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IMPACT ASSESSMENT OF THE COMPETITION ON WEED DYNAMICS, PLANT GROWTH, AND YIELD AND DETERMINATION OF CRITICAL PERIOD OF CROP-WEED COMPETITION IN GREEN GRAM (*VIGNA RADIATA* L.)

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ABSTRACT

A field experiment was conducted at Agronomy Instructional Farm, Department of Agronomy, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Banaskantha (North Gujarat Agro-climatic Zone of Gujarat) during July-September2024 on loamy sand soil to assess the Study on critical period of crop-weed competition in green gram (*Vigna radiata* L.) under North Gujarat condition which consisted eight treatments and replicated thrice in randomized block design. The variety "GM 4" was used for experiment. Among the several treatments, weed free up to harvest treatment recorded significantly higher seed and stover yield (1344 and 3247 kg/ha, respectively) and was found at par with weed free up to 45 DAS (1235 and 3125 kg/ha, respectively), weed free up to 30 DAS (1155 and 2956 kg/ha, respectively) and weedy up to 15 DAS (1122 and 2816 kg/ha, respectively) as compared to weedy up to harvest (636 and 1462 kg/ha, respectively) owing to lower density of sedges, grasses, broad leaf and total weeds at 15, 30, 45 DAS and at harvest. Furthermore, weed free up to harvest recorded higher net energy returns followed by weed free up to 45, 30 DAS and weedy up to 15 DAS as compared to weedy up to harvest.
***Keywords* :** Correlation, green gram, nodules, regression, weed density, yield, weed.

Introduction

Among the pulses, green gram (*Vigna radiata* L.) is one of the most important and extensively cultivated crop in arid and semi-arid regions of India belonging to the family *Leguminosae* subfamily *Papilionaceae.* Mungbean is one of the rich vegetarian source of protein and also contains vitamin B. Green gram plays an important role as a food security crop because of its nutritional quality as well as its ability to survive in harsh environmental conditions such as arid and semiarid lands. Green gram crop is also used as green manuring crop for increasing soil fertility and carbon source. In India, green gram is cultivated on around 51.87 lakh ha area with of production of 31.03 lakh tonnes and productivity of 598 kg/ha (Anon., 2023-24). It is primarily a rainy season crop but with the development of early maturing varieties, it has also proved to be an ideal crop for spring and summer season. Weed infestation is one of the major constraints in green gram cultivation. During the summer and rainy seasons, weeds are the main factor that reduces mungbean yield. Weeds are fast growing in nature having enormous seed production capacity compared to crops. Therefore, it is important to develop cost effective weed management practices for improving the productivity and profitability of green gram. Chaudhari *et al*. (2016) stated that in green gram, major weed flora observed were *Cyperus rotundus* in sedges, *Cynodon dactylon, Digitaria* *sanguinalis, Echinochloa crusgalli* in grasses, *Amaranthus viridis, Alternanthera pungens, Convolvulus arvensis, Digera arvensis, Eclipta alba, Euphorbia hirta, Physalis minima, Sorghum halepense, Trianthema portulacastrum, Vernonia cinerea* in broad leaf weeds. Among the different growth stages the period of crop growth which is most sensitive to weed competition is called as critical period of crop-weed competition. It begins when both competes with each other for same resources such as nutrients, light, space and water at the same time. Weeds grow faster when compared to crop and takes available resources during competition and suffer the crops from starvation. Hence, this ultimately affects the crop growth which finally leads to yield loss. Singh *et al*. (2015) stated that when green gram was severely infested with weeds during critical stages there was a yield reduction between 30 and 85 per cent. Hence, identification of critical period of crop-weed competition in green gram is very important, based on which proper weed management strategy can be implemented for the timely and effective weed control.

Material and Methods

The field experiments were carried out during *kharif* season 2024 in randomized block design (RBD) with consisted eight treatments *viz*., Weed free up to 15 DAS, Weed free up to 30 DAS, Weed free up to 45 DAS, Weed free up to harvest, Weedy up to 15 DAS, Weedy up to 30 DAS, Weedy up to 45 DAS, Weedy up to harvest at Agronomy Instructional Farm, Department of Agronomy, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Banaskantha (North Gujarat Agro-climatic region (AES IV) of Gujarat) at a 24^o 19' North latitude and 72^o 19' East longitude with an elevation of 154.52 meters above the mean sea level. The experimental field was ploughed by tractor drawn cultivator and was followed by harrowing and planking to obtain fine seedbed. The green gram cultivar "GM 4" was sown manually at a spacing of 45×10 cm^2 at a depth of on 8th July, 2024 with a seed rate of 17.5 kg/ha. The gross plot size and net plot size of the experiment were 5.0×4.5 m^2 and 3.6×2.7 m^2, respectively. The crop was fertilized with application of well decomposed FYM @ 5 t/ha at ten days before sowing and 20:40 kg/ha N:P_2O_5 at sowing. The sources of fertilizers used were DAP and urea which were commonly applied to soil for all treatments just before sowing of seeds in the furrow. The first irrigation was given immediately after sowing of crop and there was rainfall at six days after sowing which was enough for ensuring proper germination and establishment of the seed. Remaining irrigations were given as per requirement of crop.

The experimental field had an even topography with a gentle slope having good drainage. The soil of experimental field was loamy sand in texture with slightly alkaline in reaction and electrical conductivity within safe limit. The soil was low in organic carbon and available nitrogen, medium in available P_2O_5 and available K_2O. The crop was harvested on 24th September, 2024 manually at physiological maturity. Randomly selected previously tagged five plants from each net plot were harvested separately for recording different biometric observations and later on these five plant yields were added to the seed yield of respective net plots. During the crop season weeding was carried out by manual labour as per treatments. The species wise number of weeds/0.25 m^2 from each plot was recorded from two spots at 15, 30, 45 DAS and at harvest by using 50 cm × 50 cm quadrate at random locations and was averaged over two spots. Further, the data was multiplied with four to convert the data into No./m^2. Since the weed count data does not follow normal distribution, the weed count data were analyzed after subjecting to $\sqrt{x+1}$ transformation as suggested by Gomez and Gomez (1984).Chlorophyll content index (CCI) was measured by using chlorophyll concentration meter (MC-100) at 30 and 45 DAS from the previously tagged five plants leaves from the each net plot. At 30 and 45 DAS, PSII quantum yield was measured by using porometer/ fluorometer meter (LI-600) from the previously tagged five plants leaves from the each net plot. The input energy (MJ/ha) was calculated by multiplying with the all the inputs and their respective energy equivalents. The output energy was calculated by multiplying the outputs (seed and stover yield) with respective energy equivalents. From these values, the net energy returns, energy use efficiency, energy productivity, and specific energy were calculated using the following formulas (Alipour *et al*., 2012). All the growth and yield observation of green gram were measured using standard procedures. The statistical analysis of the data collected for different parameters were carried out following the standard procedures.

Results and Discussion

Effect on weed density

The density of weeds in green gram field at 15, 30, 45 DAS and at harvest was significantly affected by various weed free and weedy treatments (Table 1 to 2).Among the different treatments, density of sedges, grasses, broad leaf weeds and total weeds were recorded as nil in treatments weed free up to 15, 30, 45

DAS and at harvest. The zero density of weeds observed in these treatments was attributed to frequent and successful uprooting and removal of weeds using mechanical and physical means, which in turn led to a decrease in sedges, grasses, broad leaf weeds and total weeds. A significantly higher weed density (6.00, 17.33, 30.00 and 53.33/m², respectively) of sedges, grasses, broad leaf weeds and total weeds was observed in the weedy up to 30 DAS, which was statistically similar to the treatments with weedy conditions up to 15 DAS, weedy up to 45 DAS and weedy up to harvest due to the absence of any weed management practices during these periods. At 30 DAS stage, weed free up to 30, 45 DAS, and at harvest as well as the treatment with weedy up to 15 DAS showed zero density of sedges, grasses, broad leaf weeds, and total weed density. Following these treatments, weed free up to 15 DAS recorded comparatively lower densities of sedges, grasses, broad leaf weeds, and total weeds (4.00, 23.33, 30.67, and 58.00/m², respectively) due to weed removal being carried out during the early stages of crop growth. In contrast, a significantly higher weed density (10.67, 42.00, 58.67 and 111.33/m^2, respectively) of sedges, grasses, broad leaf weeds and total weeds was observed in the weedy up to 30 DAS which was statistically on par with the weedy up to 45 DAS and at harvest. These results are in conformity with earlier findings by Mandal *et al*. (2006) who reported that number and biomass of weeds increased gradually up to 21 DAS followed by their drastic reduction due to the shading effect of green gram plants on weeds.

At 45 DAS the density of sedges, grasses, broad leaf weeds and total weeds were depicted zero with the weed free up to 45 DAS, at harvest and weedy up to 15 and 30 DAS. Next to this treatment weed free up to 30 DAS recorded significantly lower density of sedges, grasses, broad leaf weeds and total weeds (3.33, 10.67, 18.67 and 32.67/m^2,respectively). On the other hand, weedy up to 45 DAS noticed significantly higher density of sedges, grasses, broad leaf weeds and total weeds (14.00, 42.67, 74.00 and 130.67/m^2, respectively) which was on par with weedy up to harvest. This was mainly ascribed for no weed control action from sowing to 45 DAS in these treatments. Similar results were also observed by Singh *et al.* (1996) that weed population continued to increase till 45 days after sowing. Among different treatments at harvest, weed free up to harvest and weedy up to 15, 30, 45 DAS found zero density of sedges, grasses, broad leaf weeds and total weeds. Among other treatments, significantly the lower densities of sedges, grasses, broad leaf weeds, and total weeds (2.67, 8.67, 17.33, and 28.67/m², respectively) were observed in weed free up to 45 DAS. In contrast, significantly higher densities of sedges, grasses, broad leaf weeds, and total weeds (14.00, 46.00, 74.67, and 134.67/m², respectively) were recorded in weedy up to harvest at the time of harvest. Higher weed density was observed in the weedy up to harvest treatment owing to no weed control action made throughout the crop growth period. These findings are broadly comparable to those reported by Sheoran *et al*. (2008) who reported that maintaining a weed free environment up to 40 DAS led to a significant reduction in weed population.

Effect on growth parameters

The view of dry matter accumulation per plant at 30, 45 DAS and at harvest stage of green gram are shown in Figure 1. At 30 DAS, the weed free up to harvest recorded significantly higher dry matter accumulation per plant (14.25 g/plant), which was statistically comparable to weed free up to 45, 30 and weedy up to 15 DAS. (13.31, 12.64 and 12.23 g/plant, respectively) due to reduced weeds and competition free environment at the critical stages of crop favoured the crop to utilize the factors for crop growth and production and enhanced the well balanced source sink capacities which attributed to the production of more branches and dry matter accumulation compared to all other treatments. Significantly higher dry matter accumulation per plant at 45 DAS was noticed with weed free up to harvest (29.69 g/plant) and being at par with weed free up to 45 DAS (26.78 g/plant). In the same line, among various treatments at harvest weed free up to harvest has higher dry matter accumulation (34.53 g/plant) which was on par with weed free up to 45 DAS (32.45 g/plant), weed free up to 30 DAS (30.89 g/plant) and weedy up to 15 DAS (29.70 g/plant) due to control of weeds during early growth stages resulted in improved dry matter production by crop plant. The results are in agreement with the findings by Singh and Yadav (2015), Singh *et al.* (2015), Yadav *et al.* (2018) in cowpea and Indra *et al.* (2024). However, among various treatments, weedy up to harvest recorded significantly lower dry matter accumulation per plant at 30, 45 DAS and at harvest (4.18, 10.37 and 21.16 g/plant, respectively).

At 30 DAS, significantly higher chlorophyll content index (Figure 2) was recorded under weed free treatment (41.45) which was statistically at par with weed free up to 45 DAS (40.70), weed free up to 30 DAS (39.19) and weedy up to 15 DAS (38.25). Whereas, at 45 DAS weed free up to harvest (53.52) recorded significantly higher chlorophyll content index and being at par with weed free up to 45 DAS (51.73). Next to this treatment weed free up to 30 DAS (43.02) and weedy up to 15 DAS (42.01) recorded significantly higher chlorophyll content index. On the other hand, weedy up to harvest recorded significantly lower chlorophyll content index (29.75 and 38.76, respectively) at 30 and 45 DAS. The higher total chlorophyll in these treatments might be due to better weed control in these treatments which significantly impacted chlorophyll development in plants. Similar results were also obtained by Singh *et al*. (2018) and Patel (2024). On the other hand, the lowest value was observed in the unweeded control plot, likely due to the weed population overshadowing the crop plants, limiting light availability within the crop canopy and consequently decreasing chlorophyll levels. At 30 and 45 DAS, the treatments showed no statistically significant effect on PSII quantum yield. Even though the differences were not significant, the weed free plot showed numerically the highest PSII quantum yield followed by weed free up to 45 DAS, weed free up to 30 DAS, and weedy up to 15 DAS, which also recorded relatively higher values. The lowest PSII quantum yield was seen in the unweeded check plot.

Effect on yield parameters and yield

Various yield attributes like number of pods per plant, length of pods, number of seeds per pod, test weight play vital role in increasing the productivity of green gram crop. The various yield attributing characteristics were significantly influenced by various treatments. The information concerning yield components and green gram yield affected by different weed treatments is provided in Tables 3. Among the different treatments, weed free up to harvest recorded significantly higher number of pod per plant (23.20) and found at par with weed free up to 45 DAS (22.27), 30 DAS (21.13) and weedy up to 15 DAS (20.93). While, the weedy up to harvest treatment faced severe weed competition for nutrient, light, water and space throughout the crop growth resulting in the significantly the lowest number of pods per plant (12.47). However, the length of pod, number of seeds per pod, test weight and harvest index were not significantly differed due to various treatments effects. The increase in yield attributes under these treatments due to improved crop growth parameters like higher dry matter accumulation and chlorophyll content resulting from reduced weed competition during critical growth stages.

In general, seed yield of rainy season green gram showed a declining trend with increasing initial weedy period. Season long weed infestation caused yield reduction to the tune of 52.69 % compared to weed free check. Significantly higher seed and straw yield (1344 and 3247 kg/ha, respectively) of green gram was recorded when the weed free conditions were maintained throughout the crop growth period. However, there was a non-significant variation in seed yield when weed free environment were maintained up to 45 DAS (1235 and 3125 kg/ha respectively), 30 DAS (1155 and 2956 kg/ha, respectively) and weedy up to 15 DAS (1122 and 2816 kg/ha, respectively) in comparison to weedy check. The relationship between growth, yield parameters and yield were evident from significantly strong positive correlation coefficient (Table 5) between total dry matter production per plant, number of pods per plant and stover yield per plant (0.9899**, 0.9937** and 0.9969**, respectively) with the seed yield of green gram. Further, the regression equations (Table 5) also revealed that increase in dry matter production per plant by one gram/plant, number of pods per plant by one/plant and stover yield by one kg/ha at harvest increased the seed yield of green gram by 49.35, 59.51 and 0.40 kg/ha, respectively. Jaswal *et al*. (2022) witnessed that the highest seed yield was recorded in weed free. These findings are also supported by Muthuram *et al*. (2018) and Sobhana *et al*. (2018). When weedy conditions were maintained up to harvest (636, 1462 kg/ha, respectively), 45, 30 DAS and weed free up to 15 DAS recorded significantly lower seed and straw yield. Reduction in seed yield to the extent of (52.69, 45.20, 37.29 and 35.19 %, respectively) were recorded in comparison to weed free situation maintained throughout the crop growth period.

Effect on protein content and protein yield

The mean values of protein content and protein yield, as influenced by different treatments, are presented in Table 3. The data revealed that the various treatments applied in this experiment did not caused statistically significant effect on protein content. The protein content across all treatments were found to be non-significant. Among different treatments, protein yield was significantly higher under weed free up to harvest treatment (329.25 kg/ha) which was statistically on par with weed free up to 45, 30 DAS and weedy up to 15 DAS (298.33, 282.58 and 276.87 kg/ha, respectively). Wherein, weedy up to harvest registered significantly lower protein yield (155.07 kg/ha). The increased protein yields observed in the weed free up to 30, 45 DAS, at harvest and weedy up to 15 DAS treatments can be attributed to the comparatively higher seed yield achieved as a result of effective weed control measures.

Effect on energetics

Among various treatments, input energy was found higher with weed free up to harvest (6725 MJ/ha) followed by weedy up to 15 DAS (6600

MJ/ha), weed free up to 45 DAS (6575 MJ/ha) and weedy up to 30 DAS (6499 MJ/ha). Whereas, unweeded check witnessed lower input energy (6248 MJ/ha). Whereas, among various treatments, weed free up to harvest treatment recorded higher output energy, net energy returns, energy use efficiency, energy productivity and lower specific energy (60344 MJ/ha, 53619 MJ/ha, 8.973, 0.200 kg/MJ and 5.00 MJ/kg, respectively) which was followed by weed free up to 45 DAS (57217 MJ/ha, 50642 MJ/ha, 8.703, 0.188 kg/MJ and 5.32 MJ/kg, respectively), weed free up to 30 DAS (53929 MJ/ha, 47429 MJ/ha, 8.298, 0.178 kg/MJ and 5.63 MJ/kg, respectively) and weedy up to 15 DAS (51693 MJ/ha, 45094 MJ/ha, 7.833, 0.170 kg/MJ and 5.88 MJ/kg, respectively). Wherein, weedy up to harvest recorded lower output energy, net energy returns, energy use efficiency, energy productivity and higher specific energy (27624 MJ/ha, 21376 MJ/ha, 4.421, 0.102 kg/MJ and 9.82 MJ/kg, respectively). Under the weed free up to harvest treatment, higher input energy was observed due to the greater energy demand associated with the increased use of manual labour for hand weeding. Nevertheless, the lower energy input observed under the unweeded check was directly attributed to the absence of any energy expenditure on weed control operation. The higher output energy were attributed to increased yields which were primarily due to improved crop growth conditions resulting from effective weed control, which enhanced overall growth and yield attributes. Reduced crop-weed competition and a more favorable growing environment contributed to greater energy returns relative to the energy invested. This was evident in higher net energy returns, improved energy use efficiency, greater energy productivity, and reduced specific energy consumption. This was due to severe weed competition in the weedy up to harvest, which hindered crop growth and significantly reduced yield. As a result, the overall output energy decreased, leading to lower net energy returns, reduced energy use efficiency and productivity, and higher specific energy due to poor resource utilization. Charitha *et al.* (2024) mentioned that highest pod energy output, total energy output and net energy was observed in weed free treatment in groundnut.

Conclusion

Based on results of one year field experiment, it is concluded that critical period of crop-weed competition in green gram is from 15 to 30 days after sowing to obtain higher yield and net energy return through effective weed control.

Table 1: Effect of different treatments on category wise weed density (No./m^2) at 15 and 30 DAS in green gram

Treatments	At 15 DAS				At 30 DAS			
	Sedges	**Grasses**	**Broad leaf weeds**	**Total**	**Sedges**	**Grasses**	**Broad leaf weeds**	**Total**
T_1: Weed free up to 15 DAS	1.00^b (0.00)	1.00^b (0.00)	1.00^b (0.00)	1.00^b (0.00)	2.20^b (4.00)	4.93^b (23.33)	5.61^b (30.67)	7.67^b (58.00)
T_2: Weed free up to 30 DAS	1.00^b (0.00)	1.00^b (0.00)	1.00^b (0.00)	1.00^b (0.00)	1.00^c (0.00)	1.00^c (0.00)	1.00^c (0.00)	1.00^c (0.00)
T_3: Weed free up to 45 DAS	1.00^b (0.00)	1.00^b (0.00)	1.00^b (0.00)	1.00^b (0.00)	1.00^c (0.00)	1.00^c (0.00)	1.00^c (0.00)	1.00^c (0.00)
T_4: Weed free up toharvest	1.00^b (0.00)	1.00^b (0.00)	1.00^b (0.00)	1.00^b (0.00)	1.00^c (0.00)	1.00^c (0.00)	1.00^c (0.00)	1.00^c (0.00)
T_5: Weedy up to 15 DAS	2.51^a (5.33)	3.92^a (14.67)	5.16^a (26.00)	6.81^a (46.00)	1.00^c (0.00)	1.00^c (0.00)	1.00^c (0.00)	1.00^c (0.00)
T_6: Weedy up to 30 DAS	2.58^a (6.00)	4.28^a (17.33)	5.57^a (30.00)	7.37^a (53.33)	3.40^a (10.67)	6.54^a (42.00)	7.72^a (58.67)	10.59^a (111.33)
T_7: Weedy up to 45 DAS	2.37^a (4.67)	3.87^a (14.00)	5.72^a (32.00)	7.17^a (50.67)	3.69^a (12.67)	6.32^a (39.33)	7.52^a (56.00)	10.42^a (108.00)
T_8: Weedy up to harvest	2.20^a (4.00)	4.19^a (16.67)	5.41^a (28.67)	7.09^a (49.33)	3.20^a (9.33)	6.18^a (37.33)	7.49^a (55.33)	10.14^a (102.00)
S. Em. ±	0.16	0.17	0.22	0.22	0.17	0.20	0.25	0.25
C.V. %	16.51	11.85	12.04	9.24	14.36	10.09	10.60	8.12

Figures inside and outside the parentheses are original and $\sqrt{x+1.0}$ transformed values, respectively.
Treatment means with the letter(s) in common are not significantly different by DNMRT at 5% level of significance.

Table 2: Effect of different treatments on category wise weed density (No./m^2) at 45 and at harvest in green gram

Treatments	At 45 DAS				At harvest			
	Sedges	Grasses	Broad leaf weeds	Total	Sedges	Grasses	Broad leaf weeds	Total
T_1: Weed free up to 15 DAS	2.37^b (4.67)	5.23^b (26.67)	5.87^b (34.00)	8.14^b (65.33)	2.49^b (5.33)	5.28^b (27.33)	6.13^b (36.67)	8.38^b (69.33)
T_2: Weed free up to 30 DAS	2.07^b (3.33)	3.40^c (10.67)	4.43^c (18.67)	5.79^c (32.67)	2.37^b (4.67)	3.74^c (13.33)	4.60^c (20.67)	6.30^c (38.67)
T_3: Weed free up to 45 DAS	1.00^c (0.00)	1.00^d (0.00)	1.00^d (0.00)	1.00^d (0.00)	1.90^c (2.67)	3.11^c (8.67)	4.24^c (17.33)	5.43^d (28.67)
T_4: Weed free up to harvest	1.00^c (0.00)	1.00^d (0.00)	1.00^d (0.00)	1.00^d (0.00)	1.00^d (0.00)	1.00^d (0.00)	1.00^d (0.00)	1.00^e (0.00)
T_5: Weedy up to 15 DAS	1.00^c (0.00)	1.00^d (0.00)	1.00^d (0.00)	1.00^d (0.00)	1.00^d (0.00)	1.00^d (0.00)	1.00^d (0.00)	1.00^e (0.00)
T_6: Weedy up to 30 DAS	1.00^c (0.00)	1.00^d (0.00)	1.00^d (0.00)	1.00^d (0.00)	1.00^d (0.00)	1.00^d (0.00)	1.00^d (0.00)	1.00^e (0.00)
T_7: Weedy up to 45 DAS	3.87^a (14.00)	6.58^a (42.67)	8.66^a (74.00)	11.47^a (130.67)	1.00^d (0.00)	1.00^d (0.00)	1.00^d (0.00)	1.00^e (0.00)
T_8: Weedy up to harvest	3.56^a (12.00)	6.74^a (44.67)	8.53^a (72.00)	11.37^a (128.67)	3.87^a (14.00)	6.84^a (46.00)	8.69a (74.67)	11.64^a (134.67)
S. Em. ±	0.18	0.25	0.22	0.21	0.13	0.23	0.26	0.16
C.V. %	15.74	13.34	9.51	7.12	12.50	14.10	12.77	6.13

Figures inside and outside the parentheses are original and √x+1.0 transformed values, respectively
Treatment means with the letter(s) in common are not significantly different by DNMRT at 5% level of significance

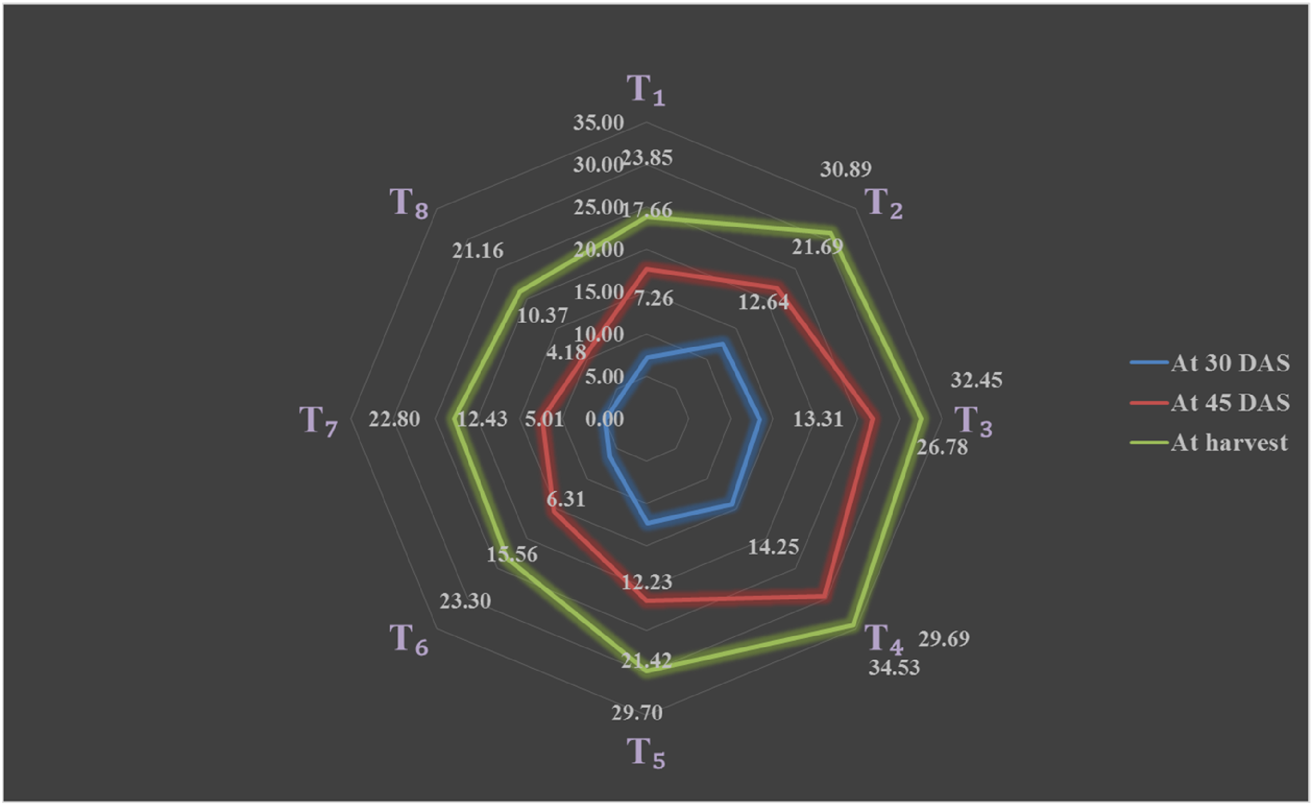

Fig. 1: Effect of different treatments ondry matter accumulation (g/plant) at different stages in green gram

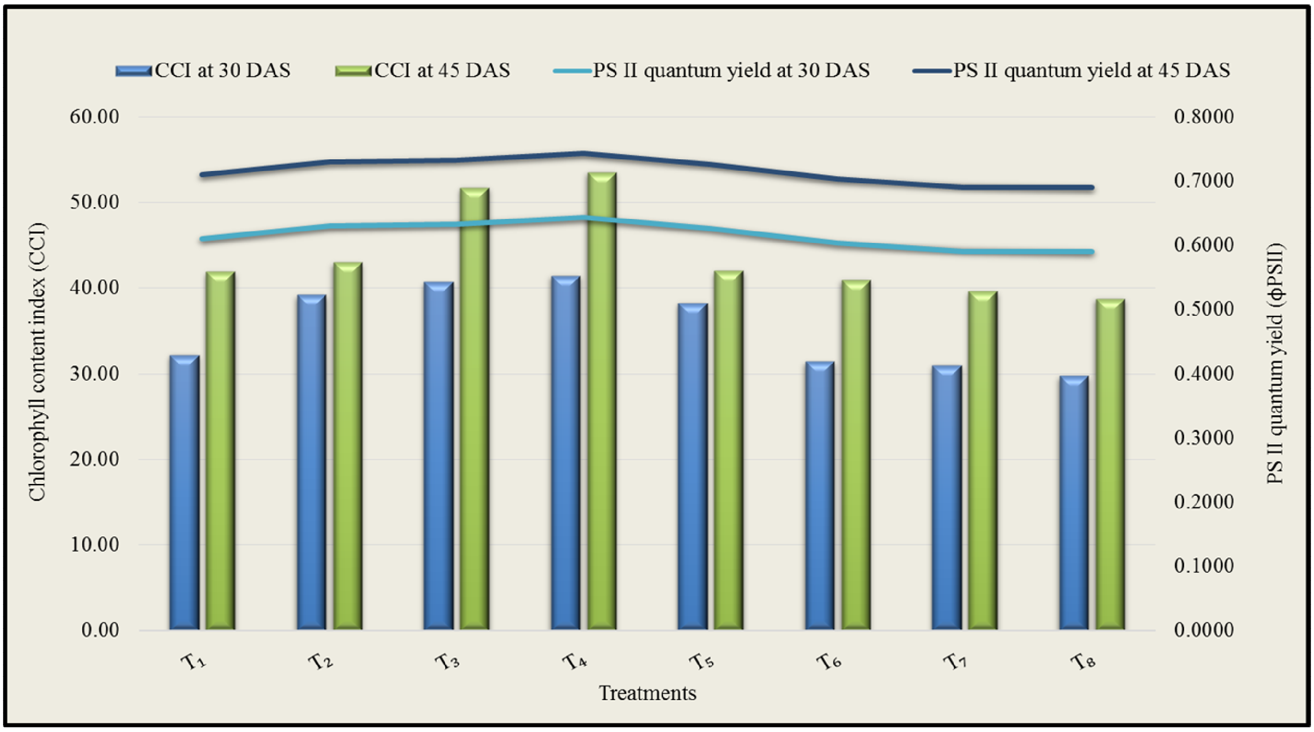

Fig. 2: Effect of different treatments on CCI and PSII quantum yield (ΦPSII) at 30 and 45 DAS in green gram

Table 3: Effect of different treatments on yield parameters, yield, protein content and protein yield in green gram

Treatments	Number of pods per plant	Length of pod (cm)	Number of seeds per pod	Test weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	HI %	Protein content (%)	Protein yield (kg/ha)
T_1: Weed free up to 15 DAS	16.00	7.93	9.40	35.58	871	2249	27.74	24.45	213.01
T_2: Weed free up to 30 DAS	21.13	8.23	9.93	36.55	1155	2956	28.25	24.48	282.58
T_3: Weed free up to 45 DAS	22.27	8.17	10.07	37.67	1235	3125	28.45	24.36	298.33
T_4: Weed free up to harvest	23.20	8.23	9.73	36.72	1344	3247	29.24	24.55	329.25
T_5: Weedy up to 15 DAS	20.93	7.45	8.93	37.13	1122	2816	28.63	24.68	276.87
T_6: Weedy up to 30 DAS	15.47	8.11	9.53	38.08	843	2189	27.77	24.32	194.59
T_7: Weedy up to 45 DAS	13.27	8.04	10.27	36.63	736	2024	26.74	24.47	164.53
T_8: Weedy up to harvest	12.47	8.05	10.40	36.06	636	1462	30.48	24.39	155.07
S. Em. ±	1.15	0.60	0.71	2.89	78	184	-	0.67	20.00
C.V. %	3.50	NS	NS	NS	236	559		NS	60.68
	11.05	13.02	12.60	13.62	13.59	12.73		4.71	14.48

Table 4: Energetics of green gram as influenced by different treatments

Treatments	Input energy (MJ/ha)	Output energy (MJ/ha)	Net energy returns (MJ/ha)	Energy use efficiency	Energy productivity (kg/MJ)	Specific energy (MJ/kg)
T_1: Weed free up to 15 DAS	6399	40916	34518	6.394	0.136	7.35
T_2: Weed free up to 30 DAS	6499	53929	47429	8.298	0.178	5.63
T_3: Weed free up to 45 DAS	6575	57217	50642	8.703	0.188	5.32
T_4: Weed free up to harvest	6725	60344	53619	8.973	0.200	5.00
T_5: Weedy up to 15 DAS	6600	51693	45094	7.833	0.170	5.88
T_6: Weedy up to 30 DAS	6549	39755	33205	6.070	0.129	7.77
T_7: Weedy up to 45 DAS	6474	36119	29645	5.579	0.114	8.80
T_8: Weedy up to harvest	6248	27624	21376	4.421	0.102	9.82

Table 5: Correlation and regression equations for various dependent and independent parameters of green gram

Sr. No.	Independent variable(x)	Dependable variable (y)	r	Regression equation	R^2
1	Dry matter accumulation/plant at harvest (g/plant)	Seed yield(kg/ha)	0.9899**	y= -356.40 + 49.35x	0.9799
2	Number of pods per plant	Seed yield(kg/ha)	0.9937**	y= -84.05 + 59.51x	0.9875
3	Stover yield (kg/ha)	Seed yield(kg/ha)	0.9869**	y= -20.40 + 0.40x	0.9739
4	Dry matter accumulation/plant at harvest (g/plant)	Stover yield (kg/ha)	0.9692**	y= -719.19 + 118.08x	0.9394

r = Correlation coefficient. '*' and '**' indicate significant at 5% and 1%, respectively

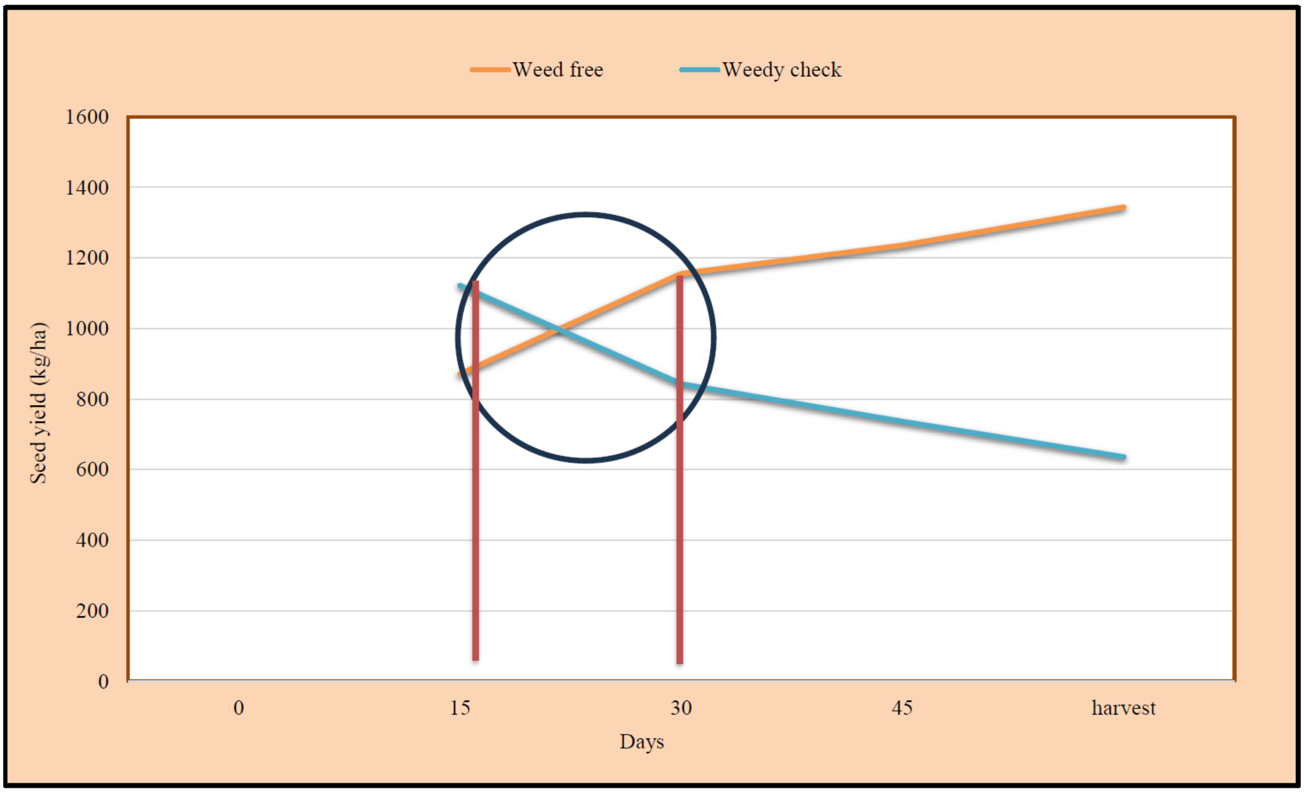

Fig. 3: Critical period of crop-weed competition in green gram

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