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Investigating the Effect of Planting Pattern and Weed Management on the Yield and Growth Indices of Two Peanut (*Arachis hypogaea* L.) Cultivars

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ABSTRACT

To investigate the effect of weed management and planting pattern on the growth and yield of two peanut cultivars, a factorial experiment based on a randomized complete block design with three replications was carried out in the Agriculture and Natural Resources Campus of Razi University, Kermanshah in 2021. The experimental factors include 1) cultivars NC2 and NC7, 2) planting pattern (row and plant spacing of 50 cm × 25 cm and 75 cm × 18 cm), and 3) two times weeding along with the use of Trifluralin 48% EC (796 g a.i.ha^{-1}), Bentazon 48% SL (960 g a.i.ha^{-1}) and Haloxyfop-r-methyl 10.8% EC (75 g a.i.ha^{-1}), weeding two times along with the use of Trifluralin (1233 g a.i.ha^{-1}), twice weeding together with the use of Haloxyfop-r-methyl and Bentazon, complete weeding and weed-infested treatment. The results showed that the weed control significantly increased the plant's dry weight. The kernels dry weight in the plant showed a significant increase in both studied planting patterns in weed control compared to no control. However, the impact of weed control treatments on the two studied planting patterns did not exhibit any significant differences, except for the complete weeding treatment. The kernels dry weight within plants subjected to complete weeding in the 50 × 25 cm planting pattern exhibited a 39.31% increase relative to those grown in the 75 × 18 cm. The response of dry weight of kernels and pods was high for cultivar NC2 in a planting pattern of 50 x 25 cm and for cultivar NC7 in 75 x 18 cm. In general, according to the obtained results, due to the high sensitivity of peanuts to weed competition, it is suggested to control weeds at the beginning of the growing season until about 60 days after planting, regardless of the type of planting pattern.

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1. Introduction

Peanut (*Arachis hypogaea* L.) is an essential oil crop in the world, cultivated for food and oil production. Peanuts are a good source of various nutrients, including biotin, copper, niacin, folate, manganese, phosphorus, vitamin E, and protein. The seeds of this plant contain a variety of unsaturated fats that are beneficial for heart health. In addition, peanuts are rich in antioxidants and a good resveratrol source (Prasad *et al.*, 2022). This plant is the third annual oilseed crop in the world after soybean and rape (Rehman *et al.*, 2001; Jordan *et al.*, 2001).

The competition between weeds and peanuts can significantly affect growth, development, and yield. Uncontrolled growth of weeds between the rows can reduce the leaf area and canopy cover of the crop and lead to yield reduction. Weed competition can also affect dry matter accumulation, stem length, and the number of leaves and pods per plant (Everaarts, 1992). The average yield reduction in groundnut is estimated between 25 and 70%, depending on the severity of weed infestation (Jat *et al.*, 2011; Mathew *et al.*, 2021). In an experiment, weeds caused about 39% reduction in peanut yield and reduced harvest efficiency (Jhala *et al.*, 2005; Clewis *et al.*, 2007). Therefore, maintaining a weed-free period is crucial to avoid significant yield reduction in groundnut cultivation. In a critical period study, weed interference in peanuts was obtained between three and six weeks after planting (Osunleti, 2022). Other research results have also emphasized that

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effective weed management during the first six weeks is critical for the high yield of groundnut (Everman *et al.*, 2008; Jat *et al.*, 2011).

Chemical control methods are mainly used to control weeds in peanuts. A study in India showed that the herbicides Imazetapir and Quizalofop effectively controlled the dominant flora of weeds in groundnuts. The weed control efficiency, yield, and net economic return were high (Tripathi and Singh, 2022). Pre-emergent herbicides have been identified as a promising approach for weed control in peanut cultivation. Pre-emergence herbicides (PREs) such as Trifluralin (Treflan) are often used in peanuts to inhibit weed germination and control residual weeds (Grichar *et al.*, 2001). Co-application of post-emergence herbicides with efficacy against dicotyledonous weeds generally increases weed control or the spectrum of control (Collavo *et al.*, 2016; Benoit *et al.*, 2019). A study evaluated the integration of pre- and post-emergence herbicides for weed management in blue peanuts. The results showed that using Pendimethalin and Imazetapir followed by hand weeding led to higher weed control efficiency and pod yield than other treatments (Parthipan, 2020). In another experiment to determine the most suitable combination of pre-emergence and post-emergence herbicides along with manual weeding in the effective control of peanut weeds, it was shown that Pendimethalin and Supergalant herbicide combinations were effective in controlling weeds and led to higher pod yields (Wilfred *et al.*, 2020).

The spatial distribution of plants in the crop arrangement in the field is an essential factor in determining yield. The yield of any crop depends on the capacity of the plant canopy to effectively use sunlight, which depends on canopy architecture, leaf size, shape and angle, number of leaves and branches, and planting patterns such as row direction and row spacing. The cultivation pattern of a plant affects the efficiency of using solar radiation and, thus, the biological and economic performance of a crop. Therefore, the spatial distribution of plants in a crop community plays a vital role in determining the efficiency of absorbing resources, such as sunlight, and can significantly affect the overall yield of crops (Dahiya *et al.*, 2023). Iddrisu et al. (2024) observed that groundnut pod yield was significantly affected by row spacing. The yield of pods in the row spacing of 30 cm was significantly higher than the row spacing of 45 cm. Planting patterns can be different in different varieties of peanuts. Currently, in the peanut production areas in Brazil, the row spacing of runner cultivars has increased from 45 to 90 cm (Agostinho *et al.*, 2006).

The standard row spacing for peanuts in Georgia is 91 cm in a single-row pattern. If cultivars are consistent and yields are not reduced, converting peanuts to narrower row spacing may be easier and more beneficial for some growers. According to the current recommendations of the scientists, peanuts are usually planted with a row spacing of 19 cm and a row spacing of 91 cm (Plumblee *et al.*, 2018). Place et al. (2010) found that the standard two-row planting pattern with a spacing of 20 x 91 cm and two narrow rows with a spacing of 20 x 46 cm compared to the single-row planting pattern with a spacing of 91 cm, Along with the chemical control of weeds, it led to an increase in peanut yield. Lanier et al. (2004) investigated the effect of planting patterns, density, and type of irrigation on peanut yield and found that standard two-row planting patterns (the distance between the two rows is 18 and the even distance of the rows from each other is 91 cm) compared to single row planting patterns (row spacing 91 cm) leads to higher yield. Jordan et al. (2001) investigated the effect of peanut planting patterns in the United States. Growing peanuts in double rows increased pod yield compared to single-row cultivation. Planting density has a significant effect on traits such as the number of pods, weight of 100 seeds, and pod yield. Different peanut cultivars showed varying responses to changes in planting density; some cultivars performed better at higher densities, while others performed better at lower densities (Al-Dulaimi and Abas, 2024). In an experiment with row spacing of 70 and 75 cm and intra-row spacing of 5, 10, 15, 20, and 25 cm between plants, the highest weight and number of pods per plant were obtained from the planting pattern of 25×70 cm. With the increase in plant density, the yield of pods per hectare increased. The highest pod yield was obtained from the planting density of 10×75 cm and the lowest from the planting density of 25×75 cm (Onat *et al.*, 2017).

Peanuts do not have the power to compete for growth resources such as sunlight, water, and nutrients with weeds. Therefore, a suitable planting pattern, along with the use of weed management methods, can increase the productivity of resources and, as a result, growth. Follow the appropriate and acceptable performance of this plant. According to the mentioned materials, this experiment aimed to investigate the effect of planting patterns and weed management on the growth and yield of two varieties of peanut plants under the weather conditions of Kermanshah City.

2. Materials and methods

This experiment was carried out in the research farm and physiology laboratory of the Agriculture and Natural Resources Campus of Razi University, Kermanshah, 2021. The studied field was located at a longitude of 45 degrees and 9 minutes east and a latitude of 34 degrees and 21 minutes north and 1319 meters above sea level. After the initial preparation of the land, sampling was done to check the soil's physicochemical properties, and it was tested from a depth of 0-30 cm, the results of which are presented in Table 1. Based on the soil test result and peanut fertilizer requirement, only urea fertilizer was added to the soil. The meteorological data for the region during the years 2018-2020 are presented in Table 2.

Table 1. Physicochemical analysis of the soil where the experiment was carried out

Soil texture	EC ($mS.m^{-1}$)	pH	Organic carbon (%)	N (%)	P ($mg.kg^{-1}$)	K ($mg.kg^{-1}$)
clay-silty	930	7.4	1.4	0.144	15.4	380

Table 2. Meteorological information of the region during 2021

Year	Parameter	May	June	July	Aug	Sept	Oct
	Temperature (°C)	21.3	25.9	30.4	29.5	26.5	19.5
2021	Humidity (%)	30	17	13	16	14	21
	Precipitation (mm)	8	0	0	0	0	0

The Government Meteorological Association of Iran (https://www.irimo.ir).

A factorial experiment based on a randomized complete block design with three replications was performed. The experimental factors include 1) cultivars NC-2 and NC-7, two large-seeded Virginia cultivars, 2) planting pattern (P1 = row spacing 50 cm × plant spacing 25 cm and P2 = row spacing 75 cm × plant spacing 18 cm) and 3) Different integrated weed management including M1 = two times weeding along with the use of Trifluralin 48% EC (796 g $a.i.ha^{-1}$), Bentazon 48% SL (960 g $a.i.ha^{-1}$) and Haloxyfop-r-methyl 10.8% EC (75 g $a.i.ha^{-1}$), M2 = twice weeding with the use of Trifluralin (1233 g $a.i.ha^{-1}$), M3 = two times weeding with the use of Haloxyfop-r-methyl and Bentazon, M4 = complete weeding during the growing season (once every two weeks) and M5 = weed-infested treatment during the growing season. A 16-liter Hyundai HP1690 rechargeable sprayer with a flat fan nozzle was used for spraying. Before spraying, calibration was done based on the amount of water volume used per unit area.

Seeds were sown in three days on May 8-10, 2021, in plots with dimensions of three by six meters and a depth of five centimeters of soil, and after that, irrigation was done on May 11. Before planting, the seeds were disinfected using mancozeb (Dithane) (Tarekegn *et al.*, 2007). Considering that the emergence of peanuts was done about two weeks after planting, weed management treatments were started three weeks after planting. Irrigation was carried out by rain according to environmental conditions, soil moisture, and plant growth stage. At the six-leaf stage, humic acid was used along with NPK-balanced fertilizer (N-P-K: 20-20-20). After flowering, high phosphorus fertilizer (Fermolife® 10-52-10) along with humic acid (Dakota® %95) was used, and two to three weeks later, high phosphorus fertilizer along with amino acid (AminoSpark®) was used. At pod formation, potassium sulfate (SoluPotasse®) was sprayed. High potash fertilizer and amino acids were sprinkled during the seed kernel growth. According to the observation of the symptoms of the false powdery mildew, a metalaxyl-mancozeb combination (3 $g.lit^{-1}$) was used. Due to the absence of widespread pests, pesticides were not used.

When most of the pods were ripe at the end of the growing season, on November 1st and 2nd, harvesting was done manually. After removing the border rows from each plot, six plants were randomly picked from the center of the plots. Then, it was dried in an oven at 60ºC for 48 hours, and the characteristics of the dry weight of a single plant, kernels dry weight per plant, and pods dry weight per plant were measured. In order to study the growth indicators of total dry matter (TDM), crop growth rate (CGR), and relative growth rate (RGR), sampling was done every 15 days in seven stages. For this purpose, three plants were taken from each plot; after sampling, the plants were washed and placed in an oven at a temperature of 60°C for 48 hours. After drying, the samples were weighted, and their averages were recorded. A sigmoidal function (Equation 1) was used to calculate the changes in dry matter accumulation of peanuts (grams per square meter) (Ahmadi *et al.*, 2018).

$$(1) \quad TDM = \frac{a}{1 + b.e^{(-ct)})}$$

TDM: daily total dry matter in grams per square meter, *a*; maximum total dry matter; *b*; when the total dry matter curve enters its linear growth phase, *c*; RGR; and *t*; Time is in days after emergence.

To calculate the CGR, the first derivative of the total dry matter accumulation equation (Equation 1) was calculated with the unit of grams per square meter per day (Equation 2) (Ahmadi *et al.*, 2018).

$$(2) \quad \frac{dY}{dt} = \frac{a.b.c.e^{(-ct)})}{(1 + b.e^{(-ct)})^2}$$

Using the amount of dry matter and the growth rate of the product, the RGR (RGR) was calculated with the unit of gram per gram per day (Equation 3) (Ahmadi *et al.*, 2018):

$$(3) \quad RGR = TDM(\frac{1}{CGR})$$

In order to calculate and fit the curves related to TDM, CGR, and RGR, SigmaPlot v.14 software and Excel 2016 software were used. In order to analyze the data, according to the precondition of the F test that the data is normal, the normality of the data was first ensured. In the case of non-normal data (Pods dry weight per plant), logarithmic transformation was used to normalize the data. In order to analyze the variance of the data, SAS v.9.4 software and the GLM procedure were used. If the F test is significant, a comparison of means was made using Duncan's multiple range test at the probability level of 5%.

3. Results and discussion

The plant dry matter and the pods dry weight per plant was significantly different between the studied cultivars. The effect of weed management on single plant dry matter, dried seed weight/plant, and pods dry weight per plant was significant (p≥0.01). Also, the interaction effect of planting pattern× cultivars on the traits of seed dry weight per plant and pods dry weight per plant was significant (p≥0.05). The interaction effect of planting pattern × weed management on seed dry weight per plant (p≥0.01) and pods dry weight per plant (p≥0.05) was significant (Table 3).

Table 3. Analysis Variance of investigated peanut traits under the influence of planting pattern, cultivar and weed management

Source of variation	df	Plant dry matter	Dried seed weight per plant	Pods dry weight per plant
Block	2	133.01^{ns}	22.42^{ns}	109.09^{ns}
Planting pattern (A)	1	25.82^{ns}	77.52^{ns}	701.78^{ns}
Cultivar (B)	1	10382.65^{**}	34.65^{ns}	2213.12^{**}
Weed management (C)	4	9988.30^{**}	1117.61^{ns}	5925.34^{**}
A×B	1	787.38^{ns}	213.57^{*}	1123.20^{*}
A×C	4	563.13^{ns}	165.81^{**}	756.14^{*}
B×C	4	1458.86^{ns}	37.17^{ns}	79.34^{ns}
A×B×C	4	1649.26^{ns}	110.76^{ns}	320.99^{ns}
Error	38	742.74	45.21	254.68
CV (%)		19.50	22.97	21.86

3.1. Plant dry matter

The highest dry weight of a single peanut plant was obtained in the NC7, which was about 46% more than the NC2 cultivar (Fig. 1). The high plant dry matter in the cultivar NC7 can be due to the more significant accumulation of dry matter as a result of the growth rate of the product and its RGR during the growing season compared to the cultivar NC2 (Fig. 1). The highest amount of dry matter was observed in cultivar NC7. However, the dry matter accumulation process in the early growing season (from the beginning of the growing period to about 90 days after planting) was almost the same for both cultivars. However, with the continuation of the growing season, the amount of dry matter accumulation in the NC7 cultivar exceeded that of the NC2 cultivar and continued (Fig. 1).

The trend of changes in the CGR of the two studied peanut cultivars (Fig. 1) showed that the CGR was low in the early season. However, during the days after planting, the rate of growth increased, and it reached its maximum value with an upward trend around 100 days after planting, which corresponds to the maximum power of the plant in converting solar energy and, as a result, producing maximum dry matter. With the continuation of the growing season, the growth rate of the studied cultivars stayed constant due to the plant reaching the maximum growth and increasing the proportion of old leaves, and after reaching the maximum point, its rate decreased. The highest growth rate of the crop was observed in the NC7 variety, which was consistent with the changes in dry matter accumulation (Fig. 1). The RGR expresses the increase in the plant's dry weight compared to its initial dry weight per unit of time, whose unit is grams per day (Sun *et al.*, 2021). The RGR during the season indicated a consistent trend until around the 60th day after emergence. Then, it had a downward trend, as the RGR decreased with the growing age of the plant and reached its lowest level at the end of the growing season (Fig. 1). The highest RGR was obtained in NC7. The decrease in relative growth from the 60th day onwards was also higher in Qom NC2 than NC7 (Fig. 1).

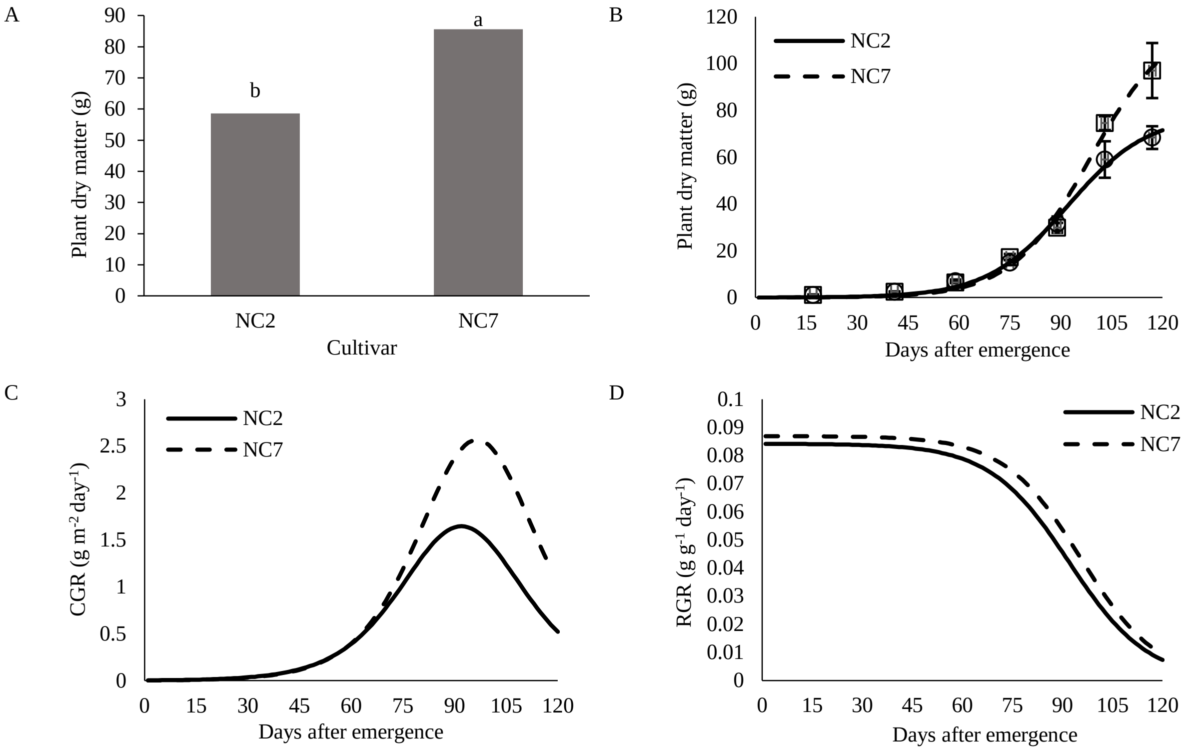

Figure 1. A- Mean comparison of the plant dry matter of the studied peanut cultivars, B- Dry matter accumulation tendency between the NC2 and the NC7 cultivars during the growing season, C- The changes in the crop growth rate (CGR) and D- Relative growth rate (RGR) during the growing season of peanuts.

The effect of different weed management treatments on single-plant dry matter was different. The highest (88.25 g) and the lowest (21.13 g) plant dry matter were obtained in hand weeding (M4) and weed-infested (M5) treatments, respectively. Also, among the integrated control treatments, the highest plant dry matter was obtained under the effect of the herbicide Trifluralin (M2) (Fig. 2). Examining the trend of dry matter accumulation among different treatments related to weed control showed that dry matter accumulation of peanut plants increased 60 days after emergence in all treatments. The highest plant dry matter weight was obtained from the manual weeding control treatment compared to other treatments (Fig. 2).

Except for the M4 treatment (hand weeding), there was no significant difference between the other weed control treatments in terms of the effect of the planting pattern on the kernels dry weight in the peanut plant. The kernels dry weight per plant in the manual weeding treatment showed a 39.31% increase under the influence of planting pattern P1 (row spacing 50 × plant spacing 25 cm) compared to planting pattern P2 (row spacing 75 × plant spacing 18 cm) (Fig. 3).

The highest seed dry weight per plant (22.64 g) was obtained under the influence of the P1 planting pattern in the NC2 variety. While under the influence of planting pattern P2 (row distance 75 × plant distance 18 cm), the highest seed dry weight per plant (21.89 g) was obtained in the NC7 cultivar (Fig. 3). Comparing the 100-seed weight of peanuts from weed-free treatments with those that were infested with weeds throughout the growing season, weed interference reduced the 100-seed weight of cultivars Kayapo (15%), Runner Tegua (14%), IAC-22 (31%), ST-Tatu (8%) and IAC figure was 1075 (15%). Therefore, the most sensitive variety to weed interference concerning the weight of 100 kernels was IAC-22, and the least sensitive was ST-Tatu (Agostinho *et al.*, 2006).

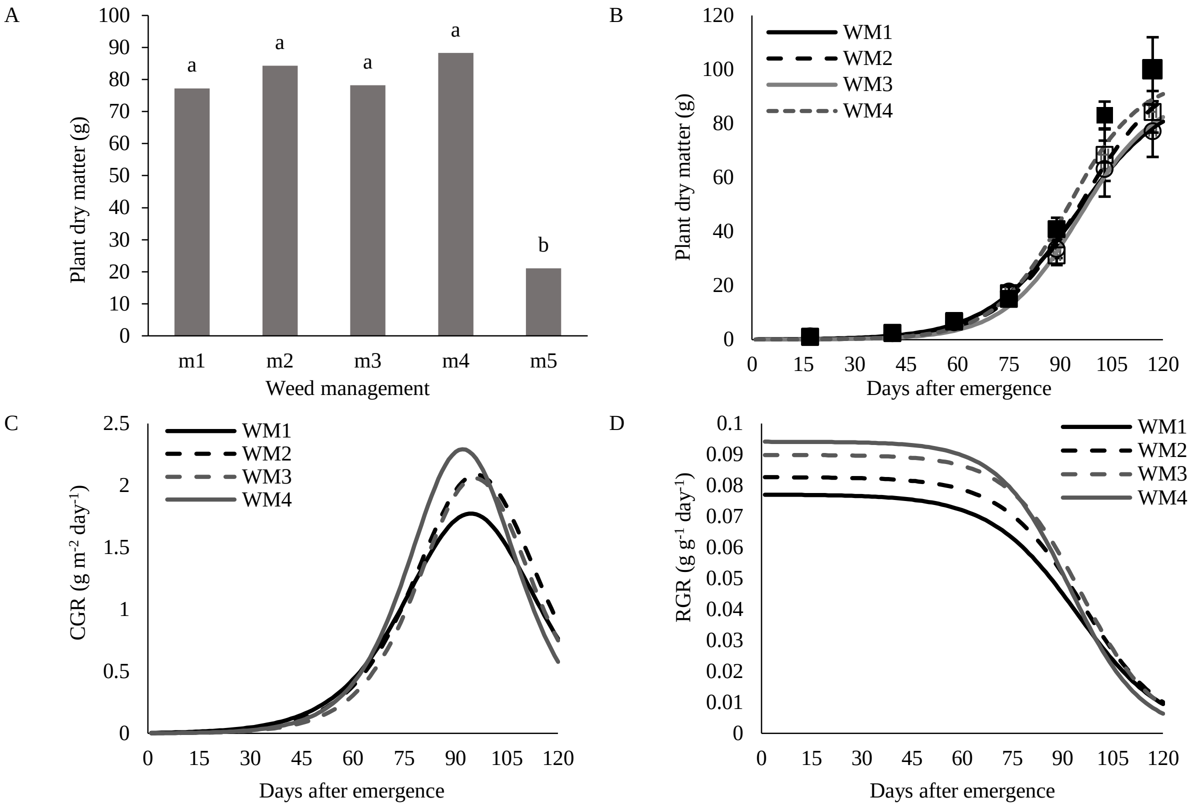

Figure 2. A- Mean comparison of the plant dry matter in the different weed management treatments, B- Dry matter accumulation tendency, C- The changes in the crop growth rate (CGR) and D- Relative growth rate (RGR) during the growing season of peanuts. M1 = Trifluralin + Bentazon + Haloxyfop-r-methyl, M2 = Trifluralin alone, M3 = Bentazon + Haloxyfop-r-methyl, M4 = weeding (every two weeks) and M5 = weed-infested

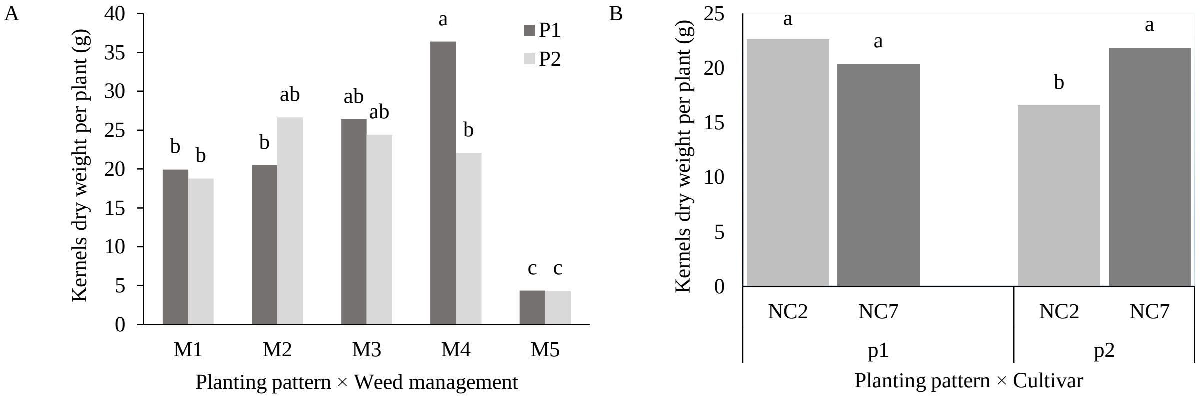

Figure 3. A- The interaction effect of different weed control methods (M1 = Trifluralin + Bentazon + Haloxyfop-r-methyl, M2 = Trifluralin alone, M3 = Bentazon + Haloxyfop-r-methyl, M4 = weeding (every two weeks) and M5 = weed-infested) and planting pattern (P1 = row spacing 50 cm × plant spacing 25 cm, and P2= row spacing 75 cm × plant spacing 18 cm), and B- the interaction effect of cultivar (NC2 and NC7) and planting pattern (P1 = row spacing 50 cm × plant spacing 25 cm, and P2= row spacing 75 cm × plant spacing 18 cm) on the kernels dry weight of peanuts

3.2. Pods dry weight per plant

The response of pods dry weight per plant to weed management and planting pattern was different. The highest pod dry weight per plant (51 g) was obtained under the influence of manual weeding management (M4) and planting pattern P1 (row spacing 50 × plant spacing 25 cm). In general, the results showed that under the influence of weed management treatments, the highest pod dry weight per plant was obtained in all treatments in the P1 planting pattern (row spacing 50 × plant spacing 25 cm) (Fig. 4).

The highest pod dry weight per plant was obtained under planting pattern P1 (row distance 50 × plant distance 25 cm) for the NC2 variety. Also, the results showed that, in general, for NC2 and NC7 cultivars, the highest pod dry weight per plant was produced in the P1 planting pattern (row spacing 50 x plant spacing 25 cm) (Fig. 4).

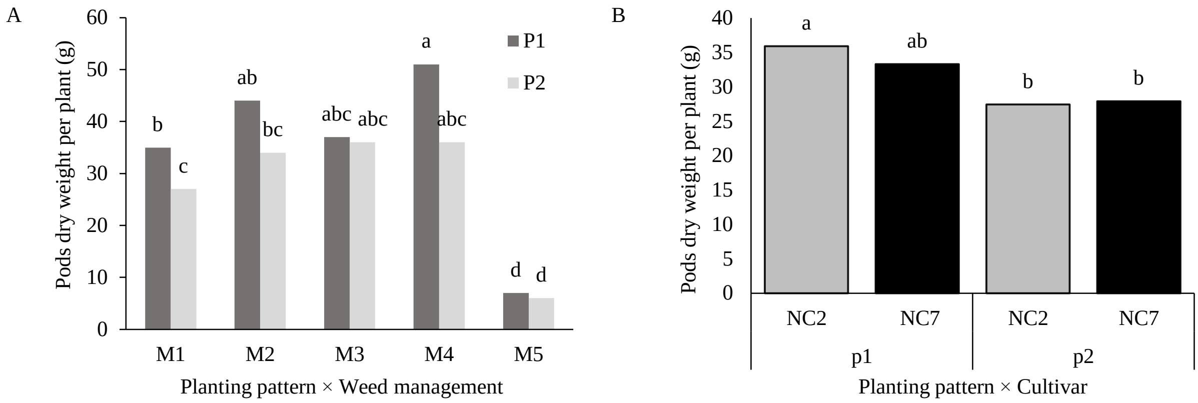

Figure 4. A- The interaction effect of different weed control methods (M1 = Trifluralin + Bentazon + Haloxyfop-r-methyl, M2 = Trifluralin alone, M3 = Bentazon + Haloxyfop-r-methyl, M4 = weeding (every two weeks) and M5 = weed-infested) and planting pattern (P1 = row spacing 50 cm × plant spacing 25 cm, and P2= row spacing 75 cm × plant spacing 18 cm), and B- the interaction effect of cultivar (NC2 and NC7) and planting pattern (P1 = row spacing 50 cm × plant spacing 25 cm, and P2= row spacing 75 cm × plant spacing 18 cm) on the pods dry weight of the peanuts

In our study plant dry matter in NC7 was higher than NC2 cultivar. The dry matter accumulation and CGR of the two peanut cultivars initially started low but increased over time. both NC7 and NC2 cultivars had similar dry matter accumulation and CGR in the early growing season. However, As the season progressed, NC7 surpassed NC2. Furthermore, the RGR of NC7 was higher than that of NC2 throughout the growing season. CGR, RGR, and plant dry matter accumulation are closely related to biomass production. Plant growth analysis using growth analysis indices provides a powerful tool for evaluating performance and growth efficiency in different plant species (Koca and Erekul, 2016). Olayinka and Etejere (2015) observed that growth and yield parameters, including CGR and RGR, were significantly different among groundnut cultivars (Samnut 10 and MK 373). Olayinka and Etejere (2015) found that differences in peanut cultivars showed that cultivar MK 373 had a higher CGR than cultivar Samnut 10, and this could be due to higher dry matter accumulation. The reduction in crop growth 8-10 weeks after planting in MK 373 and Samnut 10 cultivars, respectively, could be due to the loss of leaves due to pest attack and leaf shading, which was higher in treatments that produced more leaves.

The influence of weed management treatments on individual plant dry matter was substantial when compared to the absence of weed management. The reason for the increase in the plant dry matter under the influence of weeding treatment can be due to the complete removal of weeds and, as a result, the reduction of the competition between the crop plant and the weed to absorb water, nutrients, and light. Moreover, examining the CGR and RGR (Fig. 2) in different weed control treatments confirmed this. Comparing the effects of weed control methods on the plant dry matter did not show any significant difference. Even though weed control using these methods caused a significant increase in plant growth and dry matter accumulation compared to the no-control treatment. Based on the obtained results, it appears that during the initial phase of the growing season up to day 60, peanuts demonstrate lower levels of dry matter accumulation, slower product growth, and relatively sluggish growth compared to later stages. Consequently, these characteristics make peanuts less competitive in the early growing season stages.

Weed management had an apparent effect on the growth rate of the peanut crop. So, the CGR in WM4 treatment (hand weeding) during the growing season was higher than in other weed control treatments. The growth of peanuts has been observed to achieve its maximum potential when grown without weed interference, as indicated by studies showing that groundnut growth in the absence of weeds can lead to optimal leaf area index (LAI) and dry matter accumulation. Olayinka and Etejere (2015) found that weed control treatments significantly increased peanut yield and growth, including dry matter accumulation and CGR. Also, it has been reported that higher levels of LAI and NAR can increase CGR in hand-weeding treatment (Olayinka and Etejere, 2015). LAI is an important determinant of dry matter accumulation and can determine grain yield (Liu *et al.*, 2023). Weed control increases plant height and groundnut dry matter production (Singh and Giri, 2001). The application of herbicide significantly impacted physiological parameters such as leaf area index (LAI), dry matter accumulation, and crop growth rate (CGR). By effectively controlling weed competition, these herbicides allowed groundnut plants to allocate more resources towards growth and development. Consequently, there was a significant increase in pod yield and overall productivity compared to untreated control plots (Sahoo *et al.*, 2017).

In the P1 planting pattern, the rows were 50 cm apart, which was 25 cm closer compared to the P2 planting pattern with row spacing of 75 cm. The P2 planting pattern allowed for more space, potentially leading to a higher tolerance for weeds between the rows by peanuts. In the context of the arrangement of P1 with a row spacing of 50 cm, the closer distance between the rows could lead to earlier competition in the presence of weeds, thereby increasing the expected competitive effect of weeds.

Hand weeding of weeds in the P1 planting pattern has had a more positive effect. This proper spatial arrangement has resulted in the reduction of interspecies competition among peanut plants (plant distance of 25 cm), while weeding has decreased weed competition. These two factors have resulted in a noticeable increase in the kernels dry weight per plant. According to (Sharma *et al.*, 2015), a weed-free environment plays a crucial role in facilitating the growth and development of peanut plants and supports essential processes such as flowering, peg formation, soil penetration, pod formation, and pod development. These factors collectively contribute to an increase in the number of pods produced per plant, as well as higher seed weight and overall pod yield per hectare.

Furthermore, the increase in pods dry weight in the P1 planting pattern (row distance 50 x plant distance 25 cm) can be due to better distribution of light in the canopy, suitable spatial distribution of plants, and reduced intra-species competition between the peanut plants to use environmental factors. Also, increasing the LAI and, as a result, more photosynthesis of the plant can increase the dry weight of the pods. Research conducted by (Zhao *et al.*, 2017) indicates that an optimal planting density of 195,000-225,000 plants per hectare has been associated with the highest number of pods for pod production and dry weight yield. This suggests that the number of plants per unit area significantly impacts the productivity of peanut crops. Adhering to the recommended planting density range allows farmers to strike a balance between maximizing pod production and optimizing resource utilization. The results focus on the relationship between weed control, planting density, and peanut pod growth and yield. These findings offer valuable insights for peanut farmers and agricultural professionals seeking to enhance productivity through cultivation practices.

4. Conclusion

The findings of this study highlight the importance of cultivar selection, planting patterns, and weed management practices in optimizing peanut growth and yield. Analyzing the dry matter accumulation process, growth rate, and RGR of peanuts revealed a sluggish growth pattern from the initial stages of the season up to the 60th-day post-emergence. This underscores the critical role of weed control during this critical period. Combining herbicidal treatments with manual and mechanical weeding operations appears to be a promising approach for effective weed suppression and yield enhancement in peanut cultivation.

Conflict of interests

All authors declare no conflict of interest.

Ethics approval and consent to participate

No humans or animals were used in the present research. The authors have adhered to ethical standards, including avoiding plagiarism, data fabrication, and double publication.

Consent for publications

All authors read and approved the final manuscript for publication.

Availability of data and material

The data that support the findings of this study are available on request from the corresponding author.

Authors' contributions

Alireza Bagheri: Conceptualization, Methodology, Software, Data curation, Supervision, Reviewing and Editing, Yasin Norouzi: Conceptualization, Software, Writing-Original draft preparation, Hamidreza Chaghazardi: Conceptualization, Reviewing and Editing.

Informed consent

The authors declare not to use any patients in this research.

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