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# New Narrow Inter-Row Spacing for Maximizing Groundnut Yield under Rain-Fed Conditions of North Kordofan State, Sudan

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**Abstract:** *The experiment was conducted for three consecutive seasons (2013, 2014 and 2015), at Elobeid Research Station research farm ($12^o$ -$13^o$ N, $3^o$-$14^o$ E), under rain fed conditions, to study the effect of plant spacing on hay and pod yield of groundnut variety Geibish. Six treatment combinations (60, 40 and 30 for inter-row and 20 and 15 for intra-row spacing) were laid out in a randomized complete block design (RCBD) factorial with four replications. Days to fifty percent flowering were significant in season 2014 and 2015. The earliest flowering days were recorded for the spacing of 30×20 cm. reducing plant spacing from 60×20 cm to 30×20 cm decreased the number of weeds before first and second weeding to 50%. High significant difference (P ≤ 5) among treatments in hay and pod yield of 2643.5 kg/ha and2065.0 kg/ha were recorded for the spacing of 30×20cm, respectively, the treatment combination of 30×20 cm increased the pods 66.1% and hay yield 52.2% on average across all season. Significant differences (P ≤5) were showed between treatments in number of pods per plant and number of seeds per pod for enter row. No significant differences (P ≤5) were observed between treatments in shelling percent, maturity, harvest index*

**Keywords:** *Arashis hypogaea , plant spacing, peanut*

## 1. INTRODUCTION

Groundnut, or peanuts (*Arashis hypogaea* L.*)*, is very important oilseed crop grown in more than 100 countries of the tropics and sub-tropical parts of the world. The total annual world production of unshelled nuts amounts to about 28 million tons where India, China and U.S.A produce almost 65% of the world production. Other major groundnut producing countries include Nigeria, Senegal, Sudan and Indonesia (Osman, 2003).

In the Sudan, groundnut is an important oil and cash crop grown in large areas under rain fed conditions with an annual cultivated area exceeds 1.5 million hectares (MAARD, Annual Surveys, 2005-2015). Groundnut production is not only confined to the rain fed sector as it is also grown under irrigation in the central clay plains. However, about 80% of the area and two third of the national production comes from the traditional rain fed sector of western Sudan. In North Kordofan State, groundnut ranks fifth after pearl millet, sorghum, sesame and field watermelon (El Naim et al, 2010)). Barberton, Sodiri and Gubiesh, are widely grown varieties however, the lasted released variety "Gubeish" is dominating due to its early maturity and high pod yield. However, yields under rain fed conditions of North Kordofan State are normally very low (El Naim et al, 2011). Variety improvement needs to be complimented with proper management packages so that better yields can be obtained under rain fed conditions. Plant Spacing is the most important management option for increasing yield through increasing plant population per unit area. Proper plant spacing in row is necessary to maintain the required plant population number without hampering the intercultural operations like weeding and harvesting. Improper plant spacing and plant density affect the normal physiological activities of the crop (Ref). In densely populated crop, the inter-specific competition between the plants is high whereas wide plant spacing leads to low yield resulted from uneconomic utilization of resources (water and nutrients). Decreasing or narrowing row spacing from 80 to 40 to 20 cm and high plant population density have resulted in maximum or optimum yields of groundnuts,

(Buchana, *et.al* 1980). Therefore, the objective of this study was to evaluate yield performance of Gibeish the latest released groundnut variety in response to different inters and intra row spacing combinations for maximizing yield under rain-fed conditions of North Kordofan State.

## 2. Material And Methods

The experiment was conducted using the variety "Gubeish" under rain fed conditions for three consecutive seasons (2013, 2014 and 2015), at Elobeid Research Station field ($12^o$ -$13^o$ N, $3^o$-$14^o$ E). The spacing treatment combinations obtained from 60, 40 and 30 inter row and 20 and 15 cm between holes (Intra row spacing) were applied, with two seeds per hole. Treatments were laid out in a randomized complete block design (RCBD) factorial with four replications. Seeds were treated with Apronstar-40 at a rate of 3g/kg of seeds before sowing to prevent fungal diseases and insect damage. Sowing dates were 20, 17 and 22$^{th}$ July in season 2013, 2014, and 2015, respectively. Weeding was done twice, after two weeks, and four weeks from sowing in each season. The crop was harvested after 85 days. The amount of rain fall (mm**)** received each year is shown in Table 1. Data collected included days to flowering% (Days to 50% flowering), population (number of plants/plot at harvest time), and Yield and its components (Number of pods per plant, Number of seeds per pod, 100-seed weight, days to maturity (%) after 85 days from sowing calculated from 10 random plants as the percent of the number of mature pod over total number of pods, shelling (%), pods yield/hectare (kg/ha, and hay yield per plot. Harvest index (%) was calculated from the economical yield (Pod) divided by the total biological yield **(**Hay yield+ pod yield). Single and combined of tow way analyses of variance (ANOVA) were carried out using MSTAT- C computer program. LSD was used to separate means.

**Table1.** *The amount rainfall (mm) during study periods*

| Month | 2013 | 2014 | 2015 |
|---|---|---|---|
| May | 22.5 | 0 | 0 |
| June | 56.9 | 35 | 0 |
| July | 162.7 | 78.5 | 25.0 |
| August | 393.4 | 80.0 | 62.0 |
| September | 15.0 | 71.0 | 110.0 |
| October | 2.0 | 0.0 | 23.0 |
| Total | 652.5 | 264.5 | 220.0 |

## 3. Results And Discussion

Fifty percent flowering, population at harvest, number of weeds recorded before the first and second weeding, and yield and its components for single and combined of two ways analysis are showed in Tables 2 to 4. Fifty percent flowering was significant (P< 5) in seasons 2014 and 2015, the earliest flowering days were recorded for the plant spacing of 30×20 cm. reducing spacing from 60×20 cm to 30×20 cm decreased the number of weeds before the first and the second weeding and the cost of weeding was reduced to 50%. Cultivation of groundnut in narrow rows lead to maintenance of a complete crop cover over the soil which effectively inhibited weed germination and reduces the cost of weeding a finding earlier reported by (Lee *et al*., 1994). Early canopy closure by closely spaced groundnut crop has also been shown to smother weeds hence reducing weed/crop competition, especially for soil nutrients and water (Thellen, 2006). Such benefits are more evident under low input conditions as seen on most smallholder farms. Several workers have reported higher yields in close spaced compared to wide spaced groundnut systems (Mickelson and Renner, 1997; Ahmad *et al*., 2007), which may have been attributed to higher plant population densities that effectively utilize water, nutrients and perhaps more importantly light (Wells *et al*., 1993). Cultural weed control method involves the combination of various farming practices to reduce weed growth and at the same time encourage the growth of crops using techniques such as crop rotation, spacing, land preparation, mulching, and intercropping, (Akobundu, 1987; Bakht *et al*., 2009). However, these cultural farming practices were not originally aimed at weed control but they control weeds when undertaken (Ansa and Iyagba, 1999). The closely spaced groundnut covered the ground earlier than widely spaced crops thus suppressing weeds. This is result is in line with the explanation given by Brown *et al*. (2005) and Tillman *et al*. (2006) who reported that crops planted at shorter planting distance attain full canopy coverage earlier than widely spaced crops.

**Table2.** *Effect of inter and intra-row spacing on days to 50 % flowering of groundnut*

| | Season | | | |
|---|---|---|---|---|
| | **2013** | **2014** | **2015** | **combined** |
| Inter row | | | | |
| 60 cm | 22.6 | 24.1 | 23.3 | 23.3 |
| 40 cm | 22.1 | 23.8 | 22.8 | 22.9 |
| 30 cm | 21.1 | 22.9 | 22.3 | 22.1 |
| S.E.± | $0.43^{ns}$ | 0.24* | $0.27^{ns}$ | 0.19** |
| Intra row | | | | |
| 20 cm | 21.9 | 23.7 | 23.0 | 22.9 |
| 15 cm | 22.0 | 23.5 | 22.5 | 22.7 |
| S.E.± | $0.35^{ns}$ | $0.20^{ns}$ | $0.22^{ns}$ | $0.15^{ns}$ |
| Interaction | | | | |
| 60×20 cm | 22.5 | 24.0 | 23.5 | 22.9 |
| 60×15 cm | 22.8 | 24.3 | 23.0 | 22.0 |
| 40×20 cm | 22.3 | 24.0 | 22.3 | 23.0 |
| 40×15 cm | 22.0 | 23.5 | 23.3 | 22.5 |
| 30×20 cm | 21.0 | 23.0 | 23.3 | 23.7 |
| 30×15 cm | 21.3 | 22.7 | 21.3 | 23.5 |
| S.E.± | $0.60^{ns}$ | 0.34** | 0.38** | $0.26^{ns}$ |
| C.V | 5.5 | 2.9 | 3.3 | 4.0 |

**Table3.** *Effect of inter and intra-row spacing on the number of weeds/$m^2$before first and second weeding of groundnut*

| | **Number of weeds before first weeding** | | | | **Number of weeds before second weeding** | | | |
|---|---|---|---|---|---|---|---|---|
| | **2013** | **2014** | **2015** | **combined** | **2013** | **2014** | **2015** | **combined** |
| Inter row | | | | | | | | |
| 60 cm | 67.0 | 63.0 | 58.6 | 62.9 | 22.3 | 35.9 | 11.3 | 23.1 |
| 40 cm | 43.1 | 34.1 | 39.2 | 38.9 | 17.5 | 31.1 | 8.8 | 19.1 |
| 30 cm | 36.3 | 25.8 | 27.5 | 29.8 | 12.0 | 26.8 | 7.4 | 15.4 |
| S.E.± | 2.88** | 1.94** | 1.0** | 1.20** | 1.52** | 1.43** | 0.47** | 0.71** |
| Intra row | | | | | | | | |
| 20 cm | 51.3 | 44.9 | 45.5 | 47.3 | 18.7 | 31.3 | 9.8 | 19.9 |
| 15 cm | 46.3 | 37.0 | 38.2 | 40.5 | 15.8 | 31.3 | 8.5 | 18.5 |
| S.E.± | $2.35^{ns}$ | 1.58** | 0.82** | 0.98** | $1.24^{ns}$ | $1.16^{ns}$ | 0.38* | $0.58^{ns}$ |
| Interaction | | | | | | | | |
| 60×20 cm | 70.5 | 67.0 | 61.0 | 51.3 | 25.8 | 36.3 | 11.3 | 24.4 |
| 60×15 cm | 63.5 | 59.0 | 56.3 | 46.3 | 18.8 | 35.5 | 11.3 | 21.8 |
| 40×20 cm | 45.0 | 37.8 | 44.0 | 45.5 | 17.5 | 29.3 | 9.3 | 18.7 |
| 40×15 cm | 41.3 | 30.5 | 34.8 | 38.1 | 17.5 | 33.0 | 8.3 | 19.6 |
| 30×20 cm | 38.5 | 30.0 | 31.5 | 44.9 | 12.8 | 28.3 | 8.8 | 16.6 |
| 30×15 cm | 34.0 | 21.5 | 23.5 | 37.0 | 11.3 | 25.3 | 8.0 | 14.2 |
| S.E.± | $4.1^{ns}$ | $2.74^{ns}$ | $1.42^{ns}$ | $1.70^{ns}$ | $2.15^{ns}$ | $2.0^{ns}$ | $0.66^{ns}$ | $1.0^{ns}$ |
| C.V | 16.7 | 12.9 | 6.8 | 13.5 | 24.9 | 12.9 | 14.6 | 18.2 |

**Table4.** *Effect of inter and intra-row spacing on population of plants/ ha of groundnut*

| **Treatments** | **2013** | **2014** | **2015** | **combined** |
|---|---|---|---|---|
| Inter row | | | | |
| 60 cm | 172895.8 | 211875.0 | 205555.6 | 196775.5 |
| 40 cm | 288333.3 | 320937.5 | 264321.5 | 291197.4 |
| 30 cm | 389583.3 | 400833.3 | 398611.1 | 396342.8 |
| S.E.± | 1077.9** | 15873.7** | 8891.0** | 7048.9** |
| Intra row | | | | |
| 20 cm | 237034.7 | 245833.3 | 295727.5 | 259531.9 |
| 15 cm | 330173.6 | 376597.2 | 283264.6 | 330011.8 |
| S.E.± | 8800.1** | 12960.8** | $7259.5^{ns}$ | 5755.4** |
| Interaction | | | | |
| 60×20 cm | 126624.9 | 164166.6 | 209722.2 | 166838.0 |
| 60×15 cm | 219166.6 | 259583.3 | 201388.9 | 226713.0 |

| | | | | |
|---|---|---|---|---|
| 40×20 cm | 244479.1 | 245000.0 | 263571.4 | 251016.9 |
| 40×15 cm | 332187.5 | 396875.0 | 265071.6 | 331378.0 |
| 30×20 cm | 340000.0 | 328333.3 | 413888.9 | 360740.7 |
| 30×15 cm | 439166.6 | 523333.3 | 383333.3 | 431944.4 |
| S.E.± | 15242.3$^{ns}$ | 22448.8$^{ns}$ | 12573.8$^{ns}$ | 9968.7$^{ns}$ |
| C.V | 10.75 | 3.7 | 8.7 | 11.7 |

### 3.1. Yield and Yield Component of Treatments

Yield and its component are presented in Tables 5 to 8. There were significant differences among treatments in hay and pod yield where the highest hay and pod yields were recorded under the spacing 30×20cm. The combined increments over all seasons were 66.1% in pod yield and 52.2% in hay yield, significant differences among treatment due to enter rows, interaction were observed in pod yield just in combined analysis. Significant differences (P ≤5) were showed between treatments in number of pods per plant and number of seeds per pod for enter row. No significant Differences among treatments in shelling percent, maturity, harvest index. These results were reported earlier by Akpalu *et al*. (2012) in Bambara groundnut and that of Ansa and Adesina, (1998) in cowpea where they reported that more closely spaced plants at 25 by 25 cm recorded the highest yield. Several authors have reported that decreasing or narrowing row spacing from 80 to 40 to 20 cm (Buchana, 1980) and higher plant population density from 22 to 33 plants $m^2$ (Mercer, 1972); 18 to 30 plants $m^2$ (Roy RC, *et, al* 1980); 4 to 12 to 24 plants $m^2$ (Wright GC, *et. al* 1992) and 3.7 to 16.6 plants $m^2$ (Mayeux A, *et, al* 1989) have resulted in maximum or optimum yields of groundnuts.

**Table5.** *Effect of inter and intra-row spacing on shelling% and maturity % of groundnut*

| | **Shelling %** | | | | **Maturity** | | | |
|---|---|---|---|---|---|---|---|---|
| | **2013** | **2014** | **2015** | **combined** | **2013** | **2014** | **2015** | **combined** |
| Inter row | | | | | | | | |
| 60 cm | 60.3 | 61.4 | 29.3 | 50.3 | 81.3 | 85.0 | 86.0 | 84.4 |
| 40 cm | 56.3 | 68.5 | 35.2 | 53.3 | 80.0 | 85.3 | 85.3 | 83.5 |
| 30 cm | 60.5 | 61.4 | 37.5 | 53.1 | 79.8 | 85.8 | 84.8 | 83.1 |
| S.E.± | 1.80$^{ns}$ | 2.9$^{ns}$ | 2.90$^{ns}$ | 1.48$^{ns}$ | 1.79$^{ns}$ | 1.38$^{ns}$ | 1.38$^{ns}$ | 0.88$^{ns}$ |
| Intra row | | | | | | | | |
| 20 cm | 58.0 | 66.0 | 31.7 | 51.9 | 79.7 | 85.2 | 85.8 | 83.6 |
| 15 cm | 60.0 | 61.6 | 36.3 | 52.6 | 81.0 | 82.3 | 85.2 | 83.8 |
| S.E.± | 1.50$^{ns}$ | 2.35$^{ns}$ | 2.34$^{ns}$ | 1.21$^{ns}$ | 1.45$^{ns}$ | 1.13$^{ns}$ | 1.13$^{ns}$ | 0.72$^{ns}$ |
| Interaction | | | | | | | | |
| 60×20 cm | 58.9 | 66.6 | 26.1 | 58.9 | 82.0 | 86.0 | 86.0 | 84.7 |
| 60×15 cm | 61.8 | 56.2 | 32.4 | 61.8 | 80.5 | 85.0 | 86.0 | 84.2 |
| 40×20 cm | 53.8 | 66.0 | 34.7 | 53.8 | 82.0 | 86.0 | 86.0 | 83.0 |
| 40×15 cm | 58.7 | 71.0 | 35.7 | 58.7 | 80.5 | 84.5 | 84.5 | 84.0 |
| 30×20 cm | 61.3 | 65.3 | 34.4 | 61.3 | 77.0 | 85.5 | 84.5 | 83.0 |
| 30×15 cm | 59.6 | 57.5 | 40.7 | 59.6 | 83.0 | 85.0 | 85.0 | 83.2 |
| S.E.± | 2.54$^{ns}$ | 4.1$^{ns}$ | 4.1$^{ns}$ | 2.1$^{ns}$ | 2.51$^{ns}$ | 1.94$^{ns}$ | 1.96$^{ns}$ | 1.25$^{ns}$ |
| **C.V** | 8.6 | 12.7 | 23.9 | 13.9 | 6.3 | 6.6 | 4.6 | 5.1 |

**Table6.** *Effect of inter and intra-row spacing on 100 seed weight and harvest index of treatment season 2013 t0 2015*

| | **100 seed weight (g)** | | | | **Harvest index (%)** | | | |
|---|---|---|---|---|---|---|---|---|
| | **2013** | **2014** | **2015** | **combined** | **2013** | **2014** | **2015** | **combined** |
| Inter row | | | | | | | | |
| 60 cm | 34.2 | 38.8 | 38.5 | 37.2 | 36.7 | 44.7 | 57.1 | 46.2 |
| 40 cm | 32.9 | 38.9 | 37.7 | 37.3 | 32.9 | 43.1 | 53.8 | 43.3 |
| 30 cm | 32.8 | 37.4 | 36.1 | 35.5 | 31.6 | 40.1 | 52.7 | 41.5 |
| S.E.± | 0.72$^{ns}$ | 0.98** | 0.83** | 0.49$^{ns}$ | 1.40* | 1.62$^{ns}$ | 2.10$^{ns}$ | 1.0$^{ns}$ |
| Intra row | | | | | | | | |
| 20 cm | 32.7 | 39.6 | 37.7 | 36.7 | 35.0 | 43.3 | 56.3 | 44.9 |
| 15 cm | 33.9 | 37.2 | 38.7 | 36.6 | 32.4 | 42.0 | 52.8 | 42.4 |
| S.E.± | 0.59$^{ns}$ | 0.80$^{ns}$ | 0.68$^{ns}$ | 0.40$^{ns}$ | 1.15$^{ns}$ | 1.32$^{ns}$ | 1.72$^{ns}$ | 0.81$^{ns}$ |
| Interaction | | | | | | | | |
| 60×20 cm | 35.0 | 41.0 | 37.8 | 37.9 | 38.6 | 47.4 | 59.8 | 48.6 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 60×15 cm | 33.5 | 36.7 | 39.3 | 36.5 | 34.8 | 42.0 | 54.4 | 43.7 |
| 40×20 cm | 32.5 | 39.3 | 41.1 | 37.6 | 34.9 | 40.6 | 51.7 | 42.4 |
| 40×15 cm | 33.3 | 38.6 | 38.7 | 36.9 | 30.9 | 45.7 | 56.1 | 44.2 |
| 30×20 cm | 30.7 | 38.4 | 34.3 | 34.5 | 31.7 | 41.8 | 57.6 | 43.7 |
| 30×15 cm | 34.9 | 36.4 | 37.9 | 36.4 | 31.5 | 38.4 | 47.9 | 39.3 |
| S.E.± | 1.0* | 1.39$^{ns}$ | 1.17$^{ns}$ | 0.70$^{ns}$ | 2.0$^{ns}$ | 2.29$^{ns}$ | 2.98$^{ns}$ | 1.42$^{ns}$ |
| C.V | 6.1 | 7.2 | 6.1 | 6.6 | 11.8 | 10.7 | 10.9 | 11.3 |

**Table7.** *Effect of inter and intra-row spacing on number of pods per plant and seeds per pods of groundnut*

| | Number of pods per plant | | | | Number of seeds per pods | | | |
|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | combined | 2013 | 2014 | 2015 | combined |
| **Inter row** | | | | | | | | |
| **60 cm** | 33.8 | 35.5 | 37.6 | 35.7 | 1.84 | 1.93 | 1.92 | 1.89 |
| **40 cm** | 31.0 | 32.8 | 32.1 | 32.0 | 1.82 | 1.93 | 1.93 | 1.90 |
| **30 cm** | 31.8 | 37.6 | 35.8 | 35.0 | 1.84 | 1.90 | 1.89 | 1.87 |
| **S.E.±** | 2.0$^{ns}$ | 1.54* | 1.43* | 0.97* | 0.009$^{ns}$ | 0.010** | 0.009** | 0.005** |
| **Intra row** | | | | | | | | |
| **20 cm** | 32.6 | 35.8 | 35.1 | 34.5 | 1.82 | 1.92 | 1.92 | 1.89 |
| **15 cm** | 31.8 | 34.8 | 35.2 | 34.0 | 1.84 | 1.91 | 1.91 | 1.89 |
| **S.E.±** | 1.70$^{ns}$ | 1.26$^{ns}$ | 1.17$^{ns}$ | 0.79$^{ns}$ | 0.008$^{ns}$ | 0.007$^{ns}$ | 0.007$^{ns}$ | 0.004$^{ns}$ |
| **Interaction** | | | | | | | | |
| **60×20 cm** | 34.2 | 34.3 | 39.0 | 35.8 | 1.82 | 1.92 | 1.92 | 1.89 |
| **60×15 cm** | 33.5 | 36.8 | 36.3 | 35.5 | 1.85 | 1.94 | 1.93 | 1.84 |
| **40×20 cm** | 32.5 | 34.8 | 32.0 | 33.1 | 1.80 | 1.94 | 1.94 | 1.92 |
| **40×15 cm** | 29.5 | 30.8 | 32.3 | 30.8 | 1.83 | 194 | 1.94 | 1.91 |
| **30×20 cm** | 31.0 | 38.3 | 34.3 | 34.5 | 1.84 | 1.92 | 1.91 | 1.92 |
| **30×15 cm** | 32.5 | 37.0$^{ns}$ | 37.3 | 35.6 | 1.84 | 1.92 | 1.88 | 1.91 |
| **S.E.±** | 2.86$^{ns}$ | 2.17 | 2.0$^{ns}$ | 1.38 | 0.014$^{ns}$ | 0.013$^{ns}$ | 0.012$^{ns}$ | 0.007 $^{ns}$ |
| **C.V** | 17.8 | 12.3 | 11.5 | 13.9$^{ns}$ | 3.2 | 2.4 | 1.3 | 1.36 |

**Table8.** *Effect of inter and intra-row spacing on hay and pod yield of groundnut*

| | **Hay yield (kg/ha)** | | | | **Pod yield (kg/ha)** | | | |
|---|---|---|---|---|---|---|---|---|
| | **2013** | **2014** | **2015** | **combined** | **2013** | **2014** | **2015** | **combined** |
| Inter row | | | | | | | | |
| 60 cm | 1600.0 | 1458.3 | 1208.3 | 1422.2 | 907.6 | 1203.1 | 1604.2 | 1238.3 |
| 40 cm | 2265.6 | 2234.4 | 1669.7 | 2056.6 | 1148.7 | 1718.8 | 1964.3 | 1610.6 |
| 30 cm | 2885.4 | 2735.4 | 2305.5 | 2642.1 | 1349.9 | 1927.1 | 2444.4 | 1907.1 |
| S.E.± | 147.1** | 76.0** | 84.0** | 61.9** | 112.4* | 136.6** | 163.7** | 80.3** |
| Intra row | | | | | | | | |
| 20 cm | 2063.2 | 2225.7 | 1677.2 | 1988.7 | 1103.1 | 1692.7 | 2075.4 | 1623.8 |
| 15 cm | 2437.5 | 2059.7 | 1778.4 | 2091.9 | 1167.7 | 1539.9 | 1933.2 | 1546.9 |
| S.E.± | 120.1* | 62.0$^{ns}$ | 68.6 $^{ns}$ | 50.5$^{ns}$ | 91.8$^{ns}$ | 111.5$^{ns}$ | 133.6$^{ns}$ | 65.6$^{ns}$ |
| Interaction | | | | | | | | |
| 60×20 cm | 1554.2 | 1416.6 | 1166.7 | 1379.1 | 939.1 | 1302.1 | 1736.1 | 1325.8 |
| 60×15 cm | 1645.8 | 1500.0 | 1250.0 | 1465.3 | 876.2 | 1104.2 | 1472.2 | 1150.9 |
| 40×20 cm | 1968.8 | 2250.0 | 1642.9 | 1943.4 | 1126.5 | 1546.9 | 1767.8 | 1480.4 |
| 40×15 cm | 2562.5 | 2218.8 | 1696.4 | 2169.6 | 1170.8 | 1890.6 | 2160.7 | 1740.7 |
| 30×20 cm | 2666.7 | 3041.7 | 2222.2 | 2643.5 | 1243.7 | 2229.2 | 2722.2 | 2065.0 |
| 30×15 cm | 3104.2 | 2429.2 | 2388.8 | 2640.7 | 1456.0 | 1625.0 | 2166.7 | 1749.2 |
| S.E.± | 208.0$^{ns}$ | 107.5$^{ns}$ | 118.8 $^{ns}$ | 87.5$^{ns}$ | 159.0$^{ns}$ | 193.2$^{ns}$ | 231.5$^{ns}$ | 113.6** |
| C.V | 18.5 | 10.0 | 13.8 | 14.9 | 28.0 | 23.9 | 23.1 | 24.8 |

### 3.2. Economic Analysis

Economic analysis for pod yield obtained from different spacing combination using the groundnut variety Gubeish are summarized in Tables (9).The combined analysis indicated that the highest net benefit of (11051SDG/ha) was recorded by treatment 30X20cm. followed by treatment 30X15cm (9500 SDG/ha).

**Table9.** *Mean yield, Gross benefit and Net benefit (SDG) per hectare of effect of spacing on growth and yield of Gebaish variety of groundnut 2013-2015*

| Treatment | Grain yield Kg/ha | Hay yield Kg/ha | Gross benefit SDG/ha | Net benefit SDG/ha | Ranking |
|---|---|---|---|---|---|
| 60X20cm | 1325.8 | 1379.1 | 8013 | 5696 | 5 |
| 60X15cm | 1150.9 | 1465.3 | 7247 | 4931 | 6 |
| 40X20cm | 1480.4 | 1943.5 | 9390 | 7153 | 4 |
| 40X15cm | 1740.7 | 2169.6 | 10915 | 8678 | 3 |
| 30X20cm | 2065.0 | 2643.5 | 13026 | 11051 | 1 |
| 30X15cm | 1749.0 | 2640.7 | 11475 | 9500 | 2 |

## 4. CONCLUSION

The results of this study indicated that the highest and significant pod and hay yields, population and net benefit were obtained under the spacing of 30×20cm due to increased plant population and reduced weed competition at early stages of crop establishment and vegetative growth..

## RECOMMENDATION

Based on the results of this study, the spacing of 30×20 cm is recommended for attaining highest pod and hay yields, and high economic benefit from groundnut produced under marginal rain fed conditions on sandy soils of North Kordofan State and similar environments.

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