



RESEARCH PAPER

Integrated effect of mixed oil cake and FYM on raising of mulberry saplings and establishment of chawki garden for sustainable sericulture

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Abstract : A pilot study was conducted at Regional Sericultural Research Station, Kalimpong, West Bengal, India own research farm during the year 2012-17 with five treatments e.g. T₁: Control: FYM @ 10 mt ha⁻¹; T₂: FYM @ 10 mt ha⁻¹ + mixed oil cake @ 0.5 mt ha⁻¹; T₃: FYM @ 10 mt ha⁻¹ + mixed oil cake @ 0.75 mt ha⁻¹; T₄: FYM @ 10 mt ha⁻¹ + mixed oil cake @ 1.0 mt ha⁻¹ and T₅: FYM @ 10 mt ha⁻¹ + mixed oil cake @ 1.5 mt ha⁻¹ to study their integrated effect for raising of mulberry saplings and establishment of chawki garden. The mixed cake was applied through 'Spic Surabhi'. The main ingredient in Spic Surabhi was oil seed cake of *Neem*, groundnut, castor and sesame with turmeric powder and pungaia extracts. Based on the data analyzed, it has been observed that, the integrated effect of mixed oil cake and FYM was significant on survivability (%), root zone, growth attribute characters and leaf yield. The average height of 180 days old saplings was 159.95 cm with treatment combination T₅ followed by 156.35 cm with T₄ and 103.68 cm with T₁ (control). Maximum leaf yield was 6.5 mt ha⁻¹ in T₅ in spring season, 2016 followed by 6.4 mt ha⁻¹ in T₄ and 4.4 mt ha⁻¹ in T₁ (control). The total leaf yield gain was 47.7% in T₅ over control. In autumn season, maximum leaf yield was 5.1 mt ha⁻¹ T₅ followed by 4.9 mt ha⁻¹ in T₄ and 4.0 mt ha⁻¹ in T₁ (control). Total leaf yield was 27.5 per cent higher in autumn season with T₅ than control. In spring season, 2017, maximum leaf yield was 8.1 mt ha⁻¹ with T₅ followed by 8.0 mt ha⁻¹ with T₄ and 5.8 mt ha⁻¹ in T₁ (control). Total leaf yield gain in autumn, 2017 was 39.6 per cent higher in T₅ than control. To control the both primary and secondary infection of root rot, mixed oil cake containing *Neem* ingredients performed better, because, *Neem*, (*Azadirachta indica*), a native of arid zone of Indian sub-continent are well known for its nutritional and medicinal values worldwide.

Key Words : Mixed oil cake, Sericulture, Mulberry, Chawki garden, Silkworm

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INTRODUCTION

Sericulture or silk farming is a well known cash crop on global scenario. It is a media to produce raw silk by conversion of leaf protein into raw silk through gland

of silkworm by silkworm rearing. In India, sericulture is one of the oldest agro based industry and probably dates back to the beginning of the Christian era. Silk are also well known for one of the treasurer of India. Mulberry

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sericulture is the strongest pillar and back bone of this industry which plays a key role for empowerment of women and rural livelihood. Besides, this industry is also an array in the arsenal of weavers' community, which is giving the huge employment. The success and failure of this industry is fully dependent on chawki and late age rearing by feeding the quality mulberry leaves, because, the mulberry leaves are basic food material for silkworm *Bombyx mori* L. (Ravikumar, 1988) and nutritional quality of mulberry leaves supplied as food have greater influence on silkworm growth and cocoon yield (ESCAP, 1993).

Kalimpong hills, an extension of sub-Himalayan region have great influence on Indian sericulture industry, because, it is a sericulture hub and well known for production of bivoltine silkworm seed cocoon. Besides, Kalimpong hills also have its own identity as 'silk route of India'. Soils of this region have potential with high organic carbon content and available nitrogen, but, shallow to moderately deep soil depth, light textured soil, steep sloping, severe erosion, terrace farming, low temperature, heavy rainfall, leaching of bases, low nutrients uptake, rainfed cultivation and injudicious use of fertilizers leads 'active acidity' resulting these soils are known as problem soils (Ram *et al.*, 2017; 2016 and 2015).

Due to above morpho-physical characteristics of the soil, adverse physiography and environmental condition, raising of mulberry saplings and establishment of chawki garden is a big task for sericulture community. The major constrains for raising of saplings and establishment of new chawki garden is the severe attack of both primary and secondary infection of root rot

caused by heavy rainfall, lack of sufficient irrigation and external attack of ants, termites and other bugs etc. Besides, lack of proper nutrient management for survival of saplings is also a big cause. During the initial stage of plantations, generally heavy rainfall take place resulting growth and development of roots suffer and it promotes the primary root rot attack. Besides, after rainy season and rising of temperature, severe water stress in plantation also stunt the growth and development of root and shoot. To control the root rot with managing the nutritional requirement of the plants, a mixture of *Neem*, castor, groundnut and sesame oil seed cake alongwith turmeric powder, pungamia extracts and FYM was chosen to conduct this pilot study.

MATERIAL AND METHODS

Experimental site and climate :

The experiment was conducted during 2012-17 at Regional Sericultural Research Station (RSRS) farm, Kalimpong district, West Bengal. The experimental area lies between 26° 31' to 27° 13' N latitude and 87° 59' to 88° 53' E longitude and situated at 3550 feet (1076 m) above mean sea level. Sandstone, quartzite and mica are the major geologic formation in this area which acts as parent materials for the formation of the soil. River Teesta and its tributaries are main water bodies.

The climate is subtropical type (Sub-Himalayan region) with hot dry summers and cold winters. The mean maximum temperature during the hottest months (March to June) in the year 2011-15 was about 27.7 °C, while the mean minimum temperature in the coldest months (December to February) in same years was as

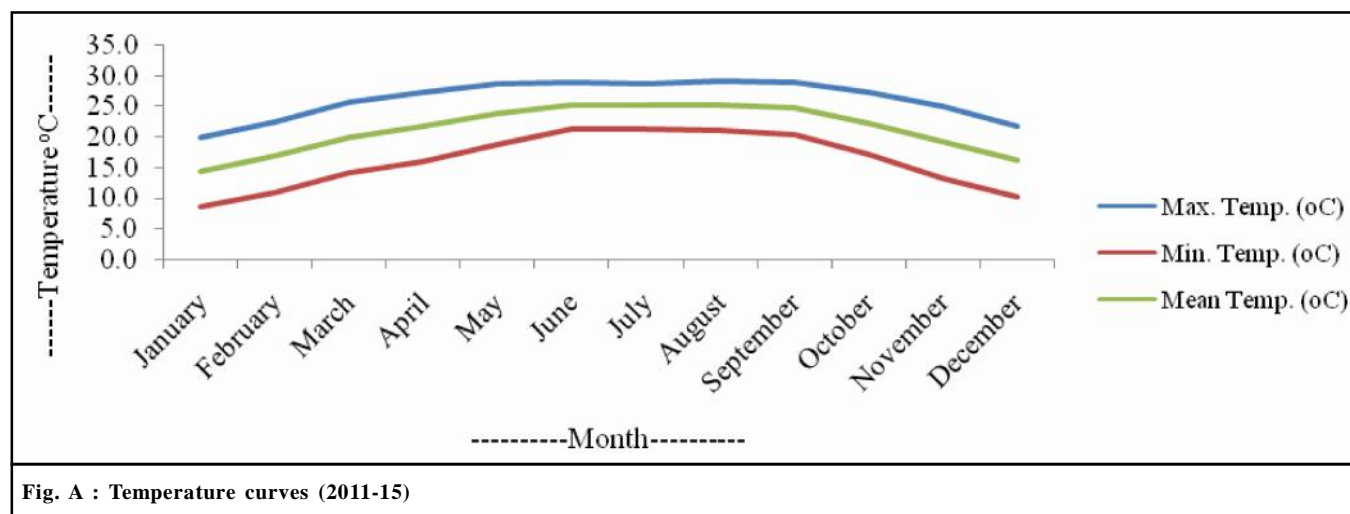


Fig. A : Temperature curves (2011-15)

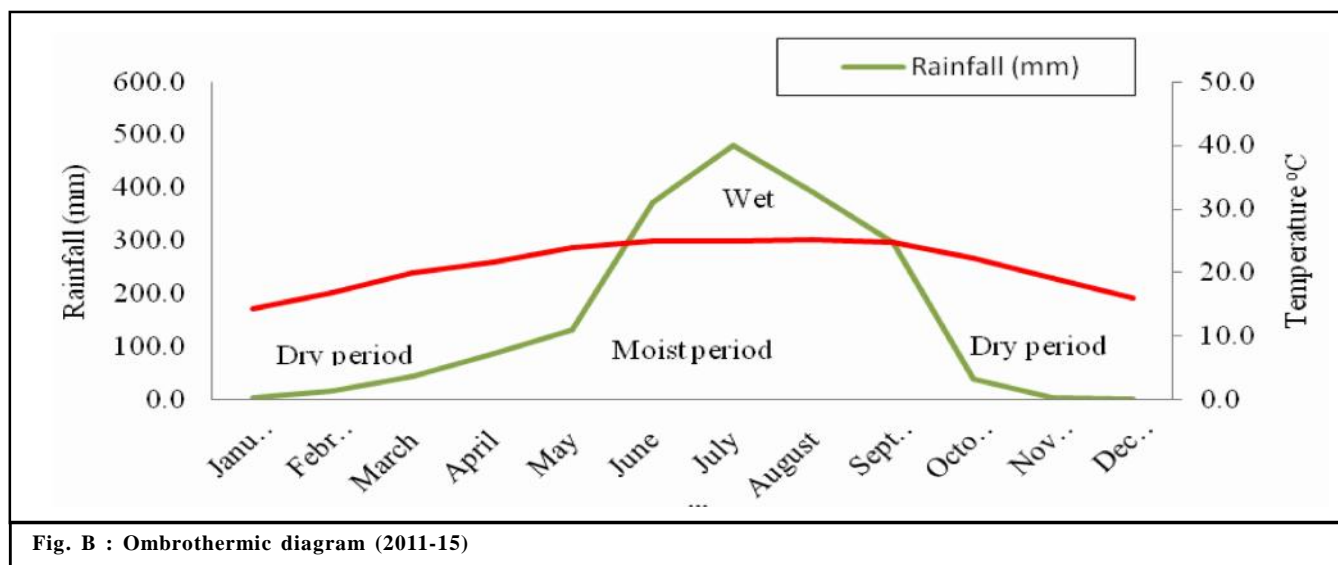


Fig. B : Ombrothermic diagram (2011-15)

low as 9.9°C. The mean annual temperature was 21.2 °C. The onset period of monsoon was in the second week of June. The mean annual rainfall was 1870.2 mm, four-fifth of which was received during June to September and remaining one-fifth in October to May. The temperature curve and ombrothermic diagram is given in Fig.A and B.

Treatment combination:

The experiment was conducted with five nutrients management practices, viz., T₁: Control: FYM @ 10 mt ha⁻¹; T₂: FYM@10 mt ha⁻¹ + mixed oil cake@0.5 mt ha⁻¹; T₃: FYM@10 mt ha⁻¹ + mixed oil cake@0.75 mt ha⁻¹; T₄: FYM@10 mt ha⁻¹ + mixed oil cake@1.0 mt ha⁻¹ and T₅: FYM@10 mt ha⁻¹ + mixed oil cake@1.5 mt ha⁻¹, respectively. There were four replications under each treatment. The recommended doses of NPK @150:50:50 kg ha⁻¹ and soil test based doses (STBD) of dolomite @ 1.5 mt ha⁻¹ was applied uniformly in all the treatment plots (Ram *et al.*, 2015).

Nature of manures, fertilizers and dolomite applied:

Integrated application mixed oil cake, FYM, dolomite and mineral fertilizers were applied as per the treatment plan. Cow dung was the only source of FYM, whereas, the 'Spic Surabhi' was the source of mixed oil cake. The main ingredient in Spic Surabhi was oil seed cake of *Neem*, groundnut, castor and sesame with turmeric powder and pungamia extracts. These oil cakes were fortified well together in a well-balanced mixed with NPK. The chemical composition of the mixed oil cake was as

under: moisture content 9.2%, pH-5.5; EC (dSm⁻¹) - 0.34, organic carbon - 26.5%, Nitrogen-2.45%, Phosphorus-0.96%, Potash-1.0% and C:N ratio- 10:81.1, respectively. The dolomite (CCE@109%) was applied as liming materials, however, nitrogen was applied through urea (46% N), phosphorus through single superphosphate (18% P₂O₅) and potash through muriate of potash (60% K₂O). The treatments were distributed in a Randomized Complete Block Design (RCBD) with five treatment and four replications in different terrace of fixed plot size.

Nature of variety and raising of saplings:

A most suitable BC₂-59 mulberry variety was chosen for raising of saplings and establishment of mulberry garden. The variety were released by Central Silk Board, Bangalore through back cross technique. The branches of the variety are semi-erect, medium in number with moderate to high growth. The leaves are large, smooth, unlobed, glossy and thick (Dandin and Giridhar, 2010). This variety is most suitable in hilly region of Kalimpong and Sikkim.

Nursery bed was prepared during the month of July, 2012 for raising of saplings. The size of nursery bed was fixed 1.8 m x 1.2 m with the distance 0.15 m from row to row and 0.10 m from cutting to cutting. Total 120 cuttings were planted in one nursery bed. Nursery bed was covered uniformly with black polythene sheet as mulch to prevent the soil moisture loss. About 15-20 cm long, middle portion of matured shoot with 12-15 cm diameter and 3 internodes was chosen for preparation of cuttings. The cutting was treated with 0.2 per cent

Carbendazim (50 WP) solution for 15 minutes to prevent from the fungal attack. Finally, the treated cutting was inserted in slightly slanting position in the nursery bed with one node projecting above the surface.

Establishment of mulberry garden:

For establishment of new mulberry garden, a pit with 0.6 x 0.6 x 0.6 m was dug at 0.9 x 0.9 x 0.9 m wider spacing in the terraced plot surrounded the bund. Dolomite was mixed uniformly in soil throughout the plot in 15 days before the transplantation. Likewise, the pit was also filled with FYM, mixed oil cake and fertilizers as per treatment plan 3-4 days before the transplantation. About one year old saplings were uprooted and transplanted in same day during the month of June, 2013 for establishment of new mulberry garden. Growth attribute characters and leaf yield were recorded after two years of plantation of chawki garden.

Root studies of sapling:

Roots of the saplings were studied adopting the standard procedures. Root length density was calculated following the procedures of (Myers *et al.*, 2007) whereas Relative root growth constant and specific root length were calculated as per the formula given by Fohse *et al.* (1991) and Ostonen *et al.* (2007), respectively.

Soil analysis:

Soil samples were collected, dried, sieved and analyzed by adopting the standard procedure Black, (1985) and Jackson (1979). The processed soil samples were analyzed by following the standard procedures e.g. soil pH (1:2.5 soil: water suspension); easily oxidizable $K_2Cr_2O_7 + H_2SO_4$ organic C (Walkley and Black, 1934); alkaline $KMnO_4$ oxidizable N (Subbiah and Asija, 1956); 0.025 N HCl+0.03 N NH_4F extractable P (Bray and Kurtz, 1945) and available K (1N NH_4OAc exchangeable K), respectively. The statistical analysis was done by using Microsoft Excel, 2007 software.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Morph-physico-chemical properties of soils:

Soils of experimental site are shallow to very deep in depth; dark yellowish brown (10 YR 4/4) to brown

(10 YR 5/4 and 6/4) in colour; sandy loam to sandy clay loam texture; single grain to fine, medium, sub-angular blocky structure; dry semi hard, moist very friable to friable, wet slightly sticky to sticky and wet slightly plastic consistency; very fine to fine, few too many pores and clear to gradual smooth, wavy horizon boundary. As per the data analyzed, soils of the area found sufficient in organic carbon and available nitrogen whereas it was deficient in available phosphorus and sulphur. Chemical characteristics of the soils under this pilot study are given in Table 1.

Sr. No.	Soil parameters	Nutrient status
1.	pH (1:2.5)	5.42
2.	EC (dSm ⁻¹)	0.17
3.	Organic C (%)	1.25
4.	Available N (kg ha ⁻¹)	433.8
5.	Available P (kg ha ⁻¹)	22.7
6.	Available K (kg ha ⁻¹)	169.5
7.	Available S (kg ha ⁻¹)	12.4

Effect of mixed oil cake on growth attributes characters of saplings:

Based on the data analyzed, it has been observed that, the integrated effect of mixed oil cake and FYM on survivability (%), root zone and growth attribute characters of mulberry saplings was significant. The highest survivability of mulberry saplings was obtained with the application mixed oil cake as per the treatment plan T₄ and T₅. Likewise, root length and other root growth attribute characters also found higher with same treatment plan. In a surprised way, the height of the saplings after 180 days in a nursery bed was highly significant with the application of mixed oil cake as per the treatment plan T₄ and T₅ and the average height was recorded between 156.35 to 159.95 cm, respectively. The average height of the control was 103.68 cm. Effect of mixed oil cake on growth attributes characters of saplings given in Table 2 and Fig. 1(a) to 1(e).

Effect of mixed oil cake on growth attributes characters and yield of chawki garden:

Based on the data analyzed, it has been observed that, the effect of mixed oil cake on growth attributes characters and leaf yield of mulberry chawki garden was significant in both autumn and spring season. Maximum height of shoot, number of leaves shoot⁻¹ and leaf yield

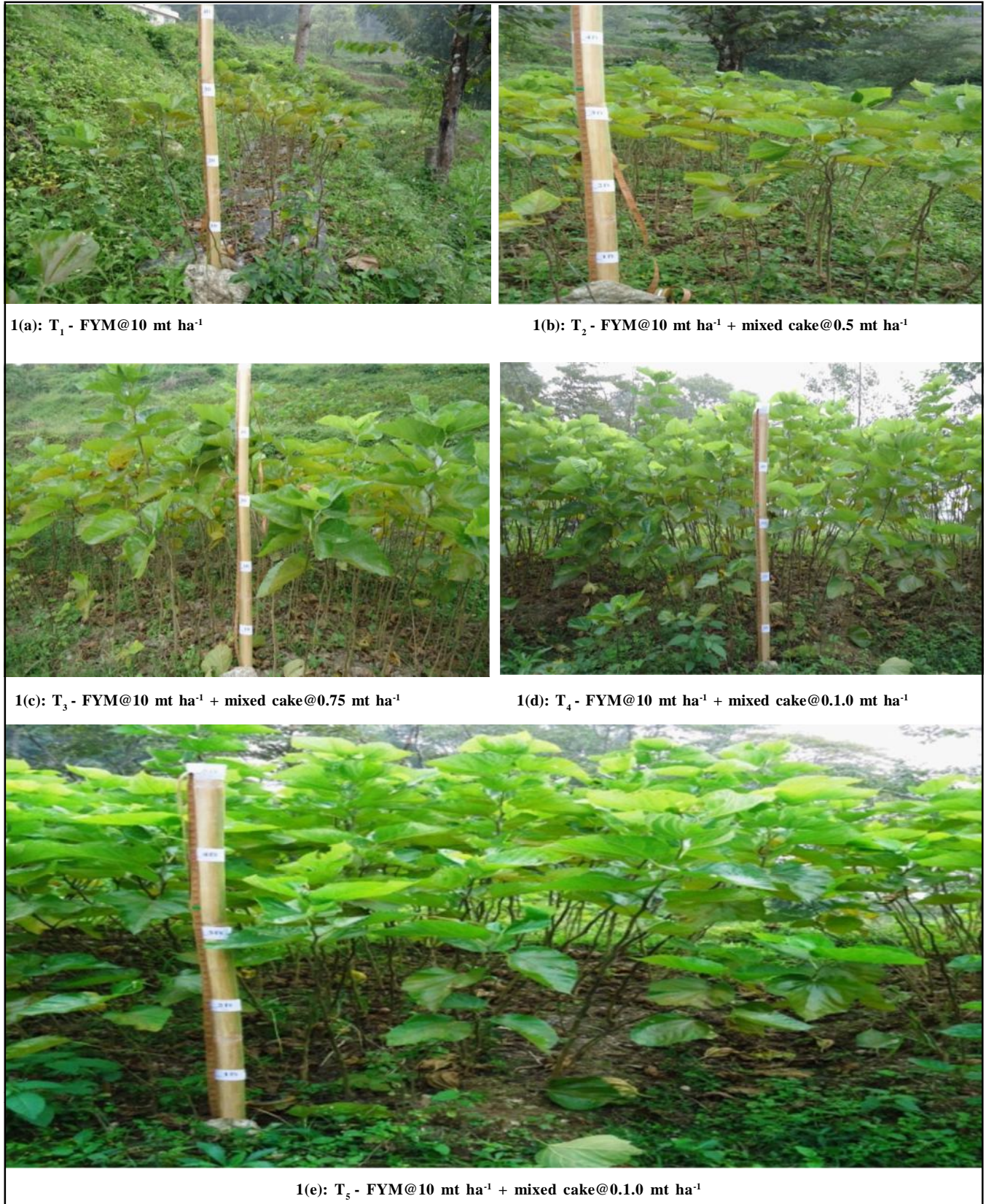


Fig. 1 (a-e): Effect of mixed oil cake on growth attributes characters of saplings

was observed in T₄ and T₅ treatment over control. While observing the effect of season (S) x Treatment (T), it was found that, the higher leaf yield was recorded in spring than autumn. In spring season, 2016, maximum estimated leaf yield 6.4 mt ha⁻¹ was recorded in the treatment combination T₄ followed by 6.5 mt ha⁻¹ in T₅ and 4.4 mt ha⁻¹ in T₁ (control). While comparing with control, the total leaf yield gain was 20.4 per cent higher in T₃ followed by 45.4 per cent in T₄ and 47.7 per cent in T₅ treatment, respectively. The survivability of saplings

planted for chawki garden with the application of mixed oil cake was also significantly higher over control. Effect of mixed oil cake on growth attributes characters and yield of chawki garden in spring season, 2016 are given in Table 3.

While estimating the effect of mixed oil cake on growth attributes characters and yield of chawki garden in autumn season 2016, it was found that, plant survivability and leaf yield gain was also significantly higher over control. Maximum estimated leaf yield 4.9

Table 2: Effect of mixed oil cake on growth attributes characters of saplings

Treatments	Survival of saplings @ 180 DAP (%)	Root length plant ⁻¹ @ 90 DAP (cm)	Root length plant ⁻¹ @ 180 DAP (cm)	Fresh weight of root plant ⁻¹ @ 180 DAP (g)	Dry weight of root plant ⁻¹ @ 180 DAP (g)	Height of saplings @ 180 DAP (cm)	RLD @ 180 DAP (cm cm ⁻³)	RRGC @ 180 DAP (cm cm ⁻¹ day ⁻¹)	Specific root length @ 180 DAP (m g ⁻¹)
T ₁	44.75	111.33	511.81	9.48	3.35	91.58	11.94	4.45	153.52
T ₂	46.50	137.90	583.63	12.40	4.40	92.90	12.84	4.95	134.30
T ₃	53.25	168.08	707.94	14.30	4.85	124.85	13.09	6.00	146.73
T ₄	60.25	195.73	747.04	14.90	5.43	156.35	14.88	6.13	138.23
T ₅	60.75	202.35	771.25	16.44	6.25	159.95	15.77	6.32	124.40
S.E ±	1.64	2.64	4.83	0.14	0.04	1.99	0.29	0.06	3.72
C.D. (P=0.05)	8.13	17.91	39.95	1.10	0.77	8.53	1.34	0.49	NS

DAP= Date after planting, RLD= Root length density, RRGC= Relative root growth constant

NS= Non-significant

Table 3: Effect of mixed oil cake on growth attributes characters and yield of chawki garden in spring season 2016

Treatments	No. of plants survived	Plant survivability (%)	No. of shoots plant ⁻¹	Height shoot ⁻¹ (cm)	No. of leave shoot ⁻¹	Total no. of leaves plant ⁻¹	Total leaf yield plant ⁻¹ (kg)	*Estimated leaf yield (mt ha ⁻¹)	Estimated leaf yield gain (%)
T ₁	45.0	70.3	4.7	73.7	14.1	66.3	0.36	4.4	0.0
T ₂	44.0	68.8	4.9	75.9	14.1	69.1	0.36	4.4	0.0
T ₃	49.0	76.6	5.2	87.4	17.3	89.9	0.43	5.3	20.4
T ₄	53.0	82.8	5.6	103.5	19.4	108.6	0.52	6.4	45.4
T ₅	54.0	84.4	5.7	103.5	19.6	111.7	0.53	6.5	47.7
S.E. ±	0.3	1.7	0.1	0.6	0.1	11.9	4.71	0.1	4.1
C.D. (P=0.05)	13.7	13.7	0.2	7.2	2.2	11.9	0.1	0.6	15.6

*Estimated leaf yield of 12345 plants ha⁻¹

Table 4: Effect of mixed oil cake on growth attributes characters and yield of chawki garden in autumn season, 2016

Treatments	No. of plants survived	Plant survivability (%)	No. of shoots plant ⁻¹	Height shoot ⁻¹ (cm)	No. of leave shoot ⁻¹	Total no. of leaves plant ⁻¹	Total leaf yield plant ⁻¹ (kg)	*Estimated leaf yield (mt ha ⁻¹)	Estimated leaf yield gain (%)
T ₁	45.0	70.3	5.9	65.7	12.2	71.9	0.33	4.0	0.0
T ₂	44.0	68.8	6.2	66.9	12.2	75.6	0.33	4.0	0.0
T ₃	49.0	76.6	6.3	75.3	13.1	82.5	0.37	4.6	15.0
T ₄	53.0	82.8	6.3	88.8	14.7	92.6	0.40	4.9	22.5
T ₅	54.0	84.4	6.4	88.8	14.7	94.0	0.41	5.1	27.5
S.E.±	0.3	1.7	0.2	1.5	0.4	3.2	4.7	0.1	5.2
C.D. (P=0.05)	1.4	8.9	NS	7.7	1.3	NS	0.1	0.7	17.6

*Estimated leaf yield of 12345 plants ha⁻¹

NS= Non-significant

mt ha⁻¹ was recorded in the treatment combination T₄ followed by 5.1 mt ha⁻¹ in T₅ and 4.0 mt ha⁻¹ in T₁ (control). While comparing with control, the total leaf yield gain was 15.0 per cent higher in T₃ followed by 22.7 per cent in T₄ and 27.5 per cent in T₅ treatment, respectively. Effect of mixed oil cake on growth attributes characters and yield of chawki garden in autumn season, 2016 are given in Table 4.

The growth attributes characters and leaf yield data once again recorded in the spring season, 2017. During this season, chawki garden was well survived and the age of the plantation was more than three years. The growth attributes characters and leaf yield in this season was very high as compare with previous two seasons. In spring season, 2017, maximum estimated leaf yield 8.0 mt ha⁻¹ was recorded in the treatment combination T₄ followed by 8.1 mt ha⁻¹ in T₅ and 5.8 mt ha⁻¹ in T₁ (control). Total leaf yield gain was 27.5 per cent higher in T₃ followed by 37.9 per cent in T₄ and 39.6 per cent in T₅ treatment, respectively. Effect of mixed oil cake on growth attributes characters and yield of chawki garden in spring season, 2017 are given in Table 5.

To control the both primary and secondary infection of root rot and also to balance the nutritional requirements of plantation, mixed oil cake was applied through 'Spic Surabhi'. The main ingredient in Spic Surabhi was oil seed cake of *Neem*, castor, groundnut and sesame with turmeric powder and pungamia extracts. These oil cakes were fortified well together in a well-balanced mixed with NPK. *Neem*, (*Azadirachta indica*), a native of arid zone of Indian sub-continent are well known for its nutritional and medicinal values worldwide. Due to its bio-degradable and eco-friendly nature, it provides all the macro and micro-nutrients to the soil and plants. It has also been used as denitrifying agent, urea coating agent, fumigant and pesticide etc. both in soil and plants.

Castor (*Ricinus communis* L.) is and industrial oilseed crop belongs to the family Euphorbiaceae, extensively cultivated in India, China and Brazil (Miller *et al.*, 2009 and Weiss, 1983). Castor is used as organic fertilizer worldwide (Severino *et al.*, 2006a; Gupta *et al.*, 2004 and Udeshi, 2004), because, it is a major source of both macro and micro nutrients which improves the physical, chemical and microbial properties of the soil (Gupta *et al.*, 2004). Like *Neem* and castor cake, groundnut and sesame cake are also very rich in both macro and micro nutrients which responsible for enhancement of nutrient uptake in plans and improvement of physical, chemical and microbial properties of the soil.

It is well known fact that, the growth attributing characters and yield of mulberry is highly influenced by the nutrients available in the soil. Besides, nutrient management also play the major role in this regard, While working on mulberry, Chowdhury *et al.* (2013) reported the significant result on yield and quality of mulberry leaves after integrated application of organic manures. Thakur *et al.* (2012) reported that the integrated application of *Neem* cake in combination of other organic manures and chemical fertilizers had significant impact on cane yield in both plant and ratoon crop. Viridia and Patel (2010) also reported the similar findings. Mahajan *et al.* (2012) reported that the application of *Neem* cake @2.5 mt ha⁻¹ are an ideal organic nutrition module to meet the nutritional requirement of basmati crop and is best alternative to inorganic fertilizer without significant loss in grain yield. Significant results of *Neem* cake in combination with other organic nutrients on various crops were also reported by the majority of scientific community. Prabhakar *et al.* (2012) found the highly significant result of neem cake on growth, yield and quality of rose onion (*Allium cepa*) whereas; Singh *et al.* (2000) reported the similar findings on rice crop and

Table 5: Effect of mixed oil cake on growth attributes characters and yield of chawki garden in spring season, 2017

Treatments	No. of plants survived	Plant survivability (%)	No. of shoots plant ⁻¹	Height shoot ⁻¹ (cm)	No. of leave shoot ⁻¹	Total no. of leaves plant ⁻¹	Total leaf yield plant ⁻¹ (kg)	*Estimated leaf yield (mt ha ⁻¹)	Estimated leaf yield gain (%)
T ₁	45.0	70.3	5.6	100.0	17.7	99.1	0.47	5.8	0.0
T ₂	44.0	68.8	5.5	100.2	17.9	98.4	0.47	5.8	0.0
T ₃	49.0	76.6	6.1	108.4	20.4	124.4	0.60	7.4	27.5
T ₄	53.0	82.8	6.5	121.1	22.1	143.6	0.65	8.0	37.9
T ₅	54.0	84.4	6.5	121.3	22.5	146.2	0.66	8.1	39.6
S.E.±	0.3	1.7	0.1	0.8	0.3	2.7	4.7	0.1	8.5
C.D. (P=0.05)	1.4	8.9	0.5	7.1	2.1	16.1	0.1	1.0	18.8

*Estimated leaf yield of 12345 plants ha⁻¹

Kumpawat (2010) on productivity and nutrient uptake of black gram. Similar findings were also reported by the various workers across the country (Senapati *et al.*, 2005; Polthanee, 2008; Prasad, 2005 and Prakash *et al.*, 2003).

Shankar (1990) reported that the deficiency of essential nutrients in the soil has been found to cause nutritional, anatomical and histological disorders in mulberry, however, Krishna and Bongale (2001) opined that, unbalanced nutrient management have adverse effect on crop productivity and nutrients availability. Modern concept of soil health management is to apply the plant nutrients in an integrated manner to achieve the targeted yield with maintaining soil health at benchmark level. Hence, several workers have conducted the research in this regard. Umesha and Sannappa (2014) reported that, INM of FYM with other organic manures enhanced the bio-chemical and mineral nutrients of mulberry leaves. Similar findings have also been reported by various workers (Ting-Xing *et al.*, 1980 and Ray *et al.*, 1973). The beneficial effect of organic manures on growth attributes, leaf yield and quality due to proper decomposition, mineralization, solubilizing effects and availability of sufficient nutrients in mulberry have reported by various workers (Das *et al.*, 1999; Setua *et al.*, 2002; 1999; Sudhakar *et al.*, 2000 and Chowdhury *et al.*, 2013).

Effect of mixed oil cake on soil borne diseases during establishment of chawki garden:

The field chosen under this pilot study was highly infected with ants, termites and others similar insects.

Shallow soil depth, active soil acidity, heavy leaching, severe soil erosion, heavy rainfall in July to September, severe water stress, terrace farming and very steep slopping was major constraints for survival of chawki garden. Besides, ants and termite attacks within the root zone was also a big task for establishment of chawki garden.

Due to above multiple reasons, newly planted saplings are not able to survived within after plantation. In summer, plants started facing the water stress and it becomes very severe during the month of February to May. After rainy season, ants and termites etc. takes their shelter within the root zone of the new plantation, resulting they damage the root zone for their survival. They also release the excreta within the root zone; resulting acidity increases and promotes the primary infection within root zone. Again, during next rainy season, primary infection of root became severe and started rotting due to damaged root, excreta and soil acidity, hence, either plants die or their growth and development stunted. One year old plantations of chawki garden infected with root rot disease are given in Fig. 2.

To control the both primary and secondary infection of root rot, mixed oil cake containing above ingredients performed better for controlling the soil borne diseases, insects and pests etc., because, neem, (*Azadirachta indica*), a native of arid zone of Indian sub-continent are well known for its nutritional and medicinal values worldwide. Due to its bio-degradable and eco-friendly nature, it provides all the macro and micro-nutrients to the soil and plants. It has also been used as denitrifying agent, urea coating agent, fumigant and pesticide etc.



Fig. 2(a-b): One year old plantations of chawki garden infected with root rot disease

both in soil and plants. Findings of Govindachari (1992) also correlate with this finding. He has reported that, *Neem* products having good evaluation characteristics against suppression of pests from different plants including mulberry. Effect of neem for suppression of disease and pest was also recorded by many scientists (Schluter *et al.*, 1985; Wilps, 1986; Garcia and Rembold, 1992).

Conclusion:

Based on the findings, it has been concluded that, the integrated effect of mixed oil cake of *Neem*, groundnut, castor and sesame with turmeric powder and pungamia extracts @ 1.0 mt ha⁻¹ and 1.5 mt ha⁻¹ alongwith FYM was highly significant on both survivability (%), root zone and growth attribute characters of mulberry saplings and establishment of chawki garden. Application of mixed oil cake @ 1.0 mt ha⁻¹ was more economic than others.

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