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RESEARCH ARTICLE

Evaluation of living mulches for weed management in french beans

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ABSTRACT

Living mulches are cover crops grown simultaneously with and near main crops. Advantages of living mulches over dead cover crops may include increased weed suppression, reduced erosion and leaching, better soil health, and greater resource-use efficiency. An experiment was conducted at Horticultural Research Station, Kahikuchi Guwahati, Assam Agricultural University, Assam during *Rabi* 2019-20 and 2020-21 to investigate the effect of living mulches on weed control and its subsequent effects on yield of french beans. The treatments were french beans interplanted with living mulches of field pea (*Pisum sativa*) (FP), Berseem (*Trifolium alexandrinum* L) (B), Faba beans (*Vicia faba*) (FB), Conventional weed management (CWM) and weedy check (WC). The pooled mean highest weed infestation was recorded in WC which accounted for the highest weed dry weight (WDW) (75.23 g/m^2). The weed control efficiency was recorded as average pooled mean of 61.35, 60.26 % in CWM and LM with berseem respectively for both the years. The conventional method and living mulch of berseem have improved french beans yield by 1.11, 0.94 t/ha of pooled mean of two years. Among the living mulches used french beans and berseem interplant suppressed weeds. The highest net returns (₹ 26056/ha) and B:C (3.45) were in CWM fb LM with B with net returns (₹ 24625/ha) and B:C (3.10) in both the years respectively. Hence, apart from the conventional method of weed management, berseem is an ideal weed suppressant and can be interplanted as a living mulch crop in french beans cultivation.

Keywords: Living mulch, Weed control efficiency, Weed Dry Weight, Weed Index, Yield

INTRODUCTION

In modern agriculture for weed control, chemicals are used extensively, but their use is now limited due to environmental and economic costs and weed resistance to herbicides (Yousef and Rahimi 2014). Growing living mulches with or near crops, increased weed suppression, reduced soil erosion and leaching, improve soil health and uses resources more efficiently. Ecosystem biodiversity enhanced with living mulches than synthetic mulches and more suitable for a cropping system. The mulch-crop competition depends on agroecosystem management as well as climate and other factors (Bhaskar *et al.* 2021). Nakamoto and Tsukamoto (2006) observed that "living mulches are cover crops which are preserved as a living ground cover crop throughout the growing season of the main crop". Sowing living mulches between the rows of a main crop is a weed control technique that does not employ herbicide application. Living mulches minimizes field weed infestation and enhance crop yield. Giorgi *et al.* (2022) revealed that living mulches, namely herbaceous plants with a habit of covering the soil, balancing different species biodiversity, crop biomass production, yield, quality, soil fertility and ultimately increase C sequestration. Fracchiolla *et al.* (2020) reported that living mulch provide many benefits to agro-ecosystems such as erosion control, nitrogen fixation, nutrient recycling, increasing organic matter, controlling weed and pest and increasing soil organism.

French beans (*Phaseolus vulgaris* L.) is a rich in several nutrients like protein (17.5-28.7% in dry seed and 1.0-2.5% in green pods, carbohydrates (61.4%), mineral content (3.2-5.0%), crude fibre (4.2-6.3%) crude fat (1.2-2.0%) and vitamin A and C (Messina 1999). Berseem (*Trifolium alexandrinum* L) is a leguminous cool season forage crop and has the potential as cover crop or annual forage in living mulch cropping system. Field pea (*Pisum sativum*) is a winter season grain legume crop. Faba beans (*Vicia faba*) can fix atmospheric nitrogen by symbiotic relationship with bacteria and enhance the productivity of agricultural land.

The objective of the study was to investigate the potential of living mulches for weed control of french beans and its subsequent effects on yield and profitability.

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MATERIALS AND METHODS

A field experiment was conducted at Horticultural Research Station Kahikuchi Guwahati, Assam Agricultural University, Assam, India situated at latitude 26°3'N, longitude 91°7'E and 64.0 m above mean sea level during *Rabi* 2019-20 and 2020-21 consecutively for two years. All the living mulches used in the experiment were leguminous crops viz. berseem, faba beans and field pea with the main crop french beans. A randomized block design was laid out with five treatments and five replications. The treatments were Living mulch (LM) of field pea (FP), Living mulch of berseem(B), Living mulch of faba beans (FB), Conventional weed management (CWM) (20 and 40 DAS) and weedy check (WC) as control. The living mulches were sown in inter spaces of the main crop. The average annual rainfall of experimental site was 651 mm extending over the period of mid-July to October and few scattered showers during winter months from south-west monsoon. Whereas, the average minimum and maximum temperature vary from 12^0C -36^0C. The soil of the experimental field was sandy loam in texture, acidic in reaction, low in organic carbon (0.35%) and available nitrogen (235 kg/ha) and was medium in available phosphorus (13.2 kg/ha) and potassium (260.2 kg/ha). French beans variety '*Arka Komal'* was sown in rows 30 x 10 cm apart on 25 October in 2019 and 30 October in 2020 using 120 kg seed/ha. Application of farm yard manure 10 t/ha. Fertilizers of phosphorus and potassium at the rate of 60 and 50 kg/ha were applied respectively. A basal dose of half of the nitrogen (60 kg/ha) was applied as per treatment and full dose of phosphorus and potassium was applied to the experimental plots by placement method just after demarcation of layout and the remaining half of nitrogen (60 kg/ha) was top dressed at maximum flowering stage. The recommended dose of fertilizers was applied to the main crop as basal. In weed free plots, weeds were removed manually twice. Other standard agronomical package and practices were followed uniformly in both the years.

Weed and weed dry weight (WDW) productions were measured at mid-season and at final harvest. Different yield and yield attributing parameters were measured at the time of harvest and adjusted to 14% moisture contents. For mid-season sampling, weed dry weight were measured from two using 0.25 m^2 quadrats from each plot. The economics of the french beans were also calculated for gross returns, net returns and B:C.

Data recorded from the field were statistically analyzed through analysis of variance (ANOVA) method and treatment means were compared through least significant difference (LSD) at 5% level of significance.

The observations recorded were **c**rop growth parameters, yield and quality, weed density, fresh and dry weight at 40 and 60 DAS, weed population, dry weight and weed control efficiency.

The weed control efficiency (WCE) of individual treatments were calculated using following formula *i.e*.

WCE (%) = WC – WT x 100/ WC

Where,

WC=Weed in control plot

WT=Weed in treated plot

Weed index (WI) refers to the reduction in crop yield due to the presence of weed in comparison to weed free plots. It was calculated by using the formula:

WI (%)= Yield from weed free plot-Yield from treated plot x100/Yield from weed free plot

RESULTS AND DISCUSSION

Yield and yield attributes

All the records were presented as pooled mean of both the years. The plant height (26.22 cm), branches/ plant (7.12 nos), pod/ plant (37.77 nos), pod length (14.34 cm) of french beans were found significantly high in treatment CWM practice fb treatment living mulch with berseem where plant height (25.22 cm), branch/plant (6.43 nos), pod/plant (33.56 nos), pod length (13 cm) for both the years. The highest yield was recorded in conventional weed management (1.11 t /ha) fb berseem (0.94 t/ha) for both the years (**Table 1**). Among the living mulch used in french beans and berseem inter plant suppressed weed. The least weed density was observed in CWM fb berseem treatment. Bhaskar *et al.* (2021) depicted from his study that optimal living mulch planting dates vary in the system, though simultaneous planting of living mulches and main crops also gave good results. The result also has close conformity with the findings of Bhaskar *et al.* (2020), where the use of living mulches in cotton production was feasible and it was effective for both weed suppression and acceptable yield. Ellis *et al.* (2000) also found that puralane living mulch gave broccoli yields as comparable to yields with conventional methods of weed management with no

Table 1. Crop growth parameters, yield of french bean

Treatment	Plant height (cm)			Branches/plant (no.)			Pod/plant (no.)			Pod length (cm)			Yield (t/ha)		
	2019	2020	Pooled mean	2019	2020	Pooled mean	2019	202 0	Pooled mean	2019	2020	Pooled mean	2019	2020	Pooled mean
LM with field pea	24.0	24.1	24.1	5.3	6.0	5.7	25.3	26.7	26.0	12.6	11.6	12.1	0.56	0.64	0.6
LM with berseem	25.1	25.3	25.2	6.3	6.5	6.4	32.4	34.7	33.6	13.1	12.9	13.0	0.89	0.99	0.94
LM with faba beans	24.7	24.9	24.8	5.8	6.1	5.9	28.4	32.0	30.2	13.4	12.5	13.0	0.65	0.78	0.72
Conventional weed management	26.1	26.3	26.2	7.0	7.3	7.1	36.2	39.3	37.8	12.9	15.7	14.3	1.06	1.15	1.11
Weedy check	20.0	20.1	20.1	4.9	5.4	5.1	22.1	23.9	23.0	12.0	12.5	12.1	0.49	0.56	0.53
LSD (p=0.05)	0.01	0.03	0.01	0.9	1.0	0.9	3.2	3.5	3.3	2.0	2.1	2.1	0.09	0.12	0.10

Table 2. Economics of the french beans

Treatment	Gross return (₹ /ha)			Net return (₹ /ha)			B:C		
	2019	2020	Pooled mean	2019	2020	Pooled mean	2019	2020	Pooled mean
LM with field pea	22400	24800	23600	12488	13750	13119	2.26	2.38	2.32
LM with berseem	35600	38750	37175	23800	25450	24625	3.00	3.19	3.10
LM with faba beans	26000	30560	28280	18474	21630	20520	2.47	2.69	2.58
Conventional weed management	37400	40235	38818	25267	26845	26056	3.15	3.29	2.15
Weedy check	19600	21846	20723	9284	10280	9782	1.9	2.09	1.20

reduction in crop quality and growth. Another findings also has similar results like cowpea living mulch plot provide maize grain and stover yield of 2, 3 t/ha compared to 0.98, 2 t/ha respectively in the control (Masud *et al.* 2021).

Economics and weed growth

The highest gross returns, net returns and B:C of ₹ 38817.5, 26056 /ha and 3.45 recorded in CWM which were fb LM with berseem with gross returns, net returns of ₹ 37175, 24625 /ha with B:C of 3.10 for both the years probably due to higher sale price and higher grain yield. This showed that french bean was more responsive towards conventional weed management and use of living mulch which gave a higher return (**Table 2**). The results depicted that the highest weed infestation was in WC (Control) which accounted for the highest average WDW (75.23 g/m^2) for both the years. In general, pooled mean data recorded at 40 and 60 days after sowing (DAS) showed that CWM, LM of B, FB and FP have reduced weed density (98.5, 233, 382.5 and 389 g/m^2) compared to weedy check (569.5 g/m^2) in 40 DAS and weed density of 84.5, 217, 231 and 278 g/m^2 in 60 DAS compared to weedy check (428.5 g/m^2) for both the years. The fresh weight (g/m^2) and dry weight(g/m^2) recorded for both the years also showed the similar trend in both 40 and 60 DAS (**Figure 2**). Weed population (no/m^2) recorded as 8.08, 8.96, 9.51 and 10.53 in CWM, LM of berseem, faba bean and field pea respectively which were significantly higher than weedy check with 20.92 no/m^2. WDW (g/m^2) were found significantly higher in weedy check with 75.23 g/m^2 compared to conventional weed management (11.72 g/m^2), LM of berseem (13.41 g/m^2), faba beans (18.69g/m^2) and field pea (15.35 g/m^2) (**Figure 1**). The results are at par with the findings of Khaliq *et al.* (2010) where the dry weights of weeds from weedy check plots were significantly greater than the mulches applied plots and hand weeding plots (396.23 and 2178.93 g/m^2). The weed control efficiency was recorded as 61.35, 60.26 % in CWM and LM with berseem respectively which were at par. The weed control efficiency (%) were significantly lower in LM with faba beans, LM with field pea and weedy check. The weed index percent lowest in LM with berseem (24.12) fb LM with faba beans (44.24), LM with field pea (53.69) and weedy check (65.79) from both the years (**Figure 1**). The results also supported by Gandomkar 2019 for weed control using live and abiotic mulches which were more effective, economical and environmentally friendly. The similar findings were reported by Talebbeigi and Ghadiri (2012) in maize with cowpea as a living mulch where increasing density of living mulch canopy closure occurred, decreasing the amount of photosynthetically active radiation (PAR) available beneath the canopy. This would decrease in weed biomass until an optimum living mulch density was achieved and after that no decrease in weed biomass occurred. Romaneckas *et al.* (2015) also reported that fabaceae living mulches reduce weed seed bank in the plough layer in maize crop by 14.1 to 57.1%. The results of the study were also supported by the findings of Kitis *et al.* (2018), they observed that living mulch of vetch in citrus orchard reduce weed density, biomass and dry weight of weeds compare to

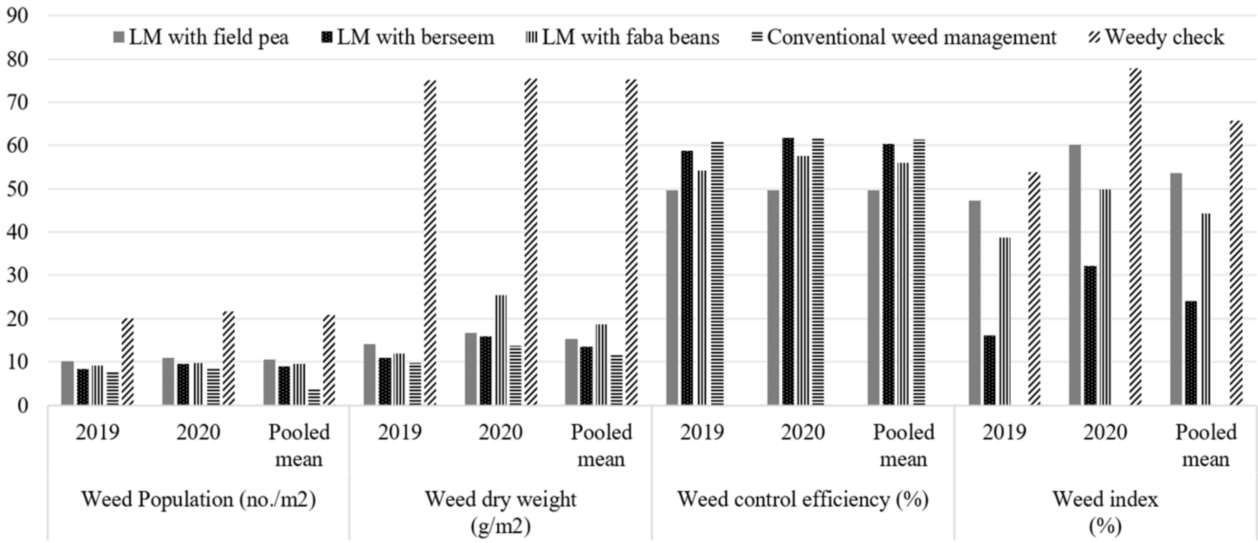

Figure 1. Weed population, dry weight, weed control efficiency and weed index

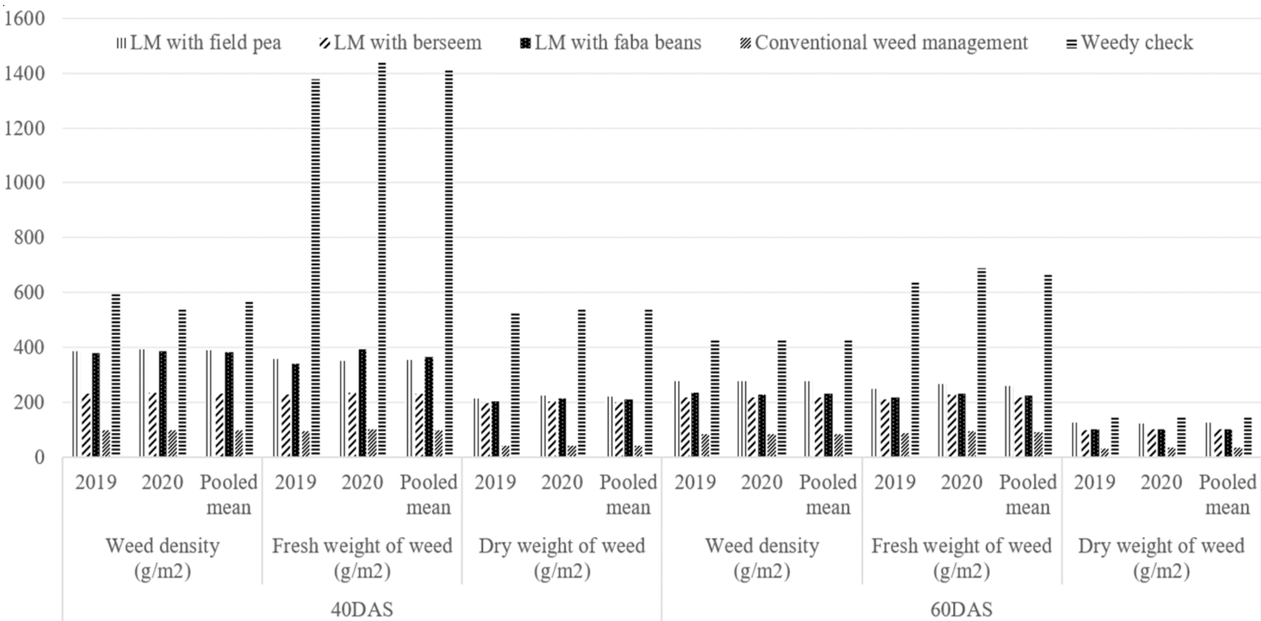

Figure 2. Weed density, fresh weight and dry weight at 40 and 60 DAS

control. Masud *et al*. (2021) also showed similar findings that cowpea living mulch plot had 0.5 t/ha weed biomass compared to 2.6 t/ha in the control. It was also reported by Borowy (2012) that living mulches decrease the soil surface temperature which lead to slow growth of weeds. The different weed flora in experimental field identified were *lternanthera sessilis, Chenopodium album, Cleome rutidosperma, Isachne globosa, Mimosa diplotricha var. inermis, Oxalis debilis, Physalis minima and Setaria pumila.*

Conclusion

On the basis of two years experimentation, it was concluded that the living mulches may be an alternative for weed management without the use of chemical herbicides without much deteriorating yield of the main crop and also good for ecosystem services. Hence, our findings confirmed that apart from the conventional method of weed management, berseem can be used as living mulch to reduce the biomass of weed and can be interplanted as a living mulch crop in french beans cultivation.

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