
**E-ISSN:** 2618-0618
**P-ISSN:** 2618-060X

NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(8): 1094-1099
Received: 13-05-2025
Accepted: 17-06-2025

**Chavan SR**
M.Sc. Scholar, Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

**Jagtap MP**
Associate Professor, Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

**Awasarmal VB**
Associate Professor, Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

**Thakare JS**
M.Sc. Scholar, Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

**Chanda S**
M.Sc. Scholar, Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

**Mali NS**
M.Sc. Scholar, Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

**Corresponding Author:**
**Chavan SR**
M.Sc Scholar, Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

# Non-chemical weed management in French bean (*Phaseolus vulgaris* L. Merrill)

**Chavan SR, Jagtap MP, Awasarmal VB, Thakare JS, Chanda S and Mali NS**

**DOI:** https://www.doi.org/10.33545/2618060X.2025.v8.i8p.3701

## Abstract
The experiment was laid out during *Kharif* 2024-25 at the experimental farm, Department of Agronomy, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (M.S.). The experiment was laid out in Randomized Block Design comprising 7 treatments *viz*., $T_1$- soil solarization, $T_2$- bio-solarization, $T_3$- smother crop (Amaranth), $T_4$- straw mulch 5 cm thickness, $T_5$- straw mulch 7.5 cm thickness, $T_6$- weedy check and $T_7$- weed free. The various quantitative traits had been studied and the data was subjected to ANOVA. The ANOVA showed significant differences for non-chemical weed management treatments for all studied traits indicating sufficient variability. The soil of the experimental field was medium black and clay loam in texture and moderatly alkaline in reaction (7.2 pH). The size of the gross and net plot was 5.4 m x 4.5 m and 4.5 m x 4.3 m, respectively. The major weeds found in French beans include *Euphorbia geniculata, Cynodon dactylon, Brachiaria eruciformis, Acalypha indica, camelina benghalensis, Digera arvensis, Convolvulus arvensis,* and *Cyperus rotundus*. The results revealed that treatment $T_1$ (Soil solarization) significantly recorded the lowest total weed density, weed dry matter and highest weed control efficiency at critical crop-weed competition period.

**Keywords:** Bio-solarization, French bean, smother crop, soil solarization

## Introduction
The French bean, scientifically known as *Phaseolus vulgaris* L. Merrill, is a common leguminous crop grown worldwide for its edible seeds and pods. It accounts for around 30% of the world's total food legume production (Vasishtha and Srivastava, 2012) [16]. French beans are member of the Fabaceae family. Filet beans, French green beans, fine beans, haricots verts, string beans, and snap beans are other names for this plant, which is native to Central and South America.

According to Sinkovic *et al*. (2024) [17], 100 grams of green pods have 1.9 grams of protein, 5.66 grams of carbs, 24 micrograms of vitamin A, 52.5 micrograms of vitamin K, 17 milligrams of calcium, and 2.6 grams of fiber. French bean is an essential crop for fostering food security and balanced diets because of their high nutritional density and low-calorie content.

From 35.92 million hectares of land, around 27.72 million metric tons of French beans were produced worldwide in 2022. (Laskar *et al*., 2023) [11]. India leads the world in both French bean production and area, with 158.53 lakh hectares and 66.10 lakh tons, respectively followed by the countries Brazil, (Area-26.08 Lakh ha, Production-28.42 Lakh tons), Myanmar (Area-28.61 Lakh ha, Production-26.63 Lakh tons), Tanzania (Area-10.03 Lakh ha, Production-13.48 Lakh tons) and Uganda (Area-7.31 Lakh ha, Production-13 Lakh tons) in area and production both. But in productivity of French bean USA ranks first in world (Productivity-2388 kg/ ha), followed by Uganda (1785 kg/ha), China (1766 kg/ha) and Tanzania (1343 kg/ha). However, only 417 kg/ha are produced in India (Anonymous 2022) [1].

There are multiple states in India that cultivate French beans. The highest-producing state is Gujrat (production of 751.99), followed by Bihar (production of 244.55), Jharkhand (production of 200.82 tons), Karnataka (production of 166.76 tons), and Maharashtra (area of 5.5 thousand hectares, production of 69.95 tons). India has a large and promising region, but the production of French beans is quite low compared to other countries.

The low yield of French beans in India is linked to a lack of important production restrictions, such as, weed infestation and inadequate fertilizer application. Among those production limitations, the use of fertilizer resulted in yield losses of up to 34%, followed by weed infestation (13%) (Bansode *et al.*, 2019) [3].

Among the above-mentioned restrictions, a significant one that prevents French beans from growing and producing as much as they could is the severe weed invasion. According to Chavan *et al.*, (2020) [4], the main weeds found in French beans include *Euphorbia geniculata, Cynodon dactylon, Brachiaria eruciformis, Acalypha indica, camelina benghalensis, Digera arvensis, Convolvulus arvensis*, and *Cyperus rotundus*. Due to their competition for resources such as light, water, soil nutrients and space (Dhaker *et al.*, 2022) [5] these significant weeds can lower French bean yields. According to (Horvath *et al.*, 2023) [6], as longer the duration weeds compete with plant, lower the pods produces per plant (Jahanbakshi *et al.*, 2015) [9]. Weed density is crucial because a greater problem is typically caused by more weeds rather than fewer weeds. Weed competition time is also crucial. Maintaining the crop free of weeds between 11 and 29 DAE can prevent yield losses of more than 5%.

To increase yields, French bean growers must use more herbicides to control weeds. Weed infestations in croplands hence raise the cost of cultivation considerably. In addition to increasing the cost of inputs, extensive chemical use can harm the environment by causing problems including water contamination, retension of herbicide residue, weed resistance to herbicides (Mirza, *et al.*, 2020) [12].

Alternative techniques like, solarization, bio-solarization and the use of smother crops present promising answers to the problem of weed infestations in croplands and minimize dependency on herbicides. In addition to lowering crop expenses, these sustainable approaches can also improve ecosystem health and lessen their negative effects on the environment (Jacob, *et al.* 2024) [7]. When compared to all other soil solarization treatments, the temperature of the soil has been considerably raised by black polythene mulch. In comparison to the non-mulched plot, the various soil solarization treatments, which resulted in increases in soil temperature due to covering, were 2 to 4 °C for 5 cm, 2 to 5 °C for 15 cm at 7:20 am, 4 to 8 °C for 5 cm, and 3 to 7 for 15 cm at 2:30 pm. (Jagtap *et al.*, 2022) [8]

Crop wastes are utilized in bio-solarization to prevent the growth of weeds. Crop residues can also improve soil quality in several ways when combined with efficient agricultural management approaches. They enhance soil structure, boost soil organic matter, lower evaporation and aid in the fixation of carbon dioxide ($CO_2$).

Non-chemical weed management techniques can be essential in meeting the dietary needs of the average person, eradicating deficiency diseases and malnutrition, alleviating stress on cereals, promoting French bean production and reducing environmental degradation brought on by increased chemical use for weed control.

## Materials and Methods

The field experiment was conducted at experimental farm, Department of Agronomy, College of agriculture, V.N.M.K.V. Parbhani (M.S) during *kharif* 2024. The site was located $19^0 16'$ North latitude and $76^0 47'$ East longitude and at 409 altitudes above mean sea level and has a semi- arid climate. The experiment was laid in Randomized Block Design (RBD) with 3 replications. The experiment comprises of 7 treatments *viz.*, $T_1$- soil solarization, $T_2$- bio-solarization, $T_3$- smother crop (Amaranth), $T_4$- straw mulch 5 cm thickness, $T_5$- straw mulch 7.5 cm thickness, $T_6$- weedy check and $T_7$- weed free. The soil of the experimental field was medium black and clay loam in texture and moderately alkaline in reaction (7.2 pH). The size of the gross and net plot was 5.4 m x 4.5 m and 4.5 m x 4.3 m, respectively. Plant protection measures were taken as per the recommended schedule. The major weeds associated with French bean were identified on the basis of cotyledons. The data collected on weed density were collected using $1m^2$ quadrate (g $m^{-2}$), weed dry weight were measured by using electric weighing balance and weed control efficiency was worked out by using the formula as below,

$$\text{WCE (\%)} = \frac{\text{DWC} - \text{DWT}}{\text{DWC}} \times 100$$

Where, WCE = Weed control efficiency in%; DWC = weed dry weight in control plot; DWT= weed dry weight in treated plot.

Data on various variables were analyzed by analysis of variance (Panse and Sukhatme, 1967) [13]. The data on weed control efficiency was further subjected to DMRT (Dunccan's Multiple Range Test).

## Results and Discussion

### Weed flora

During the experimental studies two types of weeds were observed depending on their cotyledons *i.e.* monocot and dicots. Table 1 showed major weeds associated with French bean observed during experimentation. Mainly monocots weeds are perennial weeds and dicot weeds are seasonal weeds.

The major weed flora observed in the experimental field of French bean crop included monocot weeds were shippi (*Brachiaria eruciformis*), Kena (*Commelina benghalensis*), Hariyali (*Cynodon dactylon*), Lavala (*Cyperus rotundus*), Chimanchara (*Digitaria sanguinalis*) and dicot weeds were Gajargavat (*Parthenium hysterophorus*), Deepmal (*Acalypha indica*), Kunjru (*Digera arvensis*) and Tandulja (*Amaranthus polygamous*). Similar results were found by chavan *et al.*, (2020) [4].

### Weed density (no $m^{-2}$)

The mean data on weed density of monocots, dicots and total weeds was recorded at 30, 45, 60 and 75 DAS were furnished in Table 2. The differences in monocots weed density were found to be significant at 30, 45, 60 and 75 DAS. The lower number of monocot weeds at 30 and 45 DAS were (3.00, 4.60) no $m^{-2}$ respectively, recorded with $T_1$ -soil solarisation followed by $T_7$ – weed free *i.e.* 4.00, 7.00 no $m^{-2}$ at 30 and 45 DAS respectively. This might be due to initial weed reductions with soil solarization was high. Similar result found by Corazon *et al.*, (2024) [2]. However lower number of monocot weeds at 60 and 75 DAS were (3.00, 6.00 no $m^{-2}$) respectively, recorded with $T_3$ –amaranth as smother crop followed by $T_7$ –weed free *i.e.* 7.00, 6.30 no $m^{-2}$ at 60 and 75 DAS respectively. This might be due to smother crops inhibit weed emergence by rapidly covering the ground and releasing growth-inhibiting allelochemicals. This suggests that Amaranth is effective in weed suppression in early to mid-crop stages. Teasdale *et al.*, (2007) [15]. Similar to monocots, dicots weed density was also significantly affected by non-chemical weed management treatments at 30, 45, 60 and 75 DAS. The lower number of dicot weeds recorded with $T_1$ -soil solarisation at 30 and 45 DAS were (3.47 and 6.00 no $m^{-2}$) respectively. Followed by $T_2$ -biosolarization and $T_3$-amaranth as smother crop (6.00, 7.00 no $m^{-2}$) at 30 and 45 DAS respectively. Similar result found by Corazon *et al*., (2024) [2]. This might be due to reduction in weed density in solarization and bio-solarization treatments is attributed to the elevated soil temperatures which destroy weed seeds and emerging seedlings. Similar result found by Corazon *et al*., (2024) [2]. However lower number of dicot weeds at 60 and 75 DAS were (4.98, 5.77 no m$^{-2}$) respectively, recorded with $T_3$ –amaranth as smother crop followed by $T_7$ –weed free *i.e.* 6.00, 9.33 no m$^{-2}$ at 60 and 75 DAS respectively. This might be due to smother crops inhibit weed emergence by rapidly covering the ground and releasing growth-inhibiting allelochemicals. Similar result found by Teasdale *et al.*, (2007) [15]. Total weed density was also significantly affected by weed management treatments at 30, 45, 60 and 75 DAS. Soil solarisation ($T_1$) treatment recorded significantly lower number of total weeds (6.47, 10.60 no m$^{-2}$) at 30 and 45 DAS respectively. This might be due to reduction in weed competition in solarization and bio-solarization treatments due to the increased soil temperatures which kills weed seedlings. Similar result found by Corazon *et al*., (2024) [2]. However treatment $T_3$- amaranth as smother crop recorded significantly lower number of total weeds i.e. 7.96 no m$^{-2}$ at 60 DAS and 12.07 no m$^{-2}$ at 60, 75 DAS respectively. This might be due to smothering effect of amaranth on weed emergence. Similar result found by Teasdale *et al*., (2007) [15]. However $T_6$-weedy check recorded highest weed density (monocots, dicots and total) at 30, 45, 60 and 75 DAS respectively.

**Weed dry weight (g m$^{-2}$)**

Mean data on dry matter of monocots, dicots and total weeds recorded at 30, 45, 60, 75 DAS were furnished in Table 3. At 30 and 45 DAS all the weed management treatments recorded significantly lower total weed dry matter over weedy check. At 30 DAS significantly lower dry matter of monocot weeds was recorded by $T_1$ -soil solarisation (2.00 g m$^{-2}$) followed by $T_2$ (Bio-solarization) *i.e.* 3.00 g m$^{-2}$ and at 45 DAS significantly lower dry matter of monocot weeds was recorded by $T_1$ -Soil solarization (3.00) g m$^{-2}$ followed by $T_3$ (Amaranth as smother crop) *i.e.* 5.00 g m$^{-2}$ and $T_7$ (Weed free) *i.e.* 5.57 g m$^{-2}$. Significantly higher dry matter of monocot weeds was recorded in weedy check ($T_6$) treatment *i.e*. 15.00 g m$^{-2}$, 11.00 g m$^{-2}$ at 30 and 45 DAS respectively.

Similar to monocots, dry matter of dicot weeds was also significantly affected by weed management treatments at 30 and 45 DAS. At 30 DAS the lower dry matter of dicot weeds was recorded with $T_1$-Soil solarization (5.00) g m$^{-2}$ followed by $T_4$ (Straw mulch 5 cm thickness) *i.e.* 6.57 g m$^{-2}$. At 45 DAS lower dry matter of dicot weeds was recorded with $T_1$ -Soil solarization (6.03) g m$^{-2}$ followed by $T_2$ (Bio-solarization) *i.e.* 6.43 g m$^{-2}$. Significantly higher dry matter of dicot weeds was recorded with weedy check ($T_6$) treatment *i.e*. 11.33 g m$^{-2}$, 12.00 g m$^{-2}$ at 30 and 45 DAS respectively. Similar results were found by Teasdale *et al*., (2007) [15] and Shinde *et al*., (2023) [14] reported that soil solarization significantly reduces the initial weed seed bank in the soil. The reduction in weed density in solarization and bio-solarization treatments is attributed to the elevated soil temperatures which destroy weed seeds and emerging seedlings these results in reduced weed dry matter.

Dry matter of total weeds was also significantly affected by weed management treatments at 30 and 45 DAS. Significantly the lower dry matter of total weeds at 30 DAS (7.00 g m$^{-2}$) were recorded with $T_1$-soil solarization followed by $T_2$ (Bio-solarization) *i.e.* 10.00 g m$^{-2}$. At 45 DAS significantly the lower dry matter of total weeds (9.03 g m$^{-2}$) were recorded with $T_1$ -Soil solarization followed by $T_3$ (Amaranth as smother crop) *i.e.* 12.00 g m$^{-2}$. Significantly higher dry matter of total weeds recorded with weedy check ($T_6$) treatment *i.e.* 18.77 g m$^{-2}$, 23.00 g m$^{-2}$ at 30 and 45 DAS.

At 60 DAS dry matter of monocot weeds significantly influenced by weed management treatments. Significantly lower dry matter of monocot weeds was reduced by $T_3$ -Amaranth as smother crop (3.00) g m$^{-2}$ followed by $T_2$ (Bio-solarization) *i.e.* 6.00 g m$^{-2}$ and $T_5$ (Straw mulch 7.5 cm thickness) *i.e.* 6.00 g m$^{-2}$. Significantly higher dry matter of monocot weeds recorded in weedy check ($T_6$) treatment *i.e*. 18.01 g m$^{-2}$.

Similar to monocots, dry matter of dicot weeds was also significantly affected by weed management treatments at 60 DAS. The lower dry matter of dicot weeds was recorded with $T_3$ -Amaranth as smother crop (5.97) g m$^{-2}$ followed by $T_1$ (Soil solarization) *i.e.* 7.80 g m$^{-2}$ and $T_7$ -weed free (7.83) g m$^{-2}$. Significantly higher dry matter of dicot weeds recorded in weedy check ($T_6$) treatment *i.e*. 11.53 g m$^{-2}$.

Dry matter of total weeds was also significantly affected by weed management treatments at 60 DAS. Significantly the lower dry matter of total weeds (8.97 g m$^{-2}$) were recorded with $T_3$ -Amaranth as smother crop followed by $T_5$ (Straw mulch 7.5 cm thickness) *i.e.* 10.53 g m$^{-2}$. Significantly higher dry matter of total weeds recorded in weedy check ($T_6$) treatment *i.e*. 29.54 g m$^{-2}$ at 60 DAS. Similar results were found by Kiran *et al*., (2022) [10]. This might be due to weed suppression efficiency of non-chemical weed management methods such as smother crop-Amaranth and mulching remains significant even in the later stages of crop growth.

At 75 DAS dry matter of monocot weeds significantly influenced by weed management treatments. Significantly lower dry matter of monocot weeds was reduced by $T_3$- Amaranth as smother crop (3.00) g m$^{-2}$ followed by $T_7$ (Weed free) *i.e.* 5.30 g m$^{-2}$ and $T_1$ (Soil solarization) *i.e.* 7.00 g m$^{-2}$. Significantly higher dry matter of monocot weeds recorded in weedy check ($T_6$) treatment *i.e*. 15.00 g m$^{-2}$.

Similar to monocots, dry matter of dicot weeds was also significantly affected by non-chemical weed management treatments at harvest. The lower dry matter of dicot weeds was recorded with $T_3$- Amaranth as smother crop (5.00) g m$^{-2}$ followed by $T_2$ (Bio- solarization) *i.e.* 8.50 g m$^{-2}$. Significantly higher dry matter of dicot weeds recorded in weedy check ($T_6$) treatment *i.e.* 17.10 g m$^{-2}$. Similar findings were reported by Kiran *et al.*, (2022) [10]. This might be due to smother crop releases allelo-chemicals which suppresses weed growth. Dry matter of total weeds was also significantly affected by non-chemical weed management treatments at harvest.

At 75 DAS, significantly the lower dry matter of total weeds (8.00 g m$^{-2}$) were recorded with $T_3$ -Amaranth as smother crop followed by $T_7$ (Weed free) *i.e.* 15.33 g m$^{-2}$. Significantly higher dry matter of total weeds recorded in weedy check ($T_6$) treatment *i.e*. 32.10 g m$^{-2}$.

**Weed control efficiency (%)**

The data regarding treatment means for weed control efficiency of monocot and dicot weeds were grouped using Duncan's Multiple Range Test (DMRT) at 30, 45, 60 and 75 DAS were furnished in Table 4. At 30 DAS, the highest weed control efficiency of monocot weeds was recorded under $T_1$ (Soil solarization) with 81.81%, falling in group (a) and was thus the most effective treatment for monocot suppression. It was followed by $T_2$ (Bio-solarization) with 72.72% efficiency, grouped under (ab), indicating slightly lower but comparable performance with $T_1$- soil solarization. $T_5$ (Straw mulch 7.5 cm thickness) and $T_7$ (Weed free) recorded moderate weed control efficiency for monocot weeds *i.e.* (63.63% and 62.72% respectively) grouped under (bc), indicating reasonable effectiveness. The smother crop treatment ($T_3$) and $T_4$ (Straw mulch 5 cm) had relatively lower weed control efficiency, with $T_3$ (54.54%) in group (c) and $T_4$ (36.36%) in group (d), showing lesser effectiveness for monocot weed suppression.

The highest weed control efficiency for dicot weeds (55.86%) was observed in both $T_1$ (Soil solarization) and $T_4$ (Straw mulch 5 cm thickness), grouped under (a), suggesting that both treatments were highly effective in reducing dicot weed population. $T_5$ (Straw mulch 7.5 cm) recorded 47.04% weed control efficiency grouped under (ab), and was followed by $T_7$ (Weed-free) (41.12%) in group (b). $T_2$ (Bio-solarization) was less effective against dicot weeds (38.21%), grouped under (bc). The lowest weed control efficiency (13.56%) was recorded in $T_3$ (Amaranth as smother crop), grouped under (c). Similar findings reported by Shinde *et al.*, (2023) [14] who confirmed the efficacy of solarization in reducing early weed emergence.

At 45 DAS, the highest weed control efficiency of monocot weeds was recorded under $T_1$ (Soil solarization) with 80.00%, falling in group (a) and was thus the most effective treatment for monocot suppression. The next best treatment were $T_3$ (Bio-solarization) and $T_5$ (Straw mulch 7.5 cm thickness) with 66.66% weed control efficiency, grouped under (b). $T_4$ (Straw mulch 5 cm thickness) and $T_7$ (Weed free) recorded moderate weed control efficiency for monocot weeds *i.e.* (60.00% and 62.86% respectively) grouped under (bc), indicating reasonable effectiveness. The smother crop treatment ($T_3$) recorded relatively lower weed control efficiency (53.33%) and grouped under (c).

The highest weed control efficiency for dicot weeds was observed in $T_1$ (Soil solarization) (49.75%), $T_2$ (Bio-solarization) (46.41%), $T_3$ (Amaranth as smother crop) (41.66%) and $T_7$ (weed free) (38.33) grouped under (a), suggesting that these treatments were highly effective in reducing dicot weed population. $T_4$ (Straw mulch 5 cm) recorded 25.38% weed control efficiency grouped under (b) and $T_5$ (Straw mulch 7.5 cm thickness) was least effective against dicot weeds (11.41%), grouped under (c). This might be due to the use of Amaranth as a smother crop which was not only competes for resources but also releases allelo-chemicals, thereby suppressing weed growth, particularly broadleaf species.

During the experiment, at 60 DAS the higher weed control efficiency (83.34%) for monocot weeds was recorded by treatment $T_3$ (Amaranth as smother crop) which was grouped under (a). treatment $T_2$ (Bio-solarization) recorded 66.68%, $T_5$ (Straw mulch 7.5 cm thickness) recorded 66.68% weed control efficiency and $T_7$ (Weed free) recorded 62.40% WCE which was in group (b) which was followed by $T_1$ (Soil solarisation) recorded (61.13%) weed control efficiency for monocot grouped in (bc) and lower weed control efficiency (50.02%) was recorded with $T_4$ (Straw mulch 5 cm thickness) grouped in (c) group. The highest weed control efficiency for dicot weeds was observed in $T_3$ (Amaranth as smother crop) (48.22%). Weed control efficiency of $T_1$ (Soil solarization) and $T_7$ (weed free) was (32.35, 32.09%) respectively grouped under (b) which was followed by $T_2$ (Bio-solarization) and T4 (Straw mulch 5 cm thickness) with (21.94%) WCE grouped under (bc). $T_5$ (Straw mulch 7.5 cm thickness) was least effective against dicot weeds (17.34%) grouped under (c). The similar results were obtained to confirm the long-term effectiveness of the smother crop, which was reported by Kiran *et al.*, (2022) [10], this might be due to smother crops maintain their competitiveness during the entire growth cycle, thereby reducing weed pressure effectively.

At 75 DAS, the higher weed control efficiency (80.00%) for monocot weeds was recorded by treatment $T_3$ (Amaranth as smother crop). Weed control efficiency for $T_5$ (Straw mulch 7.5 cm thickness) was 64.66% and for $T_7$ (weed free) was 60.00% both are grouped under (b) which was followed by treatment $T_1$ (Soil solarization) with 53.33% WCE. Treatment $T_2$ (Bio-solarization) recorded 46.66% WCE grouped under (c). However the lower weed control efficiency (26.66%) for dicot weeds was recorded by treatment $T_4$ (Straw mulch 5 cm thickness) grouped under (d) group. The highest weed control efficiency for dicot weeds was observed in $T_3$ (Amaranth as smother crop) (70.76%). The next best treatments were $T_2$ (Bio-solarization) with (50.29%) WCE, $T_1$ (Soil solarization) with 48.12% WCE, $T_4$ (Straw mulch 5 cm thickness) with 47.36% WCE, $T_5$ (Straw mulch 7.5 cm thickness) with 42.51% WCE, and $T_7$ (Weed free) with 41.34% WCE grouped under (b). The similar findings were reported by Shinde *et al.*, (2023) [14]. This might be due to consistent performance of the smother crop till harvest indicates its utility not just for early weed suppression but also for full-season control.

**Table 1:** Major weeds associate with French bean during experiment

| | Local name | Botanical name | Family |
|---|---|---|---|
| | | **Monocots** | |
| i | Shippi | *Brachiaria eruciformis* | Gramineae |
| ii | Kena | *Commelina benghalensis* | Commelinaceae |
| iii | Hariyali | *Cynodon dactylon* | Gramineae |
| iv | Lavala | *Cyprus rotundus* | Cyperaceae |
| v | Chimanchara | *Digitaria sanguinalis* | Gramineae |
| | | **Dicots** | |
| i | Gajargavat | *Parthenium Hysterophorus* | Asteraceae |
| ii | Deepmal | *Acalypha indica* | Euphorbiaceae |
| iii | Kunjru | *Digera arvensis* | Amaranthaceae |
| iv | Tandulja | *Amaranthus polygamous* | Amaranthaceae |

**Table 2:** Mean weed density ($m^{-2}$) of French bean at 30, 45, 60, and 75 DAS as influenced by different non-chemical weed management treatments during experiment.

| Treatment | Days after sowing | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30 | | | 45 | | | 60 | | | 75 | | |
| | Monocot | Dicot | Total | Monocot | Dicot | Total | Monocot | Dicot | Total | Monocot | Dicot | Total |
| $T_1$- Soil solarization | 3.00 | 3.47 | 6.47 | 4.60 | 6.00 | 10.60 | 7.37 | 9.00 | 16.37 | 14.00 | 18.00 | 32.00 |
| $T_2$- Bio-solarization | 5.00 | 6.00 | 11.00 | 8.00 | 11.0 | 19.00 | 8.00 | 8.00 | 16 | 15.70 | 17.30 | 33.00 |
| $T_3$- Smother crop (Amaranth) | 8.00 | 12.00 | 20.00 | 8.00 | 7.00 | 15.00 | 3.00 | 4.98 | 7.96 | 6.00 | 5.77 | 12.07 |
| $T_4$- Straw Mulch 5 cm thickness | 7.00 | 5.97 | 12.67 | 11.03 | 9.00 | 20.03 | 10.33 | 7.00 | 17.33 | 16.00 | 18.20 | 34.20 |
| $T_5$- Straw Mulch 7.5 cm thickness | 6.00 | 4.80 | 10.80 | 10.10 | 8.90 | 19.00 | 8.20 | 8.00 | 16.20 | 19.00 | 15.00 | 34.00 |
| $T_6$- Weedy check | 8.00 | 11.00 | 19.00 | 15.00 | 16.67 | 31.67 | 14.50 | 17.50 | 32.00 | 17.20 | 18.80 | 36.00 |
| $T_7$- Weed free | 4.00 | 6.30 | 10.30 | 7.00 | 10.17 | 17.17 | 7.00 | 6.00 | 13 | 6.30 | 9.33 | 15.33 |
| S.E(m)± | 0.44 | 0.49 | 0.93 | 0.49 | 0.47 | 0.96 | 0.39 | 0.36 | 0.75 | 0.63 | 0.61 | 1.24 |
| C.D at 5% | 1.37 | 1.52 | 2.89 | 1.53 | 1.47 | 3.00 | 1.23 | 1.14 | 2.37 | 1.96 | 1.90 | 2.86 |
| G. Mean | 5.85 | 7.07 | 12.92 | 9.10 | 9.90 | 19.00 | 8.38 | 8.63 | 16.97 | 13.45 | 14.62 | 28.08 |

**Table 3:** Mean weed dry matter (g $m^{-2}$) of French bean at 30, 45, 60, and 75 DAS as influenced by different non-chemical weed management treatments during experiment

| Treatment | Days after sowing | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30 | | | 45 | | | 60 | | | 75 | | |
| | Monocot | Dicot | Total | Monocot | Dicot | Total | Monocot | Dicot | Total | Monocot | Dicot | Total |
| $T_1$- Soil solarization | 2.00 | 5.00 | 7.00 | 3.00 | 6.03 | 9.03 | 7.00 | 7.80 | 14.80 | 7.00 | 8.87 | 15.87 |
| $T_2$- Bio-solarization | 3.00 | 7.00 | 10.00 | 7.00 | 6.43 | 13.43 | 6.00 | 9.00 | 15.00 | 8.00 | 8.50 | 16.50 |
| $T_3$- Smother crop (Amaranth) | 5.00 | 9.80 | 13.80 | 5.00 | 7.00 | 12.00 | 3.00 | 5.97 | 8.97 | 3.00 | 5.00 | 8.00 |
| $T_4$- Straw Mulch 5 cm thickness | 7.00 | 5.07 | 12.07 | 6.00 | 8.93 | 14.93 | 9.00 | 9.00 | 18.00 | 11.00 | 9.00 | 20.00 |
| $T_5$-Straw Mulch 7.5 cm thickness | 4.00 | 6.00 | 10.00 | 5.00 | 10.63 | 15.63 | 6.00 | 9.53 | 10.53 | 6.00 | 9.83 | 15.83 |
| $T_6$- Weedy check | 11.00 | 11.33 | 18.77 | 15.00 | 12.00 | 23.00 | 18.01 | 11.53 | 29.54 | 15.00 | 17.10 | 32.10 |
| $T_7$- Weed free | 4.00 | 6.57 | 10.67 | 5.57 | 7.40 | 12.97 | 6.77 | 7.83 | 14.60 | 5.30 | 10.03 | 15.33 |
| S.E(m)± | 0.34 | 0.46 | 0.80 | 0.52 | 0.38 | 0.90 | 0.44 | 0.40 | 0.84 | 0.44 | 0.36 | 0.80 |
| C.D at 5% | 1.08 | 1.43 | 2.51 | 1.63 | 1.20 | 2.83 | 1.38 | 1.25 | 2.63 | 1.39 | 1.14 | 2.53 |
| G. Mean | 5.15 | 7.25 | 11.75 | 6.65 | 8.34 | 14.42 | 7.96 | 8.66 | 15.92 | 7.90 | 9.76 | 17.66 |

**Table 4:** Weed control efficiency (%) of French bean at 30, 45, 60, and at harvest as influenced by different non-chemical weed management treatments during experiment

| Treatment | Days after sowing | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 30 | | 45 | | 60 | | 75 | |
| | Monocot | Dicot | Monocot | Dicot | Monocot | Dicot | Monocot | Dicot |
| $T_1$- Soil solarization | 81.81$^{a}$ | 55.86$^{a}$ | 80.00$^{a}$ | 49.75$^{a}$ | 61.13$^{bc}$ | 32.35$^{b}$ | 53.33$^{bc}$ | 48.12$^{b}$ |
| $T_2$- Bio-solarization | 72.72$^{ab}$ | 38.21$^{b}$ | 53.33$^{c}$ | 46.41$^{a}$ | 66.68$^{b}$ | 21.94$^{bc}$ | 46.66$^{c}$ | 50.29$^{b}$ |
| $T_3$- Smother crop (Amaranth) | 54.54$^{c}$ | 13.5$^{c}$ | 66.66$^{b}$ | 41.66$^{a}$ | 83.34$^{a}$ | 48.22$^{a}$ | 80.00$^{a}$ | 70.76$^{a}$ |
| $T_4$- Straw Mulch 5 cm thickness | 36.36$^{d}$ | 55.86$^{a}$ | 60.00$^{bc}$ | 25.58$^{b}$ | 50.02$^{c}$ | 21.94$^{bc}$ | 26.66$^{d}$ | 47.36$^{b}$ |
| $T_5$- Straw Mulch 7.5 cm thickness | 63.63$^{bc}$ | 47.04$^{ab}$ | 66.66$^{b}$ | 11.41$^{c}$ | 66.68$^{b}$ | 17.34$^{c}$ | 60.00$^{b}$ | 42.51$^{b}$ |
| $T_6$- Weedy check | - | - | - | - | - | - | - | - |
| $T_7$- Weed free | 62.72$^{bc}$ | 41.12$^{b}$ | 62.86$^{bc}$ | 38.33$^{a}$ | 62.4$^{b}$ | 32.09$^{b}$ | 64.66$^{b}$ | 41.34$^{b}$ |
| G. Mean | 61.96 | 41.93 | 64.91 | 35.52 | 65.04 | 28.98 | 55.21 | 50.06 |

## Conclusion

On the basis of field experiment, the effect of different non-chemical weed management practices in French bean revealed that,

The major weeds (monocot and dicot) in French bean were, *Brachiaria eruciformis*, *Commelina benghalensis*, *Cynodon dactylon*, *Cyprus rotundus*, *Digitaria sanguinalis Parthenium Hysterophorus*, *Acalypha indica*, *Digera arvensis* and *Amaranthus polygamous* respectively identified during experimentation.

In French bean lower weed density, lower weed dry weight, higher weed control efficiency and weed suppression was attained through $T_1$-soil solarization, $T_2$-bio-solarization and $T_3$-smother crop (Amaranth).

## References


1. Anonymous. Crop-wise pulses global scenario. 2022.
2. Bansode MD, Suryawanshi VP, Karanjikar KA. Production constraints analysis of kharif French bean (*Phaseolus vulgaris* L.) in vertosols. Journal of Pharmacognosy and Phytochemistry. 2019;8(4):252-254.
3. Chavan KA, Suryavanshi VP, Karanjikar PN. Analysis of weed control measures in Kharif French bean. Journal of Pharmacognosy and Phytochemistry. 2020;SP6:374-376.
4. Corazon AA, Auma E, Ngode L. Effect of Mulching as a weed management strategy in field production of French Beans (*Phaseolus vulgaris* L) in Western Kenya. Asian Journal of Advance Agricultural Research. 2024;24(2):11-20.
5. Dhaker DL, Ghasil BP, Kumar P, *et al*. Non-chemical methods of weed management in field crops: A sustainable approach. Recent Innovation Approaches in Agriculture science. 2022;vol II.
6. Horvath DP, Clay SA, Swaton CJ, Anderson JV, Chao WS. Weed Induced Crop Yield Loss: New Paradigms and New Challenges. Journals of Plant Science. 2023;28:567-582. doi:10.1590/S0100-83582016340200019.
7. Jacobs TM, Tubeileh AM, Steinmaus SJ. Thermal-Time Hazard Models of Seven Weed Species Germinability following Heat Treatment. Agronomy. 2024;14:275.
8. Jagtap M, Shinde Y, Khatri N. An investigation on the effect of soil solarization on soil temperature and soil moisture conservation. Arabian Journal of Geosciences. 2022;15. doi:10.1007/s12517-022-11046.
9. Jahanbakhshi M, Saeedipour S. Determination of critical period of weeds control in french bean (*Phaseolus vulgaris* L.) in Iran. International Journal of Biosciences. 2015;6(2):411-417. http://dx.doi.org/10.12692/ijb/6.2.411-417.
10. Kiran E, Matiwade PS, Gaddanakeri SA. Effect of smother crops and green leaf manures on weed dynamics and yield of organic sweet corn. The Pharma Innovation Journal. 2022;11(12):3307-3310.
11. Laskar RA, Dowarah B, Tamang D, Das S, Raina A. Improving French bean yield potential through induced mutagenesis using EMS and SA. 2023;2.
12. Mirza H, Saved MM, Bhuyan B, Bhuyan TF. Phytotoxicity, environmental and health hazards of herbicides: challenges and ways forward. 2020;55-99.
13. Panse VG, Sukhatme PV. Statistical methods for Agricultural workers. 4th ed. ICAR; 1967. p. 228-232.
14. Shinde Y, Jagtap M, Patil M, Khatri N. Experimental investigation on the effect of soil solarization incorporating black, silver, and transparent, and straw as a mulch, on the microbial population and weed growth. Chemosphere. 2023;336:139263.

15. Sinkovic L, Blazica V, Blazica B, Meglic Vladimir M, Pipan B. How Nutritiou Are French Beans (*Phaseolus vagaries* L.) from the Citizen Science Experiment. Plants (Basel). 2024;13(2):314. doi:10.3390/plants13020314.
16. Teasdale JR, Brandsater LO, Calegari A, Skora Neto F. Cover Crops and Weed Management Weed Management. 2007;Chap 04:4.
17. Vasishtha H, Srivastava RP. Genotypic variations in protein, dietary fiber, saponins and pectin's in French beans (*Phaseolus vulgaris* L.). Indian Journal of Agricultural Biochemistry. 2012;25(2):150-153.