in variety TAG-24 ($V_3$). This was followed by variety JL-501 ($V_1$) (40.05 and 42.33), RHRG-6083 ($V_2$) (34.05 and 36.33), and JL-776 ($V_4$) (30.39 and 32.67) during the year 2017 and 2018, respectively.

### 3.4 Shelling (%)

The mean shelling (%) were (71.76 and 72.0%), during the year 2017 and 2018 respectively.

#### 3.4.1 Effect of varieties

The shelling (%) of groundnut was significantly higher (75.12 and 76.6) in TAG-24 ($V_3$) which was superior over rest of all varieties, followed by JL-501 ($V_1$) (72.04 and 73.52) and RHRG-6083 ($V_2$) (69.83 and 71.31). The variety JL-776 ($V_4$) recorded significantly lower shelling (%) (68.17 and 69.4) during the year 2017 and 2018, respectively. The difference in shelling (%) of groundnut variety might be due to inherent genetically potential of groundnut varieties.

#### 3.4.2 Effect of sowing windows

The shelling (%) of groundnut was recorded highest at 26$^{th}$ MW sowing window (73.40 and 74.88) which was at par with 27$^{th}$ MW sowing window (71.62 and 73.10). This was followed by 25$^{th}$ MW sowing window (70.63 and 72.11). The lower shelling (%) of groundnut was observed in 28$^{th}$ MW sowing window (69.50 and 70.73) during the year 2017 and 2018, respectively.

#### 3.4.3 Effects of interaction

The shelling (%) of groundnut was significantly influenced by interaction between varieties and sowing windows during the year 2017 and 2018. Sowing at 26$^{th}$ MW sowing window ($S_2$) recorded maximum Shelling (%) of groundnut (80.48 and 79.00) in variety TAG-24 ($V_3$). This was followed by variety JL-501 ($V_1$) (74.76 and 73.28), RHRG-6083 ($V_2$) (72.48 and 71.00), and JL-776 ($V_4$) (71.81 and 70.33) during the 2017 and 2018, respectively.

### 3.5 Yield Studies

Data in respect of mean pod yield and haulm yield of groundnut as influenced by different treatments are presented in Table 2.

#### 3.5.1 Pod Yield

The mean pod yield of groundnut was 24.32 and 25.71 q ha$^{-1}$ was recorded during the year 2017 and 2018, respectively.

*3.5.1.1 Effect of varieties*

The pod yield of groundnut was influenced significantly due to different groundnut varieties. The pod yield was significantly higher in JL-776 ($V_4$) (26.59 and 28.14 q ha$^{-1}$) which was significantly superior rest of the groundnut varieties. This was followed by RHRG-6083 ($V_2$) (25.75 and 27.13 q ha$^{-1}$), JL-501 ($V_1$) (22.75 and 24.08 q ha$^{-1}$). The variety TAG-24 recorded significantly lower pod yield (22.19 and 23.49 q ha$^{-1}$) during the year 2017 and 2018, respectively. The differences in pod yield of groundnut varieties might be due to inherent genetically potential of variety.

*3.5.1.2 Effect of sowing windows*

The pod yield of groundnut was influenced significantly due to extended sowing windows. The pod yield was maximum at 26$^{th}$ MW ($S_2$) sowing window (27.25 and 28.84 q ha$^{-1}$) and was at with 27$^{th}$ MW (25.89 and 27.27 q ha$^{-1}$). This was followed by 25$^{th}$ MW sowing window (23.35 and 24.72 q ha$^{-1}$) and 28$^{th}$ MW sowing window

(20.79 and 22.01 q ha$^{-1}$) during the year 2017 and 2018, respectively. A sowing window of 26$^{th}$ MW was favorable to maximum pod production because of favorable weather condition. Similar results were reported by Frimpong [9] and Banik et al. [10].

*3.5.1.3 Effects of interaction*

The pod yield (q ha$^{-1}$) was significantly influenced by interaction between varieties and sowing windows during the year 2017 and 2018. Sowing at 26$^{th}$ MW sowing window ($S_2$) recorded maximum pod yield (32.49 and 30.70 q ha$^{-1}$) in variety JL-776 ($V_4$). This was followed by variety RHRG-6083 ($V_2$) (29.96 and 28.30 q ha$^{-1}$), JL-501 ($V_1$) (26.86 and 25.38 q ha$^{-1}$), and TAG-24 ($V_3$) (26.04 and 24.60 q ha$^{-1}$) during the year 2017 and 2018, respectively. There results showed that delay in sowing of groundnut varieties could not able to assimilate the more biomass resulted in reduced pod yield of groundnut.

### 3.5.2 Haulm yield

Data with respect to mean haulm yield of groundnut as influenced by different treatments are presented in Table 2. The mean haulm yield of groundnut was 36.24 and 33.49 qha$^{-1}$ during the year 2017 and 2018, respectively.

**Table 2. Mean pod yield and haulm yield (q ha-1) of kharif groundnut as influenced by different treatments**

| Treatment | Pod yield (q ha$^{-1}$) | | | Haulm yield (q ha$^{-1}$) | | |
|---|---|---|---|---|---|---|
| | **2017** | **2018** | **Pooled** | **2017** | **2018** | **Pooled** |
| **A) Main plot: Varieties** | | | | | | |
| $V_1$: JL-501 | 22.75$^c$ | 24.08$^c$ | 23.42$^c$ | 33.90$^c$ | 31.41$^c$ | 32.65$^c$ |
| $V_2$: RHRG-6083 | 25.75$^b$ | 27.13$^b$ | 26.44$^b$ | 38.37$^b$ | 35.23$^b$ | 36.80$^b$ |
| $V_3$: TAG-24 | 22.19$^d$ | 23.49$^d$ | 22.84$^d$ | 33.07$^d$ | 30.64$^d$ | 31.85$^d$ |
| $V_4$: JL-776 | 26.59$^a$ | 28.14$^a$ | 27.36$^a$ | 39.61$^a$ | 36.70$^a$ | 38.16$^a$ |
| S. E.± | 0.4 | 0.43 | 0.29 | 0.6 | 0.55 | 0.42 |
| C. D. at 5 % | 1.39 | 1.47 | 0.91 | 2.08 | 1.92 | 1.29 |
| **B) Sub plot: Sowing windows** | | | | | | |
| $S_1$: 25$^{th}$ MW | 23.35$^c$ | 24.72$^c$ | 24.03$^c$ | 34.80$^c$ | 32.24$^c$ | 33.52$^c$ |
| $S_2$: 26$^{th}$ MW | 27.25$^a$ | 28.84$^a$ | 28.04$^a$ | 40.60$^a$ | 37.61$^a$ | 39.11$^a$ |
| $S_3$: 27$^{th}$ MW | 25.89$^b$ | 27.27$^b$ | 26.58$^b$ | 38.57$^b$ | 35.41$^b$ | 36.99$^b$ |
| $S_4$: 28$^{th}$ MW | 20.79$^d$ | 22.01$^d$ | 21.40$^d$ | 30.98$^d$ | 28.71$^d$ | 29.85$^d$ |
| S. E.± | 0.22 | 0.23 | 0.16 | 0.33 | 0.3 | 0.21 |
| C. D. at 5 % | 0.64 | 0.68 | 0.45 | 0.95 | 0.88 | 0.61 |
| **C) Interaction (A×B)** | | | | | | |
| $S_1V_1$ | 23.26$^i$ | 21.98$^i$ | 22.62$^i$ | 30.34$^i$ | 32.75$^i$ | 31.55$^i$ |
| $S_2V_1$ | 26.86$^e$ | 25.38$^e$ | 26.12$^e$ | 35.04$^e$ | 37.82$^e$ | 36.43$^e$ |
| $S_3V_1$ | 25.22$^g$ | 23.83$^g$ | 24.53$^g$ | 32.90$^g$ | 35.51$^g$ | 34.20$^g$ |
| $S_4V_1$ | 20.97$^k$ | 19.81$^k$ | 20.39$^k$ | 27.35$^k$ | 29.52$^k$ | 28.44$^k$ |
| $S_1V_2$ | 26.24$^f$ | 24.79$^f$ | 25.51$^f$ | 34.22$^f$ | 36.94$^f$ | 35.58$^f$ |
| $S_2V_2$ | 29.96$^c$ | 28.30$^c$ | 29.13$^c$ | 39.08$^c$ | 42.17$^c$ | 40.62$^c$ |
| $S_3V_2$ | 28.40$^d$ | 27.31$^d$ | 27.86$^d$ | 36.41$^d$ | 40.69$^d$ | 38.55$^d$ |
| $S_4V_2$ | 23.91$^h$ | 22.59$^h$ | 23.25$^h$ | 31.19$^h$ | 33.67$^h$ | 32.43$^h$ |
| $S_1V_3$ | 22.47$^j$ | 21.23$^j$ | 21.85$^j$ | 29.31$^j$ | 31.64$^j$ | 30.48$^j$ |
| $S_2V_3$ | 26.04$^f$ | 24.60$^f$ | 25.32$^f$ | 33.97$^f$ | 36.66$^f$ | 35.31$^f$ |
| $S_3V_3$ | 24.94$^g$ | 23.57$^g$ | 24.26$^g$ | 32.54$^g$ | 35.12$^g$ | 33.83$^g$ |
| $S_4V_3$ | 20.51$^k$ | 19.37$^k$ | 19.94$^k$ | 26.75$^k$ | 28.87$^k$ | 27.81$^k$ |
| $S_1V_4$ | 26.89$^e$ | 25.41$^e$ | 26.15$^e$ | 35.08$^e$ | 37.86$^e$ | 36.47$^e$ |
| $S_2V_4$ | 32.49$^a$ | 30.70$^a$ | 31.59$^a$ | 42.38$^a$ | 45.74$^a$ | 44.06$^a$ |
| $S_3V_4$ | 30.52$^b$ | 28.84$^b$ | 29.68$^b$ | 39.81$^b$ | 42.97$^b$ | 41.39$^b$ |
| $S_4V_4$ | 22.65$^j$ | 21.40$^j$ | 22.02$^j$ | 29.54$^j$ | 31.88$^j$ | 30.71$^j$ |
| S. E.± | 0.44 | 0.46 | 0.32 | 0.65 | 0.61 | 0.43 |
| C. D. at 5% | 1.28 | 1.36 | 0.90 | 1.91 | 1.77 | 1.21 |
| General Mean | 24.32 | 25.71 | 25.01 | 36.24 | 33.49 | 34.87 |

*Note: Observations with same superscript are at par and with different superscript are significantly different*

*3.5.2.1 Effect of varieties*

The haulm yield of groundnut was influenced significantly due to groundnut varieties. The haulm yield was significantly higher in JL-776 ($V_4$) (39.61 and 36.7 qha$^{-1}$) and significantly superior rest of the groundnut varieties. This was followed by RHRG-6083 ($V_2$) (38.37 and 35.23 q ha$^{-1}$), JL-501 ($V_1$) (33.9 and 31.41 q ha$^{-1}$). The variety TAG-24 recorded significantly lower haulm yield (33.07 and 30.64 qha$^{-1}$) during the year 2017 and 2018, respectively. The differences in haulm yield of groundnut varieties might be due to inherent genetically potential of groundnut variety.

*3.5.2.2 Effect of sowing windows*

The haulm yield of groundnut was influenced significantly due to extended sowing windows. The haulm yield was maximum at 26$^{th}$ MW sowing window (40.60 and 37.61 q ha$^{-1}$), this was followed by 27$^{th}$ MW (38.57 and 35.41 q ha$^{-1}$) were at par with 25$^{th}$ MW sowing window. This was followed by 25$^{th}$ MW sowing window (34.80 and 32.24 q ha$^{-1}$) and 28$^{th}$ MW sowing window (30.98 and 28.71 q ha$^{-1}$) during the year 2017 and 2018, respectively. A sowing window of 26$^{th}$ MW was favorable to high haulm production because of favorable weather condition. The results are similar to those reported by Ntare et al. [11] and Bala et al. [12].

*3.5.2.3 Effects of interaction*

The haulm yield (q ha$^{-1}$) was significantly influenced by interaction between varieties and sowing windows during the year 2017 and 2018. Sowing at 26$^{th}$ MW sowing window ($S_2$) recorded maximum haulm yield (42.38 and 45.74 q ha$^{-1}$) in variety JL-776 ($V_4$). This was followed by variety RHRG-6083 ($V_2$) (39.08 and 42.17 q ha$^{-1}$), JL-501 ($V_1$) (35.04 and 37.82 q ha$^{-1}$) and TAG-24 ($V_3$) (33.97 and 36.66 q ha$^{-1}$) during the year 2017 and 2018, respectively. These results showed that delay in sowing of groundnut varieties could not able to assimilate the more biomass resulted in reduced haulm yield of groundnut.

## 4. CONCLUSIONS

The yield contributing characters viz., number of pods$^{-1}$ and weight of pods$^{-1}$ were found significantly higher in variety JL-776 over RHRG-6083, JL-501 and TAG-24, whereas shelling percentage were found significantly higher in variety TAG-24 over, JL-501, JL-776 and RHRG-6083. Pod and haulm yield were significantly higher in variety in JL-776 followed by RHRG-6083, JL-501 and TAG-24. Number of pod plant$^{-1}$, weight of pods plant$^{-1}$, 100 kernal weight and shelling percentage during 2017 and 2018, respectively which were observed significantly higher in 26$^{th}$MW ($S_2$) sowing window, which were at par with the 27$^{th}$ MW values in all the yield attributes. Pod and haulm yield were higher in 26$^{th}$ MW sowing window during the year 2017 and 2018, respectively, which were at par with 27$^{th}$ MW sowing window. Amongst all the groundnut varieties, JL-776 (Phule Bharati) variety found significantly superior under extended sowing windows followed by varieties RHRG-6083, TAG-24 and JL-501. Sowing during 26$^{th}$ MW was observed to be most suitable and optimum for groundnut considering the growth and yield attributes. This sowing window was at par with 27$^{th}$ MW sowing window.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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