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# Quantitative Variables Analysis, Growth and Yield of Groundnut (*Arachis hypogaea* L.) under Different Weed Management Practices

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## ABSTRACT

**Background:** The Groundnut or Goober peas (*Arachis hypogaea* L.) hold a prominent position as one of India's most crucial food and cash crops. One of the serious bottlenecks that limit the productivity of groundnut is the weed menace.

**Methods:** A field experiment was conducted at Perunthalaivar Kamaraj Krishi Vigyan Kendra, Puducherry during 2021 to 2023 to investigate the effects of integrated weed management practices on groundnut cultivation. The experimental setup followed a randomized block design with nine treatments, each replicated three times. The treatments comprised a range of weed management practices, including the pre-emergence herbicide pendimethalin and post-emergence herbicides like imazethapyr and quizalofop-ethyl. These herbicides were administered either individually or in conjunction with hand weeding once. In addition, hand weedings twice at 20 and 40 DAS were tested with unweeded check.

**Result:** The experiment results of the two years study revealed that the application of Pendimethalin 30% EC + Imazethapyr 2% EC with quizalofop - p- ethyl at 15-20 DAS has gave the maximum plant height (74.7 cm), dry matter production (57.9 g /plant), higher pod yield (3922 kg/ha), haulm yield (5919 kg/ha), highest net return (Rs. 91763 ha $^{-1}$) and B: C ratio (2.75). The strong positive correlations are plant height (0.96 and 0.97), shelling % (0.98 and 0.99), no. of pods plant$^{-1}$ (0.98 and 0.99), dry matter production (0.98 and 0.99) and weed control efficiency (0.85 and 0.88). These variables had a positive impact on groundnut yield.

**Key words:** Groundnut, Growth, Weed management, Yield attributes.

## INTRODUCTION

Groundnut (*Arachis hypogaea* L.) adorned as king of oilseeds, is one of the most important and ancient edible oilseed crop grown in India. Groundnut coverage area in India was 6.04 lakh ha, production 85.82 lakh tonnes and productivity 1703 kg/ha. The yield of groundnut crop depends upon various agronomic management practices and there are several reasons for low productivity. One of the major factors responsible for low productivity of groundnut is weed infestation. Weeds present a formidable challenge to achieving optimal crop yields, competing fiercely with crops for essential resources like light, nutrients, water and space. In groundnut cultivation, weed infestation stands out prominently among various constraints (Chaitanya *et al*., 2012).

Weeds disrupt the growth of groundnuts and serve as hosts for harmful insects and pathogens, further jeopardizing productivity. Crucial stages like pegging, pod development and harvesting are particularly affected (Kar *et al*., 2015). Effective weed control within three to four weeks of crop growth is paramount. Weed coverage exceeding 50% results in a staggering 70% decrease in groundnut yields. To boost oilseed crop productivity, especially groundnuts, we need creative solutions. It's crucial to overcome these challenges (Walia *et al*., 2007). Manual or mechanical methods of weed control after sowing tend to

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be less effective, labor-intensive and time-consuming. These methods also require frequent repetition at regular intervals. Manual weeding, in particular, may not always be feasible due to the high demand for labor and the challenges posed by heavy rainfall during the monsoon season, leading to intensified weed competition (Ravi *et al*., 2023). Hence, chemical weed control is often seen as a viable alternative for efficient and cost-effective weed management. Utilizing appropriate herbicides can ensure a completely weed-free environment for the crop, whereas manual or mechanical weeding can only be carried out after weeds have already emerged (Abbas *et al*., 2018).

Chemical weed control through the pre-emergence and post-emergence application of herbicides, as well as combinations of these methods, represents a competitive and promising strategy for weed management, especially during the first few weeks after crop sowing (Ajaykumar *et al.,* 2022a). The continuous process of herbicide discovery and development is essential due to the evolving nature of weed challenges in agricultural systems. The ongoing need for newer herbicides arises to achieve higher efficacy and cost-effectiveness in chemical weed control while minimizing environmental risks associated with toxicity and residue accumulation (Ravi *et al*., 2024). Combinations of cultural, mechanical and chemical weed management methods are more effective and economically beneficial than individual methods (Bajwa *et al*., 2019). The current investigation is centered on studying the growth and yield of groundnuts, with a specific focus on how different weed management practices impact on groundnut cultivation.

## MATERIALS AND METHODS

A field experiment was conducted at Perunthalaivar Kamaraj Krishi Vigyan Kendra, Puducherry during 2021 to 2023 to evaluate the performance of weed management strategies on growth and yield of groundnut.

### Experimental site

The experiment site is located at a latitude ranging from 11°46′ to 12°30′ North and a longitude ranging from 79° 36′ to 79°53′ East, with an altitude of 8.85 meters above Mean Sea Level (MSL). The soil of the experimental field was sandy clay loam in texture, low in available nitrogen, medium in available phosphorus and high in available potassium.

### Experimental design

The experiment was laid out in randomized block design with 9 treatments and replicated thrice. The treatments consisted of weed management practices were presented in Table 1.

### Cultural practices

The groundnut seeds underwent treatment with *Trichoderma viride*, administered at a rate of 2 grams per kilogram of seed. Seeds were sown in lines at 30 cm apart and 10 cm between plants. Groundnut variety TKM-13 was used for the study. Prior to sowing, the entire recommended fertilizer dose (20:50:75 kg of NPK per hectare) was evenly applied as a basal application. This dose consisted of urea, single superphosphate and muriate of potash. Gypsum at the rate of 400 kg/ha was applied in two equal splits, one at basal and another at the time of earthing up on 40 DAS.

The common weed flora of the experimental field consisted of grasses, sedges and broad leaved weeds were presented in Table 2. All other agronomic practices were meticulously executed in accordance with the specific requirements of the groundnut crop. Weed control efficiency was worked out on the basis of weed dry weight recorded in each treatment at harvest stage, using the formula suggested by Sankaran and Mani (1974). Ten plants were selected at random in each plot and were tagged for recording the observations of the growth, yield attributes and yield. Crop was harvested at maturity, threshed and plot-wise seed and yields in kg/ha was recorded. The data on the different parameters was analyzed statistically by adopting Fisher's method of ANOVA suggested by Gomez and Gomez (2010).

### Quantitative variables analysis

Correlation and multiple linear regressions were employed to study the value of money or profitability, the relationship between the various parameters (variables) and grain yield. The Pearson Correlation Coefficient (PCC) is the most prevalent sort of correlation coefficient and it creates a relationship between expected and observed values after a statistical investigation (Ajaykumar *et al*., 2022). The study utilized correlation analysis to examine the relationships among several variables, including grain yield (kg/ha), plant height (cm), pods plant$^{-1}$ (No.), dry matter production (kg/ha), shelling (%), weed density (No./ m$^2$), weed biomass (Kg./m $^2$) and weed control efficiency (%) (Ajaykumar *et al*., 2023). It was computed using the equation:

$$r_{xy} = \frac{S_{xy}}{S_x S_y} = \frac{\Sigma (x_i - \bar{x})(y_i - \bar{y})}{[\Sigma (x_i - \bar{x})^2][\Sigma (y_i - \bar{y})^2]} \quad .....(1)$$

Where,

$r_{xy}$ = Coefficient of the linear relationship between the variables x and y.

$S_x$ and $S_y$ = Sample standard deviation.

$S_{xy}$ is = Sample covariance.

$x_i$ and $y_i$ = Values of x and y variables in the sample of the population.

$\bar{x}$ and $\bar{y}$ = Sample mean.

The study also employed regression analysis as an econometric tool to investigate the association between a dependent variable and a set of independent variables. Regression analysis was performed by:

Pod yield (kg/ha) = $\alpha + \beta_1$ plant height (cm) + $\beta_2$ pods/plant (No's) + $\beta_3$ dry matter production (g/ plant) + $\beta_4$ weed density (No./ m$^2$) + $\beta_5$ Weed biomass (kg/ m$^2$) + $\beta_6$ weed control efficiency (%)+ $\mu_i$ .....(2)

## RESULTS AND DISCUSSION

### Weed characters

Total weed density, weed biomass and weed control efficiency were presented in Table 3. Application of Pendimethalin 30 EC + Imazethapyr 2 EC @ 1.0 kg ha$^{-1}$ PE (ready mix-Valor 32) + quizalofop - p- ethyl @ 50 g/ha at 15-20 DAS has significantly recorded the least weed density (96.3 No./m$^2$), weed biomass (0.43 kg/m$^2$) and higher weed control efficiency (85.1%). These results were comparable to applying Pendimethalin 30 EC + Imazethapyr 2 EC @ 1.0 kg ha$^{-1}$ PE (ready mix-Valor 32) + manual weeding at 25-30 DAS. The observed outcome could be attributed to the synergistic impact of pre-emergence and early post-emergence herbicides, which effectively limit the early establishment of weeds in groundnut fields. Moreover, groundnut's ability to smother weeds contributes significantly to this effect (Ravi *et al*., 2023).

**Table 1:** Treatment details of weed management practices.

| T. no. | Treatment details |
|---|---|
| $T_1$ | Pendimethalin @ 0.75 or 1.0 kg ha$^{-1}$ PE |
| $T_2$ | Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg ha$^{-1}$ PE (ready mix-Valor 32) |
| $T_3$ | Pendimethalin @ 0.75 or 1.0 kg ha$^{-1}$ PE + quizalofop -p- ethyl @ 50 g/ha at 15-20 DAS |
| $T_4$ | Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg ha$^{-1}$ PE (ready mix-Valor 32) + quizalofop - p- ethyl @ 50 g/ha at 15-20 DAS |
| $T_5$ | Pendimethalin @ 0.75 or 1.0 kg ha$^{-1}$ PE + Imazethapyr@ 75 or 100 g/ha at 15-20 DAS |
| $T_6$ | Pendimethalin @ 0.75 or 1.0 kg ha$^{-1}$ PE + manual weeding at 25-30 DAS |
| $T_7$ | Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg ha$^{-1}$ PE (ready mix-Valor 32) + manual weeding at 25-30 DAS |
| $T_8$ | Two manual weddings at 20 and 40 DAS |
| $T_9$ | Weedy check |

**Table 2:** Pre dominant weed flora of the experimental field.

| Weed group | Weed species | Family |
|---|---|---|
| Grasses | *Cynodon dactylon* | Poaceae |
| | *Panicum javanicum* | |
| | *Digitaria bicornis* | |
| Sedges | *Cyperus rotundus* | Cyperaceae |
| Broad leaved weeds | *Parthenium hysteroporus* | Asteraceae |
| | *Portulaca oleracea* | Portulacaceae |
| | *Acalypha indica* | Euphorbiaceae |
| | *Boerhaevia erecta* | Nyctaginaceae |

**Table 3:** Effect of weed management practices on weed characters of groundnut at harvest.

| Treatment | Total weed density (No./m$^2$) | Weed biomass (Kg/m$^2$) | Weed control efficiency (%) |
|---|---|---|---|
| $T_1$ | 220.3 | 0.72 | 55.4 |
| $T_2$ | 199.7 | 0.68 | 63.3 |
| $T_3$ | 138.3 | 0.58 | 76.5 |
| $T_4$ | 96.3 | 0.43 | 85.1 |
| $T_5$ | 119.3 | 0.53 | 79.3 |
| $T_6$ | 150.3 | 0.61 | 82.5 |
| $T_7$ | 109.3 | 0.49 | 72.0 |
| $T_8$ | 170.0 | 0.64 | 66.8 |
| $T_9$ | 291.0 | 0.80 | 0.00 |
| SEd | 3.51 | 0.01 | 2.8 |
| CD (P = 0.05) | 10.35 | 0.03 | 6.1 |

.....(3)

$T_1$: Pendimethalin@ 0.75 or 1.0 kg ha$^{-1}$ PE; $T_2$: Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg ha$^{-1}$ PE (ready mix-Valor 32); $T_3$: Pendimethalin@ 0.75 or 1.0 kg ha$^{-1}$ PE + quizalofop -p- ethyl @ 50 g/ha at 15-20 DAS; $T_4$: Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg ha$^{-1}$ PE (ready mix-Valor 32) + quizalofop - p- ethyl @ 50 g/ha at 15-20 DAS; $T_5$: Pendimethalin@ 0.75 or 1.0 kg ha$^{-1}$ PE + Imazethapyr @ 75 or 100 g/ha at 15-20 DAS; $T_6$: Pendimethalin@ 0.75 or 1.0 kg ha$^{-1}$ PE + manual weeding at 25-30 DAS; $T_7$: Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg ha$^{-1}$ PE (ready mix-Valor 32) + manual weeding at 25-30 DAS; $T_8$: Two manual weddings at 20 and 40 DAS; $T_9$: Weedy check.

Consequently the lower weed control efficiency and higher total weed density of 291 No./$m^2$ and weed biomass of 0.80 Kg/$m^2$ was registered in treatment $T_9$ (weedy check - Control) at harvest stage respectively. This might be due to the uncontrolled germination of weeds is a result of the absence of weed control measures and the continuous provision of nutrients that promote weed growth, facilitated by the application of early post-emergence herbicides (Das *et al*., 2012).

**Growth and yield of groundnut**

The various concentrations of herbicide application resulted in a significant increase in groundnut growth and yield at various concentration levels, as detailed in Table 4. Application of Pendimethalin 30 EC + Imazethapyr 2 EC @ 1.0 kg $ha^{-1}$ PE (ready mix-Valor 32) + quizalofop-p- ethyl @ 50 g/ha at 15-20 DAS revealed that the maximum plant height (74.7 cm), dry matter production (57.9 g plant) at harvest stage, pod yield (3922 kg/ha) and haulm yield (5919 kg/ha). However, it was statistically comparable to Pendimethalin 30 EC + Imazethapyr 2 EC @ 1.0 kg $ha^{-1}$ PE (ready mix-Valor 32) + manual weeding at 25-30 DAS (3801 kg/ha) and the lowest plant height (65.3 cm) and Dry Matter Production (45.6 g/plant) was observed with weedy check (Control). The reason for the lack of significant improvement in plant population could be attributed to the efficient weed control achieved through the optimal use of herbicides. This resulted in a favorable environment that facilitated higher nutrient uptake, leading to increased plant height, leaf area index and an improved source-sink relationship. The unweeded control group showed shorter plants, primarily due to the competitive effects of weeds throughout the crop's growth cycle. Conversely, all growth-related traits, which were emphasized in various weed control methods, contributed to a higher number of pods compared to the weedy check (Das *et al*., 2012). The maximum yield reduction (2904 kg/ha) was observed with weedy check. Groundnut being a deep rooted legume crop proliferation of the root at early stage is essentially required to establish the sufficient numbers of nodule and better crop growth for pegging (Ravi *et al*., 2023). Weed growth is faster than crop growth at early stage so controlling of weeds at early stage reduced the crop weed competition and thus providing nutritional security to the crop as result of better pod yield.

**Yield attributes of groundnut**

Effect of different herbicidal treatments on yield attributing characters of groundnut was found to be significant (Table 5). Application of Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg $ha^{-1}$ PE (ready mix-Valor 32) + quizalofop - p- ethyl @ 50 g/ha at 15-20 DAS has recorded the highest pod $plant^{-1}$ (28.7 No.), test weight (58.1 g), shelling (74.5%) and sound mature kernels (89.98%) which was followed by Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg $ha^{-1}$ PE (ready mix-Valor 32) + manual weeding at 25-30 DAS and the lowest pod $plant^{-1}$ (16.1No.), test weight (52.8 g), shelling (65.5%) and sound mature kernels (84.24%) was observed with weedy check (Control). This might due to an environment free of weeds and efficient crop use of applied inputs and natural resources. When weeds are not controlled up to the critical period of crop growth, they compete with plants for essential resources, resulting in inferior yield-related traits such as the number of matured pods per plant and kernel weigh. This would have reflected in poor pod yield under unweeded control (Ravi *et al*., 2024).

**Table 4:** Effect of weed management practices on growth and yield of groundnut at harvest stage (Pooled data).

| Treatment | Plant height (cm) | DMP (g/plant) | Dry pod yield (kg/ha) | Haulm yield (kg/ha) |
|---|---|---|---|---|
| $T_1$ | 68.1 | 48.0 | 3074 | 4647 |
| $T_2$ | 69.8 | 49.4 | 3264 | 4899 |
| $T_3$ | 72.9 | 54.5 | 3510 | 5345 |
| $T_4$ | 74.7 | 57.9 | 3922 | 5919 |
| $T_5$ | 73.8 | 55.4 | 3647 | 5566 |
| $T_6$ | 72.3 | 52.6 | 3453 | 5266 |
| $T_7$ | 74.2 | 57.2 | 3801 | 5733 |
| $T_8$ | 71.7 | 50.8 | 3389 | 5046 |
| $T_9$ | 65.3 | 45.6 | 2904 | 4271 |
| S.Em± | 1.40 | 1.05 | 118.38 | 101.88 |
| LSD (P=0.05) | 4.26 | 3.14 | 336.11 | 314.45 |
| CV (%) | 3.32 | 3.29 | 5.64 | 3.32 |

$T_1$: Pendimethalin@ 0.75 or 1.0 kg $ha^{-1}$ PE; $T_2$: Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg $ha^{-1}$ PE (ready mix-Valor 32); $T_3$: Pendimethalin@ 0.75 or 1.0 kg $ha^{-1}$ PE + quizalofop -p- ethyl @ 50 g/ha at 15-20 DAS; $T_4$: Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg $ha^{-1}$ PE (ready mix-Valor 32) + quizalofop - p- ethyl @ 50 g/ha at 15-20 DAS; $T_5$: Pendimethalin@ 0.75 or 1.0 kg $ha^{-1}$ PE + Imazethapyr @ 75 or 100 g/ha at 15-20 DAS; $T_6$: Pendimethalin@ 0.75 or 1.0 kg $ha^{-1}$ PE + manual weeding at 25-30 DAS; $T_7$: Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg $ha^{-1}$ PE (ready mix-Valor 32) + manual weeding at 25-30 DAS; $T_8$: Two manual weddings at 20 and 40 DAS; $T_9$: Weedy check.

**Quantitative variables analysis**

The correlation data strongly suggests that effective weed management (as indicated by lower weed density and biomass and higher weed control efficiency) is crucial for improving various growth parameters and yields in groundnut cultivation. The strong positive correlations among dry pod and haulm yields and no. of parameters, including plant height (0.96 and 0.97), shelling % (0.98 and 0.99), no. of pods plant$^{-1}$ (0.98 and 0.99), dry matter production (0.98 and 0.99) and weed control efficiency (0.85 and 0.88) and their negative correlations with weed density (-0.97 and -0.98), weed biomass (-0.99 and -0.99) underscore the importance of managing weed competition to ensure the success of the crop (Fig 1 and 2). The correlation results are tabulated in Table 6. The multiple linear regression analysis aimed to assess the influence of various parameters on pod yield (Table 7). The multiple linear regression equation, consequently derived, is as follows:

Pod yield (Kg ha$^{-1}$) = -2887.745 + 93.357 Plant height + (-25.370) No. of pods plant$^{-1}$ + 20.845 Dry matter production + 5.508 Weed density + (3061.788) Weed biomass + 1.739 * Weed control efficiency

The derived regression equation suggests that plant height and dry matter production positively impact pod yield, with each unit increase corresponding to an approximate increase of 93.357 and 20.845 Kg ha$^{-1}$, respectively. Conversely, higher weed biomass has a significant negative association with pod yield, with a decrease of approximately 3061.788 Kg ha$^{-1}$ for each unit increase in weed biomass. While weed density and weed control efficiency show weaker or non-significant relationships with pod yield, the overall model demonstrates a strong fit and validity, maintaining consistent error variance, adhering to normal distribution assumptions and being free from outliers. These findings underscore the critical importance of managing plant height, dry matter production and weed

**Table 5:** Effect of weed management practices on yield attributes of groundnut (Pooled data).

| Treatment | Pods/Plant (No.) | 100 kernel weight (g) | Shelling (%) | SMK (%) |
|---|---|---|---|---|
| $T_1$ | 19.6 | 55.8 | 67.3 | 86.88 |
| $T_2$ | 20.8 | 54.5 | 68.8 | 87.71 |
| $T_3$ | 25.4 | 56.2 | 71.9 | 87.84 |
| $T_4$ | 28.7 | 58.1 | 74.5 | 89.98 |
| $T_5$ | 26.3 | 55.1 | 70.8 | 89.21 |
| $T_6$ | 24.2 | 57.8 | 73.4 | 89.60 |
| $T_7$ | 27.4 | 53.7 | 72.7 | 86.68 |
| $T_8$ | 22.2 | 55.3 | 69.4 | 84.71 |
| $T_9$ | 16.1 | 52.8 | 65.5 | 84.24 |
| S.Em± | 0.49 | 0.08 | 1.01 | 1.52 |
| LSD (P=0.05) | 1.47 | 0.17 | 3.10 | 3.94 |
| CV (%) | 3.42 | 3.36 | 3.28 | 3.52 |

$T_1$: Pendimethalin @ 0.75 or 1.0 kg ha$^{-1}$ PE; $T_2$: Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg ha$^{-1}$ PE (ready mix-Valor 32); $T_3$: Pendimethalin @ 0.75 or 1.0 kg ha$^{-1}$ PE + quizalofop -p- ethyl @ 50 g/ha at 15-20 DAS; $T_4$: Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg ha$^{-1}$ PE (ready mix-Valor 32) + quizalofop - p- ethyl @ 50 g/ha at 15-20 DAS; $T_5$: Pendimethalin @ 0.75 or 1.0 kg ha$^{-1}$ PE + Imazethapyr @ 75 or 100 g/ha at 15-20 DAS; $T_6$: Pendimethalin@ 0.75 or 1.0 kg ha$^{-1}$ PE + manual weeding at 25-30 DAS; $T_7$: Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg ha$^{-1}$ PE (ready mix-Valor 32) + manual weeding at 25-30 DAS; $T_8$: Two manual weddings at 20 and 40 DAS; $T_9$: Weedy check.

**Table 6:** Correlation between yield attributes and growth characters of groundnut (Pooled data).

| Variables | pH | Shelling % | No. of pods | DMP | WD | WB | WCE | DPY | HY |
|---|---|---|---|---|---|---|---|---|---|
| pH | 1.00 | 0.98 | 0.99 | 0.97 | -1 | -0.96 | 0.93 | 0.97 | 0.98 |
| Shelling % | 0.98 | 1.00 | 1.00 | 1.00 | -0.98 | -1 | 0.87 | 0.99 | 1.00 |
| No. of pods | 0.99 | 1.00 | 1.00 | 1.00 | -1 | -0.99 | 0.9 | 0.99 | 1.00 |
| DMP | 0.97 | 1.00 | 1.00 | 1.00 | -0.98 | -0.99 | 0.85 | 0.99 | 1.00 |
| WD | -1 | -0.98 | -1 | -0.98 | 1.00 | 0.97 | -0.95 | -0.98 | -0.99 |
| WB | -0.96 | -1 | -0.99 | -0.99 | 0.97 | 1.00 | -0.86 | -1 | -1 |
| WCE | 0.93 | 0.87 | 0.9 | 0.85 | -0.95 | -0.86 | 1 | 0.86 | 0.89 |
| DPY | 0.97 | 0.99 | 0.99 | 0.99 | -0.98 | -1 | 0.86 | 1.00 | 1.00 |
| HY | 0.98 | 1.00 | 1.00 | 1.00 | -0.99 | -1 | 0.89 | 1.00 | 1.00 |

DMP- Dry matter production, WD- Weed density, WB- Weed biomass, WCE- Weed control efficiency, DPY- Dry pod yield, HY- Haulm yield.

**Table 7:** Multiple linear regression estimates the groundnut yield (Pooled data).

| Variables | Estimate | Standard error | t value | Pr (> \|t\|) | Significant codes |
|---|---|---|---|---|---|
| Intercept | -2887.75 | 5780.59 | -0.5 | 0.66 | NS |
| pH | 93.36 | 56.12 | 1.66 | 0.24 | NS |
| No. of pods | -25.37 | 66.09 | -0.38 | 0.74 | NS |
| DMP | 20.85 | 36.04 | 0.58 | 0.62 | NS |
| WD | 5.5 | 6.19 | 0.89 | 0.47 | NS |
| WB | -3061.79 | 656.18 | -4.67 | 0.04 | * |
| WCE | 1.74 | 2.79 | 0.62 | 0.59 | NS |

NS- Non-significant, *-Significant at 1% level, Multiple R-squared: 0.9982, Adjusted R-squared: 0.9927, F-statistic: 182.8 on 6 and 2 DF, p-value: 0.005451. Residual standard error: 28.06 on 2 degrees of freedom.

**Table 8:** Effect of weed management practices on economics of groundnut (Pooled data).

| Treatment | Cost of cultivation (Rs./ha) | Gross returns (Rs./ha ) | Net returns (Rs./ha) | Benefit cost ratio |
|---|---|---|---|---|
| $T_1$ | 51445 | 118214 | 67772 | 2.30 |
| $T_2$ | 52328 | 119859 | 68533 | 2.29 |
| $T_3$ | 50783 | 122019 | 72238 | 2.40 |
| $T_4$ | 51973 | 142735 | 91763 | 2.75 |
| $T_5$ | 51798 | 135057 | 84260 | 2.61 |
| $T_6$ | 51885 | 137565 | 86681 | 2.65 |
| $T_7$ | 50695 | 103850 | 54156 | 2.05 |
| $T_8$ | 60348 | 121338 | 62443 | 2.01 |
| $T_9$ | 50870 | 99333 | 49463 | 1.95 |

Data was not statistically analysed.

$T_1$: Pendimethalin @ 0.75 or 1.0 kg ha$^{-1}$ PE; $T_2$: Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg ha$^{-1}$ PE (ready mix-Valor 32); $T_3$: Pendimethalin@ 0.75 or 1.0 kg ha$^{-1}$ PE + quizalofop -p- ethyl @ 50 g/ha at 15-20 DAS; $T_4$: Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg ha$^{-1}$ PE (ready mix-Valor 32) + quizalofop - p- ethyl @ 50 g/ha at 15-20 DAS; $T_5$: Pendimethalin @ 0.75 or 1.0 kg ha$^{-1}$ PE + Imazethapyr @ 75 or 100 g/ha at 15-20 DAS; $T_6$: Pendimethalin @ 0.75 or 1.0 kg ha$^{-1}$ PE + manual weeding at 25-30 DAS; $T_7$: Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg ha$^{-1}$ PE (ready mix-Valor 32) + manual weeding at 25-30 DAS; $T_8$: Two manual weddings at 20 and 40 DAS; $T_9$: Weedy check.

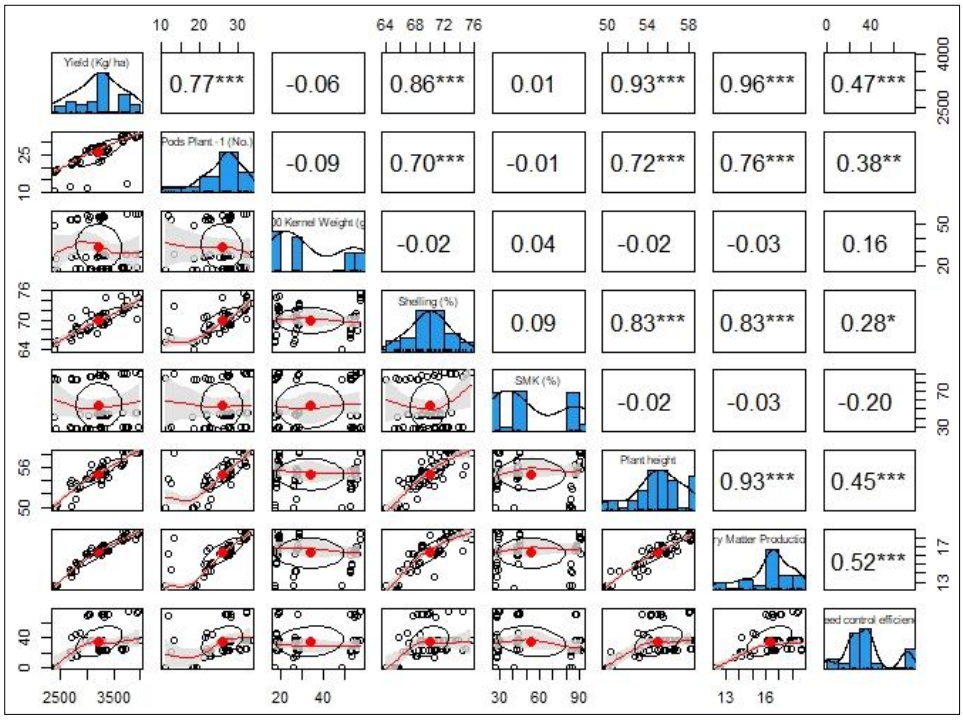


**Fig 1:** Correlation map between yield attributes and growth characteristics of groundnut.

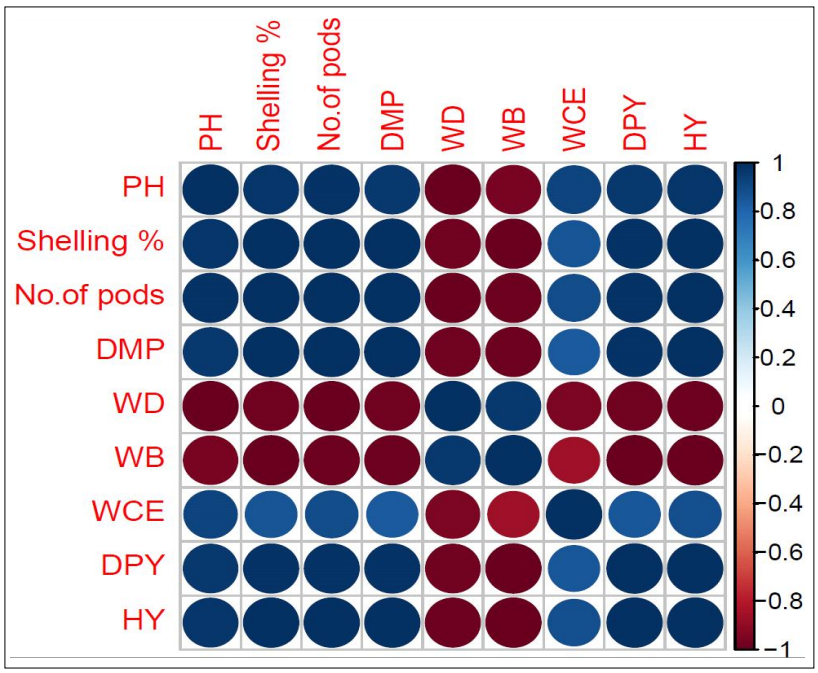


**Fig 2:** Correlation matrix between pod yield and plant characteristics.

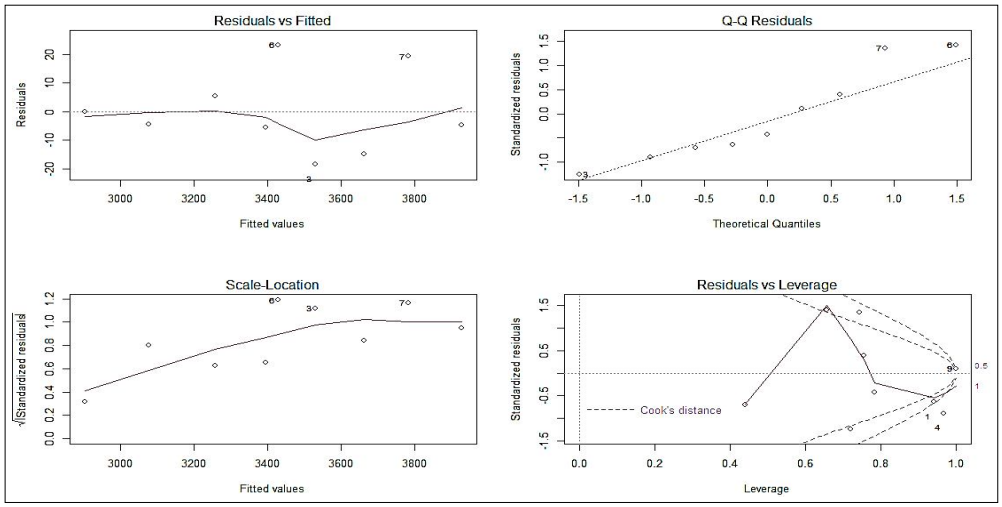


**Fig 3:** Regression diagnostic plots of groundnut pod yield.

biomass to optimize groundnut pod production. The regression diagnostic plots are illustrated in Fig 3.

### Economics

Weed management practices on economic indicators such as gross return, net returns and the benefit-cost ratio of groundnut indicated in Table 8. The effect of different treatments on the economics of groundnut cultivation showed that Pendimethalin 30 EC + Imazethapyr 2 EC @ 1.0 kg ha$^{-1}$ PE (ready mix-Valor 32) + quizalofop - p- ethyl @ 50 g/ha at 15-20 DAS recorded higher gross return (Rs. 142735 ha $^{-1}$), net return (Rs. 91763 ha$^{-1}$) and B:C ratio (2.75) and followed by Pendimethalin 30 EC + Imazethapyr 2 EC @ 1.0 kg ha$^{-1}$ PE (ready mix-Valor 32) + manual weeding at 25-30 DAS. The increased income realized with these two treatments might be due to higher pod yield obtained due to the treatment efficiency, which would have reduced the competition between weeds and crop for water and nutrients. The results are analogous to those reported by (Naim *et al*., 2010). Though the traditional method of hand weeding effectively minimizes the weed competition and maximizes the yield and higher net return, the B: C ratio would be less compared to above mentioned weed control treatment. This might to be more labor and higher wages resulted in higher cost of cultivation.

## CONCLUSION

Both the years of experiments concluded that the application of Pendimethalin 30 EC + Imazethapyr 2 EC with quizalofop

- p- ethyl at 15-20 DAS significantly increased growth characters, yield attributes and yield compared to all other treatments. Hence it can be recommended that application of Pendimethalin 30 EC + Imazethapyr 2 EC with quizalofop - p- ethyl at 15-20 DAS are the most effective broad spectrum weed management practices to increase the economic yield and monetary returns in groundnut at the times of labor short comes. The correlation and regression results showed that parameters *viz*., plant height, shelling %, no. of pods plant$^{-1}$ and dry matter production had a positive relation on the grain yield and thus variables should be focused to enhance the productivity of the groundnut.

**Conflict of interest**

The authors have no conflict of interest to declare. All co-authors have seen and agree with the content of the manuscript. We certify that the submission is original work and is not under review at any other publication.

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