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Effect of crop-weed conflict on growth and productivity of moong bean (*Vigna radiata*)

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ABSTRACT

Moong bean is one of the important pulse crop in world and India. It is cultivated in various states of India in summer and kharif. Weeds are major threat to moong bean productivity in both seasons. Hence, this study was conducted to know the effect of crop-weed conflict on growth and productivity of moong bean. The experiment was set up with initial weedy and initial weed-free treatments with three replications using a randomized block design in summer seasons of 2022. The results were indicated that the increased weed interference period decreased the moong bean height by 0.30 -10.27%, nodules per plant by 1.13-17.47%, fresh weight of nodule by 0.58- 5.48%, dry weight of nodules by 1.32- 10.58%, SPAD index by 15.18- 43.57%. Similarly, 2.52 to 75.45% and 2.80- 13.73% respectively, grain and stover yield decreased.

Key words: *Weedy, Weed-free number of nodules per plant, SPAD, Productivity, Interference*

Introduction

Moong bean is a small, green legume grown for its nutritious grain. It is a primary ingredient in various cuisines around the globe and has numerous health benefits. It is an essential crop in India, China, Myanmar, Thailand, and Vietnam. It is a low-maintenance crop that grows in various soils, making it a popular option among producers. Protein, vitamins, and minerals are abundant in moong beans. It is also a significant source of dietary fiber, making it a popular ingredient in many health cuisines. The nutritional value of moong bean makes suitable for vegetarians and vegans who may have difficulty in consuming sufficient protein. In many countries, moong bean is cultivated on a large scale for production. The FAO projects that the global production of moong beans will reach approximately 5.3 million metric tonnes (FAO, 2022). India is the leading producer of moong legumes, accounting for approximately 40 per cent of the global production. As per MAFW (2023), India was projected to produce approximately 2,1 million metric tonnes of moong bean. The high yield of moong bean cultivation in India can be attributed to favorable weather conditions, government support, and modern agricultural techniques. The government has launched several initiatives, including subsidies and loan program, to encourage producers to cultivate moong beans. In addition, the use of high-yielding varieties and modern farming practices have contributed to the rise in agricultural output. Demand for moong beans has increased recently due to their nutritional value and culinary versatility. A growing awareness of the health advantages of moong beans, such as their high protein and fibre content, has contributed to their popularity among health-conscious consumers (Hou *et al.*, 2019).

In moong bean, weed competition is a serious issue because it can affect crop productivity and quality. Unwanted plants, known as weeds, coexist with crops and competes for resources like water, nutrients, and sunlight (Rana and Rana, 2016). In addition to pests and illnesses that harm the crop, weeds can harbor them. In the early phases of moong bean growth, weed competition can be extremely harsh (Siddique *et al.,* 2012). Farmers follow the, mechanical, cultural and chemical techniques to reduce weed competition. By obstructing their growth and preventing them from establishing, appropriate tillage techniques like ploughing and harrowing can also aid in weed control. The use of hand weeding, hoeing, and inter-row cultivating are mechanical control techniques. These techniques can be labour-intensive, but they are successful at getting rid of weeds from the crop (Yadav *et al.,* 2017). Herbicides are used in chemical management strategies to prevent weed growth. Herbicides are administered before the crop emerges (pre-emergence) and after the crop has emerged (post-emergence). Herbicides can effectively manage weeds, but they may become resistant if they are used too often.

The most common weed flora detected in moong bean are *Phyllanthus niruri L., Leucas aspera, Spreng., Forsk, Cyperus rotundus, Euphorbia hirta, Cynodon dactylon, Indigoflora glandulosa, Portulaca oleracea, Panicum colonum, Digera arvensis* in south India (Chhodavadia *et al.,* 2013). *Boerhavia diffusa*, *Chloris barbata*, *Cynodon dactylon* among grasses, *Cyperus* rotundus, among the sedge and BLW were *Phyllanthus niruri, Cleome viscosa, Digera muricata, Trianthema portulacastrum*, *Dactyloctenium aegyptium*, and *Tridax procumbens* in north India (Muthuram *et al.,* 2018).

Weeds have been discovered to harbor to viruses and to be a major source of inoculums, leading to a high incidence of symptoms that are similar to viruses. (Akter *et al.,* 2013). Nonetheless, weed management goal should be to control weed populations. Weed management is crucial for optimum yield in moong beans. Weeding has resulted in significantly higher seed yields in moong bean (Hossain *et al.,* 1990; Kumar and Kiron, 1990; Musa *et al.,* 1996). Depending on the kind of weed and conflict between crop and weed, crop production can be reduced by up to 96.5% (Verma *et al.,* 2015), whereas the yield loss of mung bean is between 65.4 and 79.0% (Krishnaveni and Kalaiyarasi, 2019). If weeds are not quickly and adequately managed, they compete severely with crops.

Effective weed management techniques, including cultural, mechanical, and chemical methods, must be used to reduce weed infestation and increase crop output. Before adoption of these weed management methods need to know the effect of crop-weed competition on moon bean growth and productivity. All the crop growth stage not required weed management practices. A stage on crop growth if manage the weeds effectively that reduces maximum crop loss. So that exact stage of crop growth is more prone to weed infestation need to know. Hence the present investigation was carried and summarized in the paper.

Materials and Methods

The experiment was conducted at the Lovely Professional University School of Agriculture research farm in Jalandhar, Punjab. It was 235 meters above mean sea level and situated at 750.42' E longitude and 310.1' N latitude. Test variety of moong bean Vishwas magic used in randomized block design was used with twelve treatments, viz., (T_1) weedy up to maturity, (T_2) weedy up to 10 days later sowing, (T_3) weedy up to 20 days later sowing, (T_4) weedy up to 30 days later sowing, (T_5) weedy up to 40 days later sowing, and (T_6) weedy up to 50 days later sowing, and (T_7) weed-free up to maturity, (T_8) weed removal up to 10 days later sowing, (T_9) weed removal up to 20 days later sowing, (T_{10}) weed removal up to 30 days later sowing, (T_{11}) weed removal up to 40 days later sowing, and (T_{12}) weed removal up to 50 days later sowing and replicated thrice. The crop was sown on April 12th, 2022, and applied recommended dose of NPK (20:40:20 kg ha^{-1}).

Statistical analysis

Fisher's variance analysis method was used to evaluate and interpret the data (Gomez and Gomez, 1984). DMRT was used to find the least significant difference (LSD) between the treatments by using SPSS Window version 21.0 software (SPSS Inc., Chicago, IL).

Results

Plant height

The important time for conflict between crops and weeds significantly affects the moong bean height during the summer season of 2022. Maximum plant height (42.13cm) was found in weed-free until maturity (T_7), followed by T_{12} and T_{11}. Similarly, the lowest plant height (37.80 cm) was in weedy until maturity (T_1), which was signed at par with the weedy up to 50 DAS (T6) and the weedy period in moong bean reduced the height by 10.27 % over weedy until maturity.

Relative growth rate

The RGR was significantly affected due to the weed interference period among the treatments during the summer season of 2022. The RGR was highest at 30-40 DAS. Weed-free until maturity achieved the highest RGR (0.0781mg g day^{-1}). At the same time, the weedy until maturity results in the lowest RGR. The result indicates a significant decrease in relative growth rate by (7.81%).

Net assimilation rate

The conflict between crops and weeds will affect the net assimilation rate of the moong bean in 2022. 30-40 DAS achieved the highest NAR. The season long weed-free plots achieved highest NAR (2.757g m^{-2} day^{-1}). However, the lowest was found in weedy until maturity (T_1), followed by T6. Furthermore, the weedy period reduced the net assimilation rate by (28.12%).

SPAD index

The moong bean chlorophyll content was significantly affected due to the conflict between crops and weeds during the summer of 2022. The maximum chlorophyll index (67.82) was recorded in weed-free until maturity (T_7). However, the minimum (39.57) was recorded in weedy until maturity (T_1), followed by T6. The result indicates a decrease in chlorophyll content by 41.65 % over a weed-free until maturity.

Nodules count per plant

The nodules count per plant was affected due to the conflict between crops and weeds at 20 and 40 DAS during the summer. The maximum no of nodules per plant (15.60 no. and 22.83 no. at 20 and 40 DAS) was found in the weed-free until maturity (T_7). Similarly, the least no of nodules per plant was found in the weedy until maturity (T_1), followed by T6.

Nodule weight per plant

The vital time for conflict between crops and weeds significantly affects fresh and dry nodules weight at 20 and 40 DAS. Season long weed-free treatment (T_7) achieved highest fresh nodule weight, *i.e.* 164.93g and 412.71g and dry weight of nodules was 40.30g and 66.51g, respectively at 20 and 40 DAS. However, the lowest fresh weight at 20 and 40 DAS (148.55g and 390.08g) and dry weight (35.60g and 59.47g) were in weedy until maturity. However, a significant decrease in fresh nodules by 9.93% and 5.48 % and dry weight by 11.66% and 10.58%, respectively at 20 and 40 DAS over weed-free until maturity.

Table 1. Effect of crop-weed conflict on RGR and NAR of moong bean during summer 2022.

Treatment	RGR (g g^{-1} day^{-1})				NAR (g m^{-2} day^{-1})			
	10-20 DAS	20-30 DAS	30-40 DAS	40-50 DAS	10-20 DAS	20-30 DAS	30-40 DAS	40-50 DAS
T_1	0.0327bc	0.0179g	0.072ba	0.0136b	0.102c	0.126c	1.98c	0.937d
T_2	0.0353a	0.0197de	0.0752a	0.0186a	0.146a	0.158ab	2.49a	1.702cde
T_3	0.035a	0.0196de	0.0751a	0.0181a	0.146a	0.156a	2.403a	1.599def
T_4	0.0334a	0.0193de	0.075a	0.0177a	0.144b	0.152a	2.386a	1.528ef
T_5	0.0334ab	0.0192e	0.0748a	0.0176a	0.134b	0.152b	2.277a	1.426ef
T_6	0.0333ab	0.0183f	0.0726b	0.0168b	0.134c	0.136b	2.201b	1.291f
T_7	0.0421a	0.022a	0.0781a	0.0208a	0.189a	0.197a	2.757a	2.198ab
T_8	0.0355a	0.02d	0.0757a	0.0188a	0.148a	0.162ab	2.548a	1.76def
T_9	0.0378a	0.0201c	0.0758a	0.0191a	0.149a	0.167a	2.62a	1.847cde
T_{10}	0.0386a	0.0202b	0.0758a	0.0199a	0.152a	0.168a	2.653a	1.99bcde
T_{11}	0.0391a	0.0204b	0.0758a	0.0203a	0.157a	0.171a	2.692a	2.083abc
T_{12}	0.0391a	0.0216a	0.0768a	0.0208a	0.162a	0.184a	2.711a	2.186ab
SE(m) ±	0.0013	0.0013	0.0013	0.0013	0.01	0.01	0.09	0.094
CD (0.05%)	0.0038	0.0038	0.0038	0.0038	0.02	0.02	0.27	0.277

The figures within columns with different letters differed significantly with each other.

Grain and Stover yield

Both grain and stover yield were significantly affected due to the conflict between crops and weeds in summer moong bean during 2022. The maximum grain yield (1385 kg ha^{-1}) and stover yield (3385 kg ha^{-1}) was found in the weed-free until maturity (T_7) which was statistically at par with the T_{12} and T_{11}. In contrast, the minimum grain (340 kg ha^{-1}) and stover yield (2920 kg ha^{-1}) were found in weedy until maturity, followed by the T_6. The result indicated that significantly decreased grain yield by 75.45 and stover yield by13.73 % over season long weed free treatment.

Harvest index

Crop-weed interference significantly affects the harvest index of the summer moong bean during 2022. The maximum harvest index (29.47) was in the weed-free until maturity (T_7), which was statistically at par with T_{12}. Similarly, the minimum (10.37) was in the weedy until maturity. However, weed interference decreased in harvest index by 2.06% to 64.81 %% season long weed-free.

Discussion

Growth development of moong bean

Crop-weed conflict reduced the moong bean height, relative growth rate, net assimilation rate chlorophyll index (SPAD), during the summer season of 2022. Season long weed free treatment was greater the growth and development of moong bean. This may be due to weed management during the crop growth and development stage, which may result in good availability of nutrients, space, and moisture, as well as a variety of other ideal circumstances for growth and development. Weed-free periods increase relative growth rate, chlorophyll content in groundnut (Korav *et al.*, 2018). While the weedy pe-

Table 3. Effect of crop-weed conflict on grain yield, stover yield and harvest index of moong bean during summer season of 2022.

Treatment	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index
T_1	340f	2920c	10.37
T_2	1211bc	3162abc	27.92
T_3	1150c	3094abc	26.85
T_4	700e	3047bc	23.53
T_5	410f	2984bc	18.16
T_6	355f	2913c	11.12
T_7	1385a	3385a	29.47
T_8	400f	3183abc	11.69
T_9	1000d	3154abc	26.56
T_{10}	1210bc	3178abc	27.40
T_{11}	1300ab	3249ab	28.48
T_{12}	1350a	3290ab	28.86
SE(m) ±	0.3	0.93	0.31
CD (0.05%)	0.87	2.73	0.91

The figures within columns with different letters differed significantly with each other.

Table 2. Effect of crop-weed conflict on nodules count per plant, nodules weight per plant of moong bean during summer season of 2022.

Treatment	No of nodule per plant (No.)		Undried weight (g plant^{-1})		Dried weight (g plant $^{-1}$)	
	20 DAS	40 DAS	20 DAS	40 DAS	20 DAS	40 DAS
T_1	12.30f	18.84e	148.55b	390.08a	35.60c	59.47b
T_2	14.30abcde	20.88abcde	160.01ab	396.36a	37.85abc	62.21ab
T_3	13.90bcde	20.35bcde	158.84ab	395.13a	37.51abc	61.72ab
T_4	13.80cde	20.11bcde	158.00ab	394.65a	37.23abc	61.58ab
T_5	13.50def	19.65cde	158.17ab	393.35a	36.74abc	60.39ab
T_6	13.10ef	19.12de	152.39ab	392.29a	36.08bc	60.18ab
T_7	15.60a	22.83a	164.93a	412.71a	40.30a	66.51a
T_8	14.60abcd	21.14abcd	161.31ab	396.47a	38.09abc	62.87ab
T_9	14.80abcd	21.40abc	162.82ab	397.22a	38.46abc	63.08ab
T_{10}	14.80abcd	21.76ab	163.68ab	397.83a	38.92abc	63.25ab
T_{11}	15.10abc	22.01ab	164.06ab	398.11a	39.17abc	64.44ab
T_{12}	15.30ab	22.57a	164.75ab	410.30a	39.81abc	65.63ab
SE(m) ±	0.43	0.63	4.77	11.88	1.14	1.87
CD (0.05%)	1.25	1.83	14.00	34.83	3.33	5.49

The figures within columns with different letters differed significantly with each other.

riod throughout the maturity plots reduced the moong bean growth and development, this might be due to conflict between crops and weeds for the light, space, nutrients and water, which might reduce the moong bean height, net assimilation rate, relative growth rate and SPAD index. These findings are likewise consistent with previous studies on black seed (Seyyedi *et al.,* 2016), cowpea (Olorunmaiye, 2010), and mung bean (Kundu *et al.,* 2009). Early weed growth will decrease the chlorophyll (SPAD) of the moong bean due to leaf shedding (Olorunmaiye, 2015 and Korav *et al.,* 2018).

Plant root nodules

The nodule count per plant, nodules fresh and dry weight were low in season long weedy plot. This might be due to allelochemicals released by weeds in their vicinity. Released allelochemicals reduced the growth and development of nodules. Similarly, higher the effective nodules and their weight was found in different weed-free period and season long weed free plots this might be due to wider space availability to their root growth and less production effect of allelochemicals in their vicinity. Mirjha *et al.* (2013) found that, nodule count per plant was reduced by 22.8% due to weed infestation. Fresh and dry weight of nodules per plant increased with increased weed-free periods (Mirjha *et al.,* 2013). These findings are correlated with earlier findings in mung bean (Raman and Krishnamurthy. 2005), chickpea (Patel *et al.,* 2007), black gram (Raman. 2006), pea (Abdallah *et al.,* 2021), soybean (Abdelhamid and Metwally, 2008) and groundnut (Shittu *et al.,* 2022).

Grain yield, stover yield and harvest index

The grain yield, stover yield and harvest index of the moong bean were reduced by increased weed interference period. This might be above and below ground crop and weed competition for light, space, O_2, moisture and nutrients. Weeds increases yield loss during the beginning of crop growth and development, so the early stage of the conflict is considered the primary mechanism of yield loss. The growth of the moong bean was suppressed by the weeds causing allelopathic effects and uptake of resources, which may result in yield loss. These results are correlated with earlier findings with (Stagnari and Pisante, 2011; Duary and Hazra, 2013; Seyyedi *et al.* 2016; Absy and Yacoub, 2020 and Korav *et al.,* (2020). They found that no weed treatments had greatest and lowest yields in the weedy check. The grain and stover yield of the moong bean reduced with the increase in weed interference period among the treatments (Seyyedi *et al.,* 2016). These findings agree with Stagnari and Pisante. (2011) in French bean, and Safdar *et al.* (2016) in maize.

Conclusion

Crop-weed competition is a serious problem in moong bean. Due to their extensive suppression capacity, they may reduce crop growth, development and productivity. The present study stipulates that weeds in summer can reduce moong bean yield by 2.52 to 75.45%. Weeds compete heavily with summer crops if they are not controlled immediately and adequately. Successful weed control increases moong bean productivity while decreasing weed seed bank buildup. When crop growth and development is hampered owing to physiological reasons, it can have a detrimental impact on yield characteristics and overall crop yield. Implementing weed control measures during the critical period of crop-weed conflict is a cost-effective strategy that saves both time and chemical costs.

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