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Effect of system of rapeseed intensification on productivity and profitability of gobhi sarson (*Brassica napus*) under irrigated conditions of Jammu region

Akshay Ujjwal, BR Bazaya, Vivek, Lovish Preet Kaur and Vikas Tomar

Abstract
An investigation "Effect of system of rapeseed intensification on growth and productivity of Gobhi sarson (*Brassica napus*) under irrigated conditions of Jammu region" was conducted at Research Farm of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu during *Rabi* season of 2017-18. The experiment was laid out in Randomized Block Design with three replications consisting of ten treatments *viz*. system of rapeseed intensification with 15 days old seedling with spacing 30 cm x 30 cm, 45 cm x 45 cm, 60 cm x 60 cm, system of rapeseed intensification with 30 days old seedling with spacing 30 cm x 30 cm, 45 cm x 45 cm, 60 cm x 60 cm, direct sowing with spacing 30 cm x 30 cm, 45 cm x 45 cm, 60 cm x 60 cm and conventional sowing (Farmer practice) with spacing 45 cm x 10 cm. The variety DGS-1 of Gobhi sarson was sown. The soil of the experimental field was sandy clay loam in texture, slightly alkaline in reaction, low in organic carbon and available nitrogen and medium available phosphorous and potassium. All the practices of system of rapeseed intensification like nursery raising, transplanting with wide spacing and integrated nutrient management were followed as per treatments.
The experimental results revealed that treatment T_{10}: conventional sowing (Farmer practice) with spacing 45 cm x 10 cm recorded higher plant height at 60, 90 DAS and at harvest as compared to rest of the treatments. Plant dry matter accumulation, plant root weight, root volume, leaf area index and CGR were recorded highest in treatment T_3: 15 days old seedling with spacing 60 cm x 60 cm, whereas lowest in treatment T_{10}: conventional sowing with spacing 45 cm x 10 cm. The yield attributes such as number of primary and secondary branches per plant were significantly higher in T_3: 15 days old seedling with spacing 60 cm x 60 cm but it was found to be statistically at par with treatment T_2: 15 days old seedling with spacing 45 cm x 45 cm and T_9: direct sowing with spacing 60 cm x 60 cm. The highest siliquae per plant was recorded with treatment T_3: 15 days old seedling with spacing 60 cm x 60 cm, which was statistically at par with treatment T_9: direct sowing with spacing 60 cm x 60 cm and T_6: 30 days old seedling with spacing 60 cm x 60 cm and it was found to be significantly superior to rest of the treatments. Length of siliqua and number of seeds per siliqua were recorded significantly higher in treatment T_3: 15 days old seedling with spacing 60 cm x 60 cm but it remained statistically at par with T_2: 15 days old seedling with spacing 45 cm x 45 cm. Uptake of N, P & K by stover and seed were also significantly higher with treatment T_2: 15 days old seedling with spacing 45 cm x 45 cm but found to be statistically at par with T_1: 15 days old seedling with spacing 30 cm x 30 cm. The highest protein content in seed was recorded in T_{10}: conventional sowing with spacing 45 cm x 10 cm, whereas oil content in seed was higher in T_3: 15 days old seedling with spacing 60 cm x 60 cm but was statistically found to be non-significant. The higher seed and stover yield were recorded with treatment T_2: 15 days old seedling with spacing 45 cm x 45 cm, which was found to be statistically at par with treatment T_1: 15 days old seedling with spacing 30 cm x 30 cm but was significantly superior to rest of the treatments. However, in late transplanting situations, 30 days old seedling with spacing 45 cm x 45 cm was also found to be at par with conventional sowing (Farmer practice) in terms of seed and stover yield. The Higher net return and B:C ratio were recorded in treatment T_2: 15 days old seedling with spacing 45 cm x 45.

Keywords: System of rapeseed intensification, plant spacing, nutrient uptake

Introduction
Rapeseed-mustard is a group of crops comprising of rapeseed *Brassica campestris* toria, brown sarson and yellow sarson, Indian mustard *Brassica juncea*, black mustard *Brassica nigra* and taramira *Eruca sativa*. Some exotic species of *Brassicas* like gobhi sarson *Brassica napus*, Ethopian mustard or Karan Rai *Brassica carinata* and white mustard *Sinapis alba* have been brought into cultivation in India. The crops of rapeseed group are largely cross pollinated whereas Indian mustard is largely self-pollinated. Out of these species Indian mustard fits well in cropping system of rainfed areas and accounts for more than 75 percent of the total area

Under rapeseed-mustard cultivation in India. Edible oil constitutes an important part of our daily diet, being source of energy, essential fatty acids like linoleic and oleic acids, amino acids like lysine, leusine, histidine, tryptophan etc., which are vital for our growth.

Oilseed crops have been the back bone of agricultural economy of India since the time immemorial. The role being played by oilseeds in our national economy needs no renewed emphasis. It is utilized in India as oil, medicine, lubrication and other agricultural allied sectors. As majority of Indian population is vegetarian, oilseeds constitutes the major dietary part of vegetarian people to supplement the requirement of fats. Among oilseed crops rapeseed-mustard is one of the important edible oil seed crop and is the main cooking media.

Brassica spp account for about 10 percent of total oilseeds and 14 percent of total vegetable oil production. Mostly they are cultivated for edible oils but also used as condiments, spices and as fodder for livestock. Its oil could also be potentially developed in the form of biodiesel. In addition to oil production, the leaves and stems of rapeseed provide high quality forage because of their low fibre and high protein content (Wiedenhoeft and Bharton, 1994) [12]. It contains protein (36-40%), omega-3- fatty acids, vitamin-C and K, glucosinolates (30 µg). It has by and large also antibacterial and antifungal properties. It has less than 2% erucic acid and oil percentage varies from 40-45%.

Rapeseed and mustard *Brassica* sp L. belongs to family cruciferae. The crop has larger adaptability to varying climatic conditions in India and ranks third in terms of production in the world after China and Canada. The area, production and productivity of rapeseed-mustard in the world is about 36.37 mha, 72.53 mt and 1994 kg/ha, respectively. However, in India, it is cultivated over an area of about 6.7 m ha with a production of 7.96 mt and the productivity of 1188 kg/ha (Anonymous 2017) [2].

Jammu and Kashmir UT is found to be deficient in oilseed production and among oilseeds, rapeseed and mustard is the most important *Rabi* oilseed crop of the UT. In Jammu and Kashmir, total area under oilseeds crop is about 54,520 hectares with total production of about 32,600 tones and productivity of about 597 kg/ ha (Anonymous, 2017) [2]. Rapeseed and mustard are of the sub-tropical as well as of the temperate zone crops and require relatively cool temperature for satisfactory growth and development. In India, they are grown in *Rabi* season when temperature is low. *Brassica sp*. Grown well in areas receiving 350-550 mm rainfall annually. Few attempts have been made in traditional mustard growing areas of Jammu and Kashmir with respect to selection of suitable genotypes for a particular set of environment to achieve the potential yield.

System of Rapeseed Intensification through transplanting could offer such an options which can further increase the yield of rapeseed and mustard under irrigated areas of Jammu region. It has major advantages such as higher yields, reduction in duration of crop cycle by 10-15 days, minimum input requirements *viz*., fertilizers, seed rate, low water requirement and improved it quality parameters such as oil content and grain weight. The yield attributes like branches/plant, siliqua/plant, seeds/siliquae and 1000-seed weight were influenced significantly by the planting method. The transplanted crop is expected to produce more number of primary and secondary branches over the conventionally sown crop, which was due to branching taking place from the basel part of the main shoot in transplanted crop Chaudhary *et al.* (2016) [3].

Materials and Methods

The field experiment was conducted at Agronomy Farm, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu-Chatha. The weekly mean maximum temperature during crop growing period varied between 34.4 °C to 16.8 °C, whereas the mean minimum temperature was between 2.6 °C to 20.6 °C. The area receives mean annual rainfall of 845 mm, of which more than 80% is in the month of July- September through south-west monsoon. The mean relative humidity during crop period varied between 94.0 to 35.0 percent. Before sowing of Gobhi sarson, soil samples to a depth of 0-15 cm were taken randomly from 10 places in the experimental field. The collected samples were mixed homogenously and a composite soil sample was drawn, air dried, powdered and allowed to pass through 2 mm sieve for analyses of soil physical and chemical properties. The soil of experimental site was sandy loam in texture, low in available nitrogen and organic carbon, medium in available phosphorus and potassium and slightly alkaline in reaction. The predominant soil at the experimental site is classified as Topic Ustochrept with sandy-loam texture having pH 7.6, bulk density 1.49 g/cm^3, low organic carbon content (4.7 g/kg), Soil samples for 0-15 cm depth at the site were collected and tested prior to applying treatments and the basic properties were low available nitrogen, low organic carbon, available phosphorus, available potassium medium and alkali in reaction. The gross and net plot size were 5.4 x 3.6 m^2 and spacing 30 cm × 30 cm (4.2 x 2.4 m), spacing 45 cm × 45 cm (3.6 x 2.7m), spacing 60 cm × 60 cm (3.0 x 2.4m) and (3.6 x 3.2 m), respectively. Experiment was laid out randomized block design with three replications. Ten treatments [15 days old seedling with spacing 30 cm × 30 cm (SRI), 15 days old seedling with spacing 45 cm × 45 cm (SRI), 15 days old seedling with spacing 60 cm × 60 cm (SRI), 30 days old seedling with spacing 30 cm × 30 cm (SRI), 30 days old seedling with spacing 45 cm × 45 cm (SRI), 30 days old seedling with spacing 60 cm × 60 cm (SRI), Direct sowing with spacing 30 cm × 30 cm, Direct sowing with spacing 45 cm × 45 cm, Direct sowing with spacing 60 cm × 60 cm and Conventional sowing 45 cm × 10 cm (Farmer practice) were used for the experimentation. Plant-to-plant distance was maintained ~ 60 x 60 cm in a row spacing of 45 x 10 cm. Diammonium phosphate (DAP) was applied 100 kg/ha at the time of seed bed preparation as per recommendation. To ensure proper germination, field was prepared after pre-sowing irrigation and subsequent irrigation was given as per requirement. Economics of treatments was computed on the basis of prevailing market price of inputs and outputs under each treatment. The total cost of cultivation of crop was calculated on the basis of different operations performed and materials used for raising the crop including the cost of fertilizers and seeds. The cost of labour incurred in performing different operations was also included. Statistical analysis of the data was done as per the standard analysis of variance technique for the experimental designs following SPSS software based programme, and the treatment means were compared at $p<0.05$ level of probability using t-test and calculating CD values.

Results and Discussion

Influence on yield parameters of Gobhi sarson

Number of siliquae/plant was affected significantly by various

treatments involving direct sowing. Among rapeseed intensification and direct sowing treatments, the lowest siliquae/plant (165.61 siliquae/plant) was found in Conventional sowing 45 cm x 10 cm (Farmer practice), which was significantly lower than the remaining treatments. The highest siliquae/plant (882.13 siliquae/plant) was found in 15 days old seedling with spacing 60 cm x 60 cm, which was statistically at par with Direct sowing with spacing 60 cm x 60 cm (858.79 siliquae/plant) and 30 days old seedling with spacing 60 cm x 60 cm (797.93 siliquae/plant) and significantly higher than other treatments.

Table 1: Effect of system of rapeseed intensification and direct sowing on yield attributes of Gobhisarson.

Treatments	Yield attributes			
	No of siliquae/ plant	Siliqua Length (cm)	Number of seeds/ siliqua	1000 seed weight (g)
T_1: 15 days old seedling with spacing 30 cm x 30 cm	302.67	6.26	19.50	3.55
T_2: 15 days old seedling with spacing 45 cm x 45 cm	670.70	6.35	20.52	3.64
T_3: 15 days old seedling with spacing 60 cm x 60 cm	882.13	6.47	21.51	3.87
T_4: 30 days old seedling with spacing 30 cm x 30cm	250.00	5.13	18.25	3.22
T_5: 30 days old seedling with spacing 45 cm x 45 cm	548.57	5.23	18.33	3.40
T_6: 30 days old seedling with spacing 60 cm x 60 cm	797.93	5.40	19.63	3.67
T_7: Direct sowing with spacing 30 cm x 30 cm	264.07	5.21	18.27	3.29
T_8: Direct sowing with spacing 45 cm x 45 cm	573.11	5.43	18.57	3.48
T_9: Direct sowing with spacing 60 cm x 60 cm	858.79	5.77	18.74	3.64
T_{10}: Conventional sowing 45 cm x 10 cm (Farmer practice)	165.61	4.97	14.17	3.09
SEm±	35.85	0.17	0.53	0.11
CD (P= 0.05)	106.51	0.52	1.58	0.32

Various treatments involving direct sowing. Among rapeseed intensification and direct sowing treatments, the lowest siliqua length (4.97 cm) was found in Conventional sowing 45 cm x 10 cm (Farmer practice), which was significantly lower than the remaining treatments. The highest siliqua length (6.47 cm) was found in 15 days old seedling with spacing 60 cm x 60 cm treatment, which was statistically at par with 15 days old seedling with spacing 45 cm x 45 cm (6.35 cm) and 15 days old seedling with spacing 30 cm x 30 cm (6.26 cm) and significantly higher than other treatments.

Number of seeds/siliqua was affected significantly by various treatments involving direct sowing treatments. Among rapeseed intensification and direct sowing treatments, the lowest number of seeds/siliqua (14.17 seeds/siliqua) was found in Conventional sowing 45 cm x 10 cm (Farmer practice) treatment. The highest seeds/siliqua (21.51 seeds/siliqua) was found in 15 days old seedling with spacing 60 cm x 60 cm treatment, which was at par with 15 days old seedling with spacing 45 cm x 45 cm (20.52 seeds/siliqua).

1000-seed weight was affected significantly by various treatments involving direct sowing treatments. Among rapeseed intensification and direct sowing treatments, the lowest 1000-seed weight (3.09 g) was found in Conventional sowing 45 cm x 10 cm (Farmer practice) treatment. The highest 1000-seed weight (3.87 g) found in 15 days old seedling with spacing 60 cm x 60 cm treatment followed by 30 days old seedling with spacing 60 cm x 60 cm (3.67 g) and 15 days old seedling with spacing 45 cm x 45 cm (3.64 g). Similar results have also been reported by Gupta (1994) [4] and Momoh and Zhou (2001) [7].

Crop Productivity

Seed yield was affected significantly by various treatments Involving direct sowing treatments. Among rapeseed intensification and direct sowing treatments, the lowest seed yield (1581 kg ha^{-1}) was found in Conventional sowing 45 cm x 10 cm (Farmer practice). The highest seed yield (2495 kg ha^{-1}) was found in 15 days old seedling with spacing 45 cm x 45 cm, which was statistically at par with 15 days old seedling with spacing 30 cm x 30 cm (2318 kg ha^{-1}).

Table 2: Effect of system of rapeseed intensification and direct sowing on seed yield, stover yield, harvest index of Gobhi sarson

Treatments	Yield (kg ha^{-1})		Harvest Index
	Seed	Stover	
T_1: 15 days old seedling with spacing 30 cm x 30 cm	2318	10861	17.60
T_2: 15 days old seedling with spacing 45 cm x 45 cm	2495	11326	18.06
T_3: 15 days old seedling with spacing 60 cm x 60 cm	2158	10384	17.21
T_4: 30 days old seedling with spacing 30 cm x 30cm	1714	8393	17.01
T_5: 30 days old seedling with spacing 45 cm x 45 cm	1843	9144	16.77
T_6: 30 days old seedling with spacing 60 cm x 60 cm	1643	8104	16.83
T_7: Direct sowing with spacing 30 cm x 30 cm	1709	8269	17.17
T_8: Direct sowing with spacing 45 cm x 45 cm	1812	9028	16.71
T_9: Direct sowing with spacing 60 cm x 60 cm	1627	8056	16.87
T_{10}: Conventional sowing 45 cm x 10 cm (Farmer practice)	1581	7794	16.81
SEm±	112	295	1.12
CD (P= 0.05)	333	877	NS

Stover yield was affected significantly by various treatments involving direct sowing treatments. Among rapeseed intensification and direct sowing treatments, the lowest stover yield (7794 kg ha^{-1}) found in Conventional sowing 45 cm x 10 cm (Farmer practice). The highest biological yield (11326 kg ha^{-1}) was found in 15 days old seedling with spacing 45 cm x 45 cm, which was statistically at par with 15 days old seedling with spacing 30 cm x 30 cm (10861 kg ha^{-1}). Similar findings

were reported by Ozur *et al.* (2003) [8] and Singh and Prasad (2003) [10].

Harvest index was non-significantly affected by various treatments involving direct sowing treatments. Among rapeseed intensification and direct sowing treatments, the lowest harvest index (16.71%) was found in direct sowing with spacing 45 cm x 45 cm, while the highest harvest index (18.06%) in 15 days old seedling with spacing 45 cm x 45 cm. Similar findings were reported by Paraya *et al.* (2009) [9] and Alam *et al.* (2014) [1].

Economics

Cost of cultivation was affected by various treatments involving direct sowing treatments. Among rapeseed intensification and direct sowing treatments, the lowest cost of cultivation (Rs. 25060 ha^{-1}) found in Direct sowing with spacing 60 cm x 60 cm, which was lower than the remaining treatments. The highest cost of cultivation (Rs. 35430 ha^{-1}) was found in 30 days old seedling with spacing 30 cm x 30 cm treatment, which was higher than other treatments. Kumari *et al.* (2012) [5], Lakra *et al.* (2018) [6] and Singh *et al.* (2018) [11] also reported similar results.

Gross return was affected significantly by various treatments involving direct sowing treatments. Among rapeseed intensification and direct sowing treatments, the lowest gross return (Rs. 63240 ha^{-1}) was found in Conventional sowing 45 cm x 10 cm (Farmer practice), which was significantly lower than the remaining treatments. The highest gross return (₹ 99800 ha^{-1}) was found in 15 days old seedling with spacing 45 cm x 45 cm treatment, which was higher than other treatments.

Net return was affected significantly by various treatments involving direct sowing treatments. Among rapeseed intensification and direct sowing treatments, the lowest net return (₹ 33130 ha^{-1}) was found in 30 days old seedling with spacing 30 cm x 30 cm and significantly lower than the remaining treatments, while the highest net return (₹ 68810 ha^{-1}) was found in 15 days old seedling with spacing 45 cm x 45 cm treatment and significantly higher than other treatments. These findings are in close agreement with the results of Singh and Prasad (2003) [10] and Ram *et al.* (2008).

Table 3: Effect of system of rapeseed intensification and direct sowing on relative economics

Treatments	Cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B: C ratio
T_1: 15 days old seedling with spacing 30 cm x 30 cm	34782	92720	57938	1.66
T_2: 15 days old seedling with spacing 45 cm x 45 cm	30950	99800	68810	2.22
T_3: 15 days old seedling with spacing 60 cm x 60 cm	28758	86320	57562	2.00
T_4: 30 days old seedling with spacing 30 cm x 30 cm	35430	68560	33130	0.93
T_5: 30 days old seedling with spacing 45 cm x 45 cm	31598	73720	42122	1.33
T_6: 30 days old seedling with spacing 60 cm x 60 cm	29406	65720	36314	1.23
T_7: Direct sowing with spacing 30 cm x 30 cm	29680	68360	38680	1.30
T_8: Direct sowing with spacing 45 cm x 45 cm	27670	72480	44810	1.61
T_9: Direct sowing with spacing 60 cm x 60 cm	25060	65080	40020	1.59
T_{10}: Conventional sowing 45 cm x 10 cm (Farmer practice)	29533	63240	33707	1.14

B: C ratio was affected significantly by various treatments involving direct sowing treatments. Among rapeseed intensification and direct sowing treatments, the lowest B: C ratio (1.14) was found in Conventional sowing 45 cm x 10 cm (Farmer practice), which was significantly lower than the remaining treatments, while the highest B: C ratio (2.22) was recorded in 15 days old seedling with spacing 45 cm x 45 cm treatment.

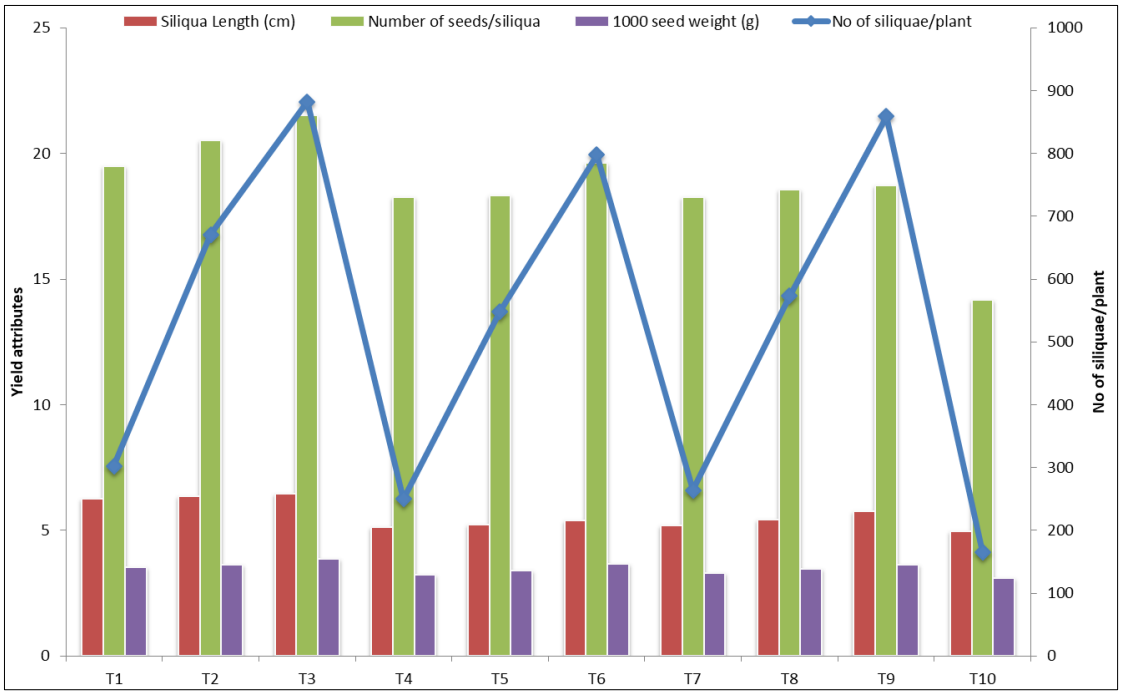

Fig 1: Effect of system of rapeseed intensification and direct sowing on yield attributes of Gobhi sarson

Fig 2: Effect of system of rapeseed intensification and direct sowing on seed yield, stover yield, harvest index of Gobhi sarson

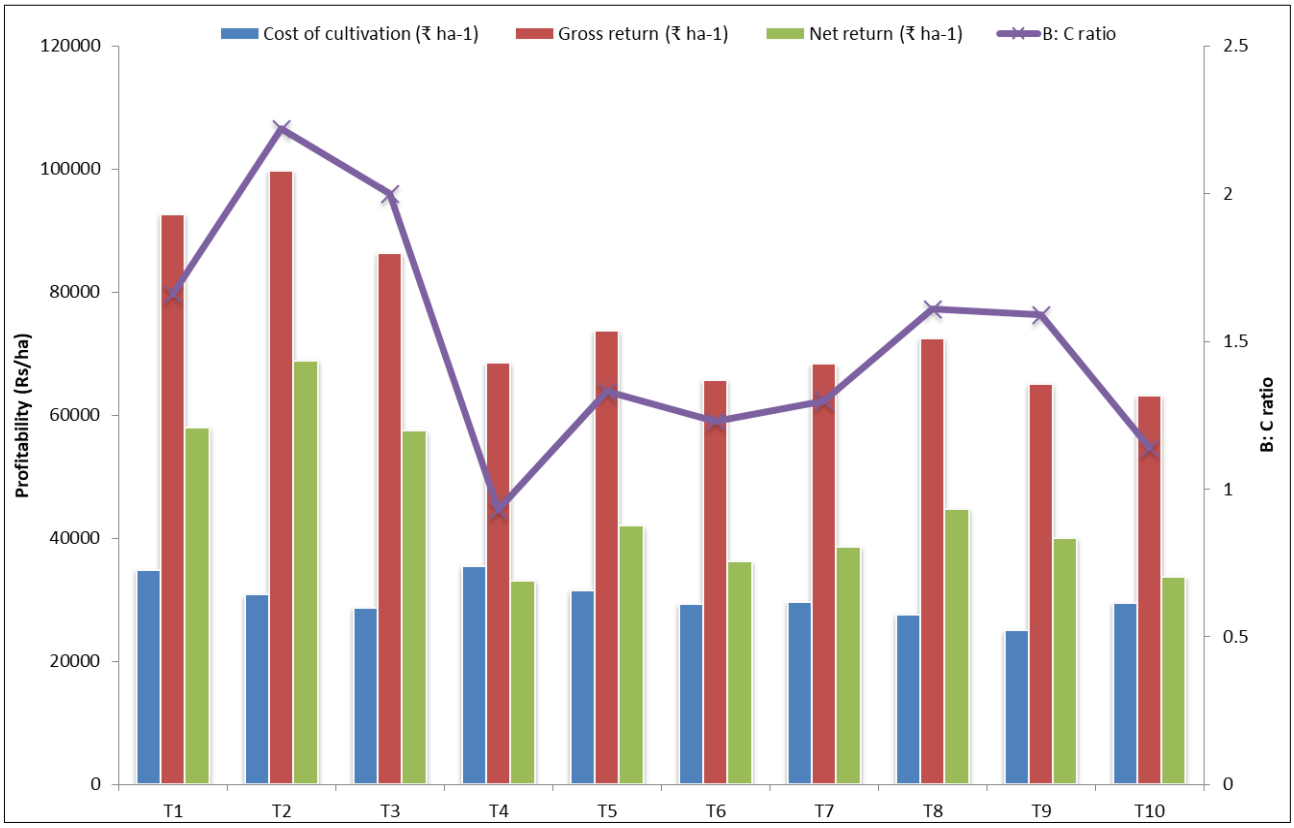

Fig 3: Effect of system of rapeseed intensification and direct sowing on relative economics

Conclusion

Based on the results of experimentation, it can be concluded that all rapeseed intensification and direct sowing treatments proved effective. Among the treatment 15 days old seedling with spacing 45 cm x 45 cm was found excellent in gross return, net return, and B: C ratio. Although maximum net return was obtained in 15 days old seedling with spacing 45 cm x 45 cm followed by 15 days old seedling with spacing 30 cm x 30 cm. Thus the application of 15 days old seedling with spacing 45 cm x 45 cm seems better for higher productivity and profitability of Gobhi sarson crop.

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