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Effect of integrated weed management on summer green gram (*Vigna radiata*)

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Abstract
A field experiment was conducted in the experimental research farm of School of Agricultural Sciences and Rural Development (SASRD), Nagaland University during the summer period of 2021 to study the "Effect of Integrated Weed Management in summer green gram (*Vigna radiata*)". The experimental design was randomized block design (RBD) with three replications. The treatment consists of T_1: Weedy check, T_2: Hand weeding at 20 DAS and 40 DAS, T_3: Rice straw mulching @5 t/ha^{-1}, T_4: Pendimethalin @ 0.75 kg/ha^{-1} (PE) fb Hand weeding at 20 DAS, T_5: Pendimethalin @0.75 kg/ha^{-1} (PE) fb Rice straw mulching @5 t/ha-1, T_6: Pendimethalin @0.75 kg/ha^{-1} (PE) fb Quizalofop p-ethyl @ 0.15 kg/ha^{-1} (PoE) at 30 DAS, T_7: Imazethapyr @ 0.5 kg/ha^{-1} (EPoE) at 15 DAS fb Quizalofop p-ethyl @0.15 kg/ha^{-1} (PoE) at 30 DAS. The result revealed that hand weeding at 20 DAS and 40 DAS gave the highest growth and yield of green gram (627.81 kg/ha^{-1}) which was found to be at par with pendimethalin @ 0.75 kg/ha^{-1} (PE) *fb* Hand weeding at 20 DAS (614.64 kg/ha^{-1}). Among the weed management practices, hand weeding at 20 DAS and 40 DAS gave minimum weed population, weed dry weight accumulation there by, giving the highest weed control efficiency and recorded highest growth and yield in green gram followed by pendimethalin @ 0.75 kg ha^{-1}(PE) *fb* Hand weeding at 20 DAS recorded the highest growth and yield parameters. Pendimethalin @ 0.75 kg ha^{-1} (PE) *fb* Hand weeding at 20 DAS gave the highest B:C ratio (1.59) and was found to be economically best feasible treatment for summer green gram.

Keywords: Green gram, hand weeding, herbicides, weed management

Introduction
Green gram is one of the most important legume crops in south and southeast Asia. Green gram is botanically called as *Vigna radiata* and it is believed to have been originated from India and Central Asia. Green gram is also called as Mung bean or Moong. It is a warm season annual highly branched having trifoliate leaves. The global green gram area is about 7.3 million ha, and the average yield is 721 kg/ha. India and Myanmar each account for 30% of global output of 5.3 mt. In India, green gram is sown on an area of about 3 million hectares with the production of about 1 million tonnes. Indian contributes more than 70% of world's green gram production. The major green gram states are Orissa, Maharashtra, Andhra Pradesh, Telangana, Rajasthan, Madhya Pradesh, Bihar, Karnataka and Uttar Pradesh. Orissa stands first in area, production as well as productivity of green gram in India, followed by Maharashtra and Andhra Pradesh as compared to Maharashtra.

Among all the biotic factors responsible for production of green gram, weeds are one of the factors which play a significant role in green gram production by deteriorating its growth stages and effect on its yield where undue importance on weed management could result in 30-90% yield losses in green gram (Mirjha, *et al*. 2013) [7]. The most commonly noticed grass weeds in green gram are *Echinochloa colona, Echinochloa crussgalli, Digitaria sanguinalis, Eleusine indica* etc., sedges like *Cyperus rotundus* and broad weeds like *Chenopodium album* etc. Certain herbicides have proved remarkably effective in providing weed free conditions. Herbicidal treatments like quizalofop-ethyl, fenoxaprop-p-ethyl, pendimethalin, Imazethapyr, oxyfluorfen etc., are found to be relatively more effective in controlling weeds in green gram. Cultural practices like two hand weeding with two inter culture 20 DAS and 40 DAS proved its superiority over rest of the weed management in summer green gram. In order to prevent any overuse of herbicide as well as to reduce the high cost of repeated hand weeding, combination of cultural, mechanical and chemical methods of weed management may give higher weed control efficiency and economic benefits than that of any individual method. Therefore, to find out the effective ways of weed management, the experiment was carried out in the summer season of Nagaland.

Materials and Methods

An experiment was conducted at the research farm of Agronomy of School of Agricultural Sciences and Rural Development (SASRD), Nagaland University campus, Medziphema during summer season, 2021. The climate of the experimental field represented sub-tropical zone with high relative humidity, moderate temperature with medium to high rainfall. The soil of experimental field was medium in nitrogen (274.67 kg/ha^{-1}), low in phosphorus (12.7 kg/ha^{-1}) and medium in potassium (191.20 kg/ha^{-1}) content and acidic in soil reaction (pH 4.56). Experiment was conducted in randomized block design having seven treatments with three replications. Weed management practices comprised of viz., T_1 : Weedy check, T_2 : Hand weeding at 20 DAS and 40 DAS, T_3 : Rice straw mulching @ 5 t/ha^{-1}, T_4 : Pendimethalin @ 0.75 kg/ha^{-1} (PE) *fb* Hand weeding at 20 DAS, T_5: Pendimethalin @ 0.75 kg/ha^{-1} (PE) *fb* Rice straw mulching @ 5 t/ha^{-1}, T_6 : Pendimethalin @ 0.75 kg/ha^{-1} (PE) *fb* Quizalofop p-ethyl @ 0.15 kg/ha^{-1} (PoE) at 30 DAS, T_7 : Imazethapyr @ 0.5 kg/ha^{-1} (EPoE) at 15 DAS *fb* Quizalofop p-ethyl @ 0.15 kg/ha^{-1} (PoE) at 30 DAS. The recommended dose of fertilizer NPK was applied at the rate of 20 kg N, 40 kg P and 40 kg K ha^{-1}. The green gram variety SG-1 (Pratap) was used and seed rate 25 kg/ha^{-1} was used for sowing with spacing of 30 cm x 10 cm at the depth of 5 cm. The sowing was done at 10th April, 2021 and harvested at three intervals. Spraying of herbicides were done with the help of a knap sack sprayer with flood jet deflector nozzle size WFN 0.040 to ensure uniform spraying. Hand weeding was carried out as per the treatment with the help of local hand hoe and khurpi. For growth and yield attributes, five plants from each plot were selected randomly and tagged with a label for recording. Weed population were counted individually from each plot from inside an area of 0.5 × 0.5 m and expressed as count m^{-2}. The counting of weeds was done at 20 DAS, 40 DAS and 60 DAS. The data was then converted to number per square meter and was transformed using square root transformation ($\sqrt{x} + 0.5$). For weed dry weight, weeds were collected from each plot and then it was cleaned and oven dried at 60 °C till constant weight was obtained. Weeds that was oven dried were taken weight, recorded and converted to g m^{-2}. Economics of different weed control treatments was worked out on prevailing market prices of inputs and outputs.

Results and Discussion

Maximum weed infestation was observed in weedy check and the dominants broadleaf weeds were *Ageratum conyzoides* (L.), *Amaranthus viridis* (L.), *Borreria latifolia* (L.), *Chromalaena odorata* (L.), *Euphorbia hirta* (L.) and *Mimosa pudica* (L.). Among sedge weeds *Cyperus rotundus* (L.) and *Cyperus iria* (L.) were dominant. Among grassy weeds, *Cynodon dactylon* (L.), *Digitaria sanguinalis* (L.), *Eleusine indica* (L.) and *Imperata cylindrica* (L.) were most dominant.

Weed management practices showed significant influenced on weed population at 60 DAS where hand weeding at 20 DAS and 40 DAS showed minimum weed population which is due to non-selective removal of all categories of weeds and this was followed by Pendimethalin @ 0.75 kg/ha^{-1} (PE) *fb* hand weeding at 20 DAS. The initial slow growth of weeds due to application of herbicide accompanied by hand weeding at 20 DAS could reduce the weed population even up to 60 DAS. Weedy check recorded maximum weed population. Similar findings were recorded by Chaudhari *et al*. (2016) [2], Azam *et al.* (2018) [1] and Singh *et al*. (2018) [10]. In dry matter accumulation of weeds, weedy check recorded the highest weed dry matter at 60 DAS. The minimum was showed at hand weeding at 20 DAS and 40 DAS as the weeds were removed and very few weeds emerged at 60 DAS and was at par with Pendimethalin @ 0.75 kg/ha^{-1} (PE) *fb* Hand weeding at 20 DAS. This might be because of the effect of pendimethalin where it has acted on the root and the shoot growth of weeds and at the same time the removal of weeds at 20 DAS through hand weeding resulted in very limited growth of weeds. Similar findings were also found by Khaliq *et al*. (2002) [4] where two hand weeding reduced dry weight of all weeds by 79%. Also similar findings by Kumar *et al*. (2019) [6] and Kaur *et al*. (2009) [3]. Due to the control of weeds, hand weeding at 20 DAS and 40 DAS showed highest weed control efficiency, which was followed by Pendimethalin @ 0.75 kg/ha^{-1} (PE) *fb* hand weeding at 20 DAS. Similar findings have been recorded by Patel *et al*. (2016) [9]. It could be seen that application of herbicides like Quizalofop p-ethyl and Imazathapyr also resulted in better weed control efficiency than rice straw mulching.

Table 1: Effect of weed management practices on Total weeds population (no. weeds m^{-2}), total dry weight accumulation (g m^{-2}) and weed control efficiency at 60 DAS.

Treatments	Total weed population	Total dry matter accumulation	Weed control efficiency
T_1	9.97 (89.75)	26.08	---
T_2	5.64 (26.51)	6.31	77.37
T_3	6.58 (37.08)	12.21	52.51
T_4	5.85 (28.71)	7.00	74.69
T_5	6.36 (34.38)	8.26	69.83
T_6	6.14 (31.83)	7.46	73.16
T_7	6.11 (31.49)	7.20	74.04
SEm±	0.35	1.98	2.80
C.D. (P=0.05)	1.08	6.11	8.62

Note: DAS – Days after sowing, Figures in parentheses indicate original values which were subjected to square root transformation.

The highest value in plant height observed in two hand weeding may be due to better utilization of resources as the competition of weeds and crop are kept minimum and weeds were removed particularly at the time of critical crop weed competition. This was closely followed by Pendimethalin @ 0.75 kg/ha^{-1} (PE) *fb* Hand weeding at 20 DAS. The good amount of weed population removed in T_4 (Pendimethalin @ 0.75 kg/ha^{-1} (PE) *fb* Hand weeding at 20 DAS) at 20 DAS might be the reason for better growth of green gram compared to other treatments. The growth parameters were found to be lowest in weedy check. Due to the control of weeds in different weed management treatments, the crop could efficiently make use of the nutrients, moisture, space and sunlight where it was most pronounced in two hand weeding at 20 and 40 DAS followed at par with Pendimethalin @ 0.75 kg/ha^{-1} (PE) *fb* Hand weeding at 20 DAS thus giving greater number of pods plant^{-1}, seed yield and stover yield. Similar finding was recorded by Nagender *et al*. (2017) [8]. Due to

uncontrolled growth of weeds in weedy check it has led to higher competition between crop and weeds which resulted in lowest number of pods plant^{-1} and yield of green gram.

Table 2: Effect of weed management practices on plant height (cm), leaf area index (LAI), plant dry weight (g plant^{-1}), No. of pods plant^{-1}, Seed yield (kg/ha^{-1}) and stover yield (kg/ha^{-1}).

Treatments	Plant height (cm) at 60 DAS	Leaf area index (LAI) at 60 DAS	Plant dry weight (g plant^{-1}) at 60 DAS	No. of pods plant^{-1}	Seed yield (kg/ha^{-1})	Stover yield (kg/ha^{-1})
T_1	21.01	0.63	4.5	10.96	390.04	1396.66
T_2	32.22	1.19	7.9	16.33	627.81	1520.66
T_3	27.83	0.8	5.59	14.86	541.33	1480
T_4	32.03	1.15	6.93	16.06	614.64	1523.33
T_5	28.95	1.03	6.13	14.96	558.98	1483.33
T_6	29.43	0.90	6.00	15.17	560.01	1496.66
T_7	29.92	1.02	6.20	15.22	589.56	1503.33
SEm±	0.51	0.04	0.06	0.27	21.59	10.84
C.D. (P=0.05)	1.59	0.15	0.20	0.84	66.54	33.4

Among the weed management practices the highest cost of cultivation (₹ 22,112 ha^{-1}) was recorded with hand weeding at 20 DAS and 40 DAS which also recorded the highest gross return (₹51,746.03 ha^{-1}). However, the highest net return (₹ 31,156.53 ha^{-1}) was recorded with Pendimethalin @ 0.75 kg/ha^{-1} (PE) *fb* Hand weeding at 20 DAS and this treatment also recorded the highest benefit cost ratio (1.59). Similar findings were reported from the work of Khan *et al.* (2011) [5]. Thus, it is found that weed management in green gram is could substantially reduce the yield loss and when management is integrated particularly with herbicide and cultural practice, it could result in higher profit to the farmers.

Table 3: Economics as influenced by various treatments.

Treatments	Cost of cultivation	Gross return	Net return	Benefit Cost Ratio
T_1	16,400	32,599.87	16,199.87	0.98
T_2	22,112	51,746.03	29634.03	1.34
T_3	21,400	44,786.40	23,386.40	1.09
T_4	19,538	50,694.53	31,156.53	1.59
T_5	21,850	46,201.73	24,351.73	1.11
T_6	18,705	46,297.46	27,592.46	1.47
T_7	18,995	48,668.69	29,673.69	1.56

Conclusion

It is concluded from the experiment that hand weeding at 20 DAS and 40 DAS gave highest control of weed population resulting in lowest dry weight of weeds and achieved highest weed control efficiency among the different weed management practices. It is found that application of herbicides helped in reducing the population and dry weight of weeds and could achieve good weed control. Results have indicated that use of pendimethalin as pre-emergence followed by one hand weeding at 20 DAS was found to be at par with two hand weeding in most of the weed control parameters and plant growth. The control of weeds in these treatments could lead to better growth and yield of the crops. However, considering the economics of the treatment, it could be seen that net return in hand weeding at 20 DAS and 40 DAS was not highest owing to highest cost of cultivation. Hence, looking from the point of benefit cost ratio in relation to green gram cultivation, it could be concluded that application of pendimethalin @0.75 kg/ha^{-1} (PE) *fb* hand weeding at 20 DAS is more beneficial.

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