High Yields of Mustard-Rapeseed through System of Crop Intensification (SCI)

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Abstract
System of Crop Intensification (SCI) aims to achieve higher production with less expenditure on land, labor, capital and water through simple changes in crop management practices. SCI practices help farmers to unlock the latent potential that are inherent in the crops and the soil biota. SCI in Mustard-Rapeseed involves very low seed rates of 120 to 600 g/ha; sowing of primed seeds in 20-60 m^2 nursery and line transplanting 8 to 12 day old seedlings (having 3 to 4 leaves) in a wider square grid of 30 to 75 cm depending on the varietal duration. This is followed by inter cultivation operations at fortnightly intervals using a cycle wheel hoe. Liquid organic manures and botanical preparations are used as inputs. The technique gives average yields of 2.5 MT/ha using organic inputs in farmer's fields as compared to the national average of 1.1 MT/ha and global average of 2.06 MT/ha. Since 2009 in the Eastern Indian state of Bihar thousands of farmers have benefitted from SCI using farmer selected varieties of Karan Rai (*Brassica carinata*) by 50% increase in yields and 93% increase in income. It has also been successfully demonstrated in the Indian states of Madhya Pradesh, Odisha and West Bengal in the last 2 years; with the highest recorded yield of 5.73 MT/ha in Umaria district, of Madhya Pradesh. SCI practices have been successfully demonstrated with different medium to long duration *Brassica* varieties (*B carinata, B juncea* and *B rapa*) having crop cycles of 120-150 days. The technique gives higher yields while significantly reducing input costs by half, through simple agronomic practices without involving change in seeds through hybridisation or genetic modification and resorting to high cost inputs.

Keywords: Dryland weeder, Organic, SCI, Transplanting, Young Seedlings
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Introduction:

System of Crop Intensification (SCI) aims to achieve higher production with less expenditure on land, labor, capital and water through simple changes in crop management practices. SCI practices help farmers to unlock the latent potential that are inherent in the crops and the soil biota (Abraham *et al.*, 2014). The remarkable increase in productivity is attributed to the multitude of symbiotic organisms that inhabit soils and plants. These soil-plant food webs which feed among each other and improve the environment of complementary species and in turn support and sustain crop production.

SCI practices have been successfully demonstrated to increase yield and produce quality across a number of crops namely: rice, wheat, barley, maize, finger millets, pigeon pea, green gram, black gram, soybean, kidney bean, faba bean, sugarcane as well as a number of vegetables. It has spread across more than 50 nations in Africa, Asia and South America.

The SCI methodology can be summarised in 4 simple principles namely;

- Establish young and healthy plants nurturing them to significant root establishment and associated shoot growth.
- Giving each plant more space to grow above and below soil, by reducing plant populations
- Enriching soil with organic matter and keeping it well aerated to support root growth and beneficial soil biota.
- Judicious use of water to favour plant and soil microbial growth

The present study demonstrates the application of SCI principles in Karan Rai (*Brassica carinata*) to increase productivity in farmer's fields in Sundargarh district of Odisha state in Eastern India. Young Seedlings were transplanted in pits in a square grid, followed by multiple interculture operations using a manual Dry land Weeder and application of liquid organic manures. Farm residues were used as mulch; intercropping with onion, garden pea, radish, potato and maize. The seed yield was measured by whole field harvest consistently for 3 years with an average of 2.55 MT/ha as compared to 1.04 MT in control plots under conventional farming.

Materials & Methods

Seeds of farmer selected variety of Karan Rai (RP-09) @ 300 g/ha were primed for sowing by immersing in warm water in the ratio of 1:2. Further a mixture of cow urine, vermicompost and jaggery (1:1:1) was poured in the vessel and the seeds are allowed to soak for 6-8 hours. The germinated seeds were planted on a raised bed nursery having an area of 20 m^2. The seed bed soil was mixed with vermicompost @ 2 kg/sqm. The soil was kept moist at the time of sowing and the sprouted seeds were planted at a depth of 1 cm, in a square grid of 5 cm. The seeds were further covered with vermicompost and paddy straw mulch. The young plants were transplanted to the main field at 10 DAS (Days after Sowing).

The main field was prepared by 3 rounds of ploughing and planking to obtain a fine tilth. Farm Yard Manure (FYM) was added @ 7 cartloads per hectare. Small pits of depth 15 cm and diameter of 20 cm were made in a square grid of 60 cm. The pits were left exposed to sun for 2 days. The main field soil was mixed with vermicompost (1:1) and put into the pits; before transplanting all the pits were kept moist. The nursery was irrigated, 2 hours before transplantation to ease seedling removal. The seedlings were uprooted by spade keeping the mud ball intact. Further they were transplanted at shallow depth in the pit within 30 minutes and the manually irrigated with a sprinkler for 4 days for seedling establishment.

At 15 DAT (Days After Transplanting), first irrigation was given followed by a spray of Jeevamrit (Jeevamrit is a microbial culture prepared by mixing 10 kg fresh cow dung, 5 litres cow urine, 1 kg Jaggery, 2 kg Bengal Gram flour and a handful of white ant soil in 200 litres of water. It is fermented over 5 days in a cool shady place, the mixture being stirred twice a day. 10% solution is used as liquid manure.); while at 20 DAT, weeds were removed using a Dry land Weeder. At 30 DAT second irrigation was given followed by Interculture with Dryland Weeder and Jeevamrit application. At 40 DAT earthing up soil at the base was done till 30 cm to aid root growth. Irrigation was carried out at 60 and 100 DAT. Straw mulching and intercropping with onion, potato, radish and garden pea was done to conserve soil moisture. A few maize plants were also sown randomly to act as cover crop. Five Leaf Extract (Five Leaf Extract is a concoction which is prepared by taking equal quantities of Neem, Vitex, Calotropis, Custard Apple and Pongamia leaves. 10% solution is used as a broad spectrum biopesticide) was sprayed after flowering, thrice at intervals of 15 days to prevent pests and diseases. In the control plots under conventional method - the same variety of Rapeseed were broadcast after land preparation without any priming directly in the main field. A single irrigation was given at 30 DAS while no inter cultivation was carried out. The yield was measured by whole field harvest method at crop maturity for 3 consistent years under both the methods. The Table: 1 Methodological comparison between control (conventional method) plot and SCI plots.

Table 1: The methodological comparison between control (conventional method) plot and SCI plots-

Component	Control-Conventional	SCI
Seed Rate	6 kg	120 g
Priming & Seed Treatment	Not Done	With Jaggery, Cowurine, Vermicompost & Water
Planting Method	Broadcasting	Transplanting
Plant Spacing	Irregular	60 x 60 cm
Sprouting	7 DAS	Sprouted seeds are used in nursery
Weeding & soil work	Not done	15, 20 & 40 DAT
Irrigation	Once at 30 DAS	15, 30, 60 & 100 DAT

Results and Discussion

The Table: 2 indicates the mean and best yields obtained from SCI in Rapeseed. The mean yield of Rapeseed under SCI method was 2.55 MT/ha with a best yield of 3.58 MT/ha (Plate 1).

Table 2: The mean and best yields obtained from SCI in Rapeseed-

Year	Number of farmers	Mean Yield- MT/ha	Best Yield-MT/ha
2014	12	2.52	3.58
2015	37	2.43	2.96
2016	65	2.72	3.28

The Table: 3 indicates the mean and best yields obtained in control (conventional farming) plots.

Table 3: The mean and best yields obtained from conventional farming in Rapeseed-

Year	Number of farmers	Mean Yield- MT/ha	Best Yield-MT/ha
2014	11	1.11	1.45
2015	41	0.97	1.37
2016	68	1.05	1.54

The mean yield of Rapeseed under conventional method was 1.04 MT/ha with a best yield of 1.54 MT/ha (Plate 2).

Figure 1: Comparative Yield (MT/ha) of Rapeseed under SCI & Conventional Methods.

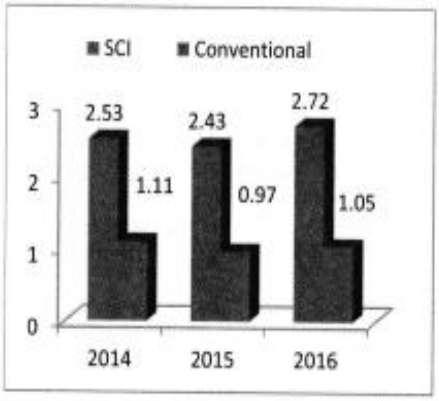


Fig 1 indicates the comparative yield (MT/ha) of Rapeseed under SCI & Conventional methods

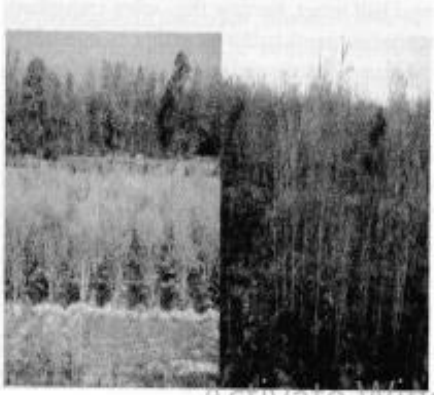
Plate 1: SCI Rapeseed Nursery

Profuse branching, taller height and higher siliqua were observed in SCI plots as compared to the control. The comparative results show SCI plot yields were more than double the yields in control plots (Plate 3 and 4).

Plate 2: Transplanting Young Seedlings

Plate 3: Maturing Rapeseed under SCI

Plate 4: Matured Rapeseed under SCI (LHS) & Conventional Practice (RHS)



Conclusion

Results of 3 years trials show that adopting simple agronomic practices and low cost organic inputs without any change in seed, doubles the yield of Rapeseed under SCI. Thus even though the technique involves additional activities, involving irrigation and labor, it is compensated by the 2 to 3 fold increase in yield and input cost saved in due to significantly lower seed rates. Additionally, the farmers also obtained vegetables grown as intercrops, while the mustard stalks were used as fuelwood and brooms. Similar demonstrations carried out in Gaya district of Bihar and Umaria district of Madhya Pradesh have also shown high yields of up to 4.27 MT/ha and 5.73 MT/ha with the same variety. Trials carried out with *Brassica juncea* and *Brassica rapa* varieties at Dryland Research Institute (Bankura, West Bengal) and Directorate of Mustard-Rapeseed Research (Bharatpur, Rajasthan) respectively, have also shown yields of 2.66 MT/ha and 3.47 MT/ha which are significantly higher than the national average of 1.1 MT/ha and global average of 2.06 MT/ha.

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