

EFFECT OF DIFFERENT PLANTING SYSTEM AND SULPHUR LEVEL ON YIELD AND QUALITY OF CASTOR (*RICINUS COMMUNIS* L.) INTERCROPPED WITH CLUSTERBEAN [*CYAMOPSIS TETRAGONOLOBA* (L.) TAUB] UNDER BAEI BASED AGRI-HORTI SYSTEM

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Abstract: A field experiment was conducted during *kharif* season of 2013-14 at Agricultural Research Farm, Rajeev Gandhi South Campus (Banaras Hindu University), Barkachha, Mirzapur, Uttar Pradesh, to investigate, "Effect of different planting system and sulphur level on yield and quality of castor (*Ricinus communis* L.) intercropped with clusterbean [*Cyamopsis tetragonoloba* (L.) Taub] under bael based agri-horti system". The treatment comprised of 4 different planting systems ($PS_1=1:2$), ($PS_2=1:4$), ($PS_3=1:6$), ($PS_4=1:8$) as main plots and 3 levels of sulphur ($S_1=25\text{ kg ha}^{-1}$), ($S_2=50\text{ kg ha}^{-1}$), ($S_3=75\text{ kg ha}^{-1}$) as sub plots replicated thrice in a split-plot design. Significantly improvement in the yield and yield attributes and quality of castor and clusterbean component crops was observed under PS_3 , (1:6) treatment and application of (S_2), (50 kg ha^{-1}) recorded significantly higher, yield and yield attributes parameters and stalk yield of castor and clusterbean parameters. Similar effect of these treatments was observed on N, P, K, and Sulphur content and total uptake in grain and straw of castor and clusterbean treatments. And also recorded higher gross return (133955 Rs. ha^{-1}) with net returns (116285 Rs. ha^{-1}), and B: C ratio (6.58) under PS_3 , (1:6) treatment.

Keywords: Planting system, Castor, Clusterbean, Sulphur, Intercropping, Bael, Agri-horti system

INTRODUCTION

Castor (*Ricinus communis* L.) is produced in more than 30 countries across the globe. However, India is the major producer and holds a giant share of around 83 per cent, of the total global production, followed by China 6 per cent, Brazil 5 per cent and Mozambique 4 per cent. India is the largest exporter and China is the net importer of castor oil. In India, Gujarat is the top producing state which contributes 63 per cent followed by Andhra Pradesh 19 per cent, Rajasthan 14 per cent and Maharashtra 2 per cent. India being the largest producer of castor in the world, area, production and productivity of castor in the country during 2011-12 was 11.50 lakh hectares, 16.19 lakh tonnes and 1417 kg ha^{-1} respectively. (Special Report on Castor Seed 3-4, 2011-12).

Castor (*Ricinus communis* L.) is most important oilseed crop of India due to the fact that its oil has diversified uses and has great value in foreign trade. Unfortunately, in India, castor along with other oilseed crops are raised under limited resource condition which leaving the crop thirsty and hungry by the resource poor farmers. However, as castor is a long duration, widely spaced crop with comparatively thin plant population as compared to other field crops, provide ample scope for growing intercrop in order to increase production from unit area of land.

The importance of sulphur in oilseeds, sulphur plays a significant role in the quality and development of

seeds. Therefore, crops of oilseeds require a higher quantity of sulphur for proper growth and development for higher yields (Salwa *et al.*, 2010). Sulphur is one of the essential elements required for plant growth and plays a major role in many plant processes. Sulphur plays an important role in enhancing the productivity and quality of oilseed crops by providing environment in the soil. Castor is an oilseed crop, so for the production of high oil content, sulphur is required. Today, sulphur is recognized as fourth major nutrient after nitrogen, phosphorus and potassium.

In agroforestry systems there are both ecological and economical interactions between the different components. In agroforestry, tree and agriculture crops are combined together and they compete with each other for growth resource such as light, water and nutrients. The resource sharing in component crop may result in complementary or competitive effect depending upon nature of species involved in the system. The incorporation of woody species into crop production system is one option that has received significant attention in recent years.

A field experiment was conducted at Agricultural Research Farm, Rajeev Gandhi South Campus (Banaras Hindu University), Barkachha, Mirzapur, Uttar Pradesh (India). Which is situated in vindhyan region of district Mirzapur ($25^{\circ} 10'$ latitude, $82^{\circ} 37'$ longitude and altitude of 147 meters above mean sea level) during *kharif* season, of 2013-14 on sandy loam soils containing 0.58 % organic carbon, bulk

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density 1.44 and particle density 2.65 g/cc, available nitrogen (177.2 kg ha^{-1}), low in available phosphorus (10 kg ha^{-1}), and potassium (115.7 kg ha^{-1}), having slightly acidic soil Ph (5.84). The experiment laid out in split-plot design with three replications. The treatments combination comprised 4 different planting system viz., ($PS_1 = 1:2, 45 \times 15 \text{ cm}$), ($PS_2 = 1:4, 22.5 \times 15 \text{ cm}$), ($PS_3 = 1:6, 15 \times 15 \text{ cm}$), ($PS_4 = 1:8, 11.25 \times 15 \text{ cm}$) in main plots and 3 sulphur levels ($S_1 = 25 \text{ kg ha}^{-1}$), ($S_2 = 50 \text{ kg ha}^{-1}$), ($S_3 = 75 \text{ kg ha}^{-1}$), in sub plots. Fertilizers were placed in planting system rows 8-10 cm below the surface. Full dose of sulphur as per treatments through elemental sulphur were applied just before sowing of crops. Castor "GCH-4" and Clusterbean "RGC-1003" varieties of castor and clusterbean, respectively were used for experimental purpose. Sowing of the crops was done on 15 August in 2013. The spacing between row to row in castor was maintained 90 cm and plant to plant was maintained 45 cm. and for intercropping as well as clusterbean ($PS_1 = 1:2, 45 \times 15 \text{ cm}$), ($PS_2 = 1:4, 22.5 \times 15 \text{ cm}$), ($PS_3 = 1:6, 15 \times 15 \text{ cm}$), ($PS_4 = 1:8, 11.25 \times 15 \text{ cm}$). The plants from net plots were harvested from the ground level and were left for sun drying *in-situ*. The castor and clusterbean were threshed manually. Grains were cleaned and weighed for expressing yield in kg ha^{-1} . The weight of the stalk was recorded separately and used for estimating stover yield. The observed data were analysed statistically using analysis of variance at 5 per cent level of significance.

Planting system brought a significantly variation in yield, yield attributes and quality of castor, viz., except (days to 50% flowering, seed index (g), straw yield (q ha^{-1}), harvest index (%), oil content in seed (%), no. of racemes plant^{-1} , no. of capsules racemes^{-1} , no. of seeds plant^{-1} , length of main spike (cm), seed yield plant^{-1} (g), grain yield (q ha^{-1}), oil yield (q ha^{-1}), planting system (PS_3) recorded significantly higher value of yield and yield attributes of castor, remained at par with (PS_2) when compared with (PS_4) and (PS_1) treatments in (Table 1 & 2) and also planting system brought a significantly variation in yield and yield attributes of clusterbean, viz., except [Harvest index (%)], no. of pods plant^{-1} , no. of seeds pod^{-1} , length of pod (cm), test weight (g), grain yield (q ha^{-1}), straw yield (q ha^{-1}), gum content (%), gum yield (q ha^{-1}) planting system (PS_3) recorded significantly higher value of yield and yield attributes of clusterbean remained at par with (PS_2) when compared with (PS_4) and (PS_1) treatments. in (Table 1 & 2). This might be due to the absence of competition between the main crop (castor) and intercropped (clusterbean) for growth resources such as nutrients, moisture, solar radiation because of shorter duration and non spreading nature of clusterbean. This can be attributed to the increase in plant height, dry matter accumulation plant^{-1} under the different planting system. Short duration, short plant nature, non-bushiness and also neither

complementary non competitive nature of intercrops did not influence the growth parameters. Because of the harvested of intercropped as well as clusterbean. PS_3 treatment recorded the higher yield attributes and yield due better availability of resources. The results of the present investigation are in close proximity with the finding of Kumar *et al* (2002) and reported that a wide spacing $90 \text{ cm} \times 60 \text{ cm}$ increased all the growth parameters like plant height, dry matter plant^{-1} . This result is in close proximity with the findings of Patel and Patel (2004).

Application of sulphur with $50 (\text{kg ha}^{-1}) (S_2)$ treatment significantly recorded higher values of yield and yield attributes of castor except [days to 50% flowering, harvest index (%)] and clusterbean [Harvest index (%)] remained at par with (S_3) $75 (\text{kg ha}^{-1})$ treatments. The results are also in close proximity with the finding of Fyjee and Raju (1991). It may be attributed to the fact that application of sulphur improved not only availability of S but other nutrient to which are considered vitally important for growth and development of plants. Being an essential constituent of several biologically active compounds like amino acids (cystine, cysteine and methionine), vitamins (thiamine and biotin), lipoic acid and S play multiple role in the plant metabolism might have been helped in terms of vigorous root growth, formation of chlorophyll, resulting in higher photosynthesis. The increase in yield attributes might be due to the fact that increment in supply of S the process of tissue differentiation from somatic to reproductive, meristematic activity and development of floral primordial might have increased, resulting in more flower and capsules. When supply of sulphur optimum, greater translocation of photosynthesis occurs from leave to the site *i.e.* capsules and seed yield.

Different planting system had significant effect on total N_2 , P_2O_5 , K_2O and Sulphur uptake by castor and clusterbean during the year of study in (Table: - 3) planting system (PS_3) recorded significantly except (K_2O in clusterbean) higher value of total N_2 , P_2O_5 , K_2O and Sulphur uptake and remained at par with (PS_2) when compared with (PS_4) and (PS_1) treatments in (Table 3).

Sulphur levels showed remarkable recorded maximum improvement in N_2 , P_2O_5 , K_2O and Sulphur uptake by castor and clusterbean under application of sulphur with $50 (\text{kg ha}^{-1}) (S_2)$ treatments remained at par with (S_3) $75 (\text{kg ha}^{-1})$ treatments and minimum was observed under the treatments (S_2) $50 (\text{kg ha}^{-1})$. This may be attributed to less competition among the crop plants for all the available resources.

Intercropping system remains significantly superior in enhancing the gross return as compared to other treatment. Among the different planting system (table: - 3) treatment recorded the highest gross returns ($133955 \text{ Rs. ha}^{-1}$), net return ($116285 \text{ Rs. ha}^{-1}$)

¹), and as well as B: C ratio (6.58), was recorded the highest in PS₃ (1:6) treatment. Closely followed by PS₂ treatments. The higher gross returns realized with intercropping systems was attributed to better performance of component crops castor + clusterbean which have produced higher equivalent yield compared to their respective sole crops. The higher net returns with castor + clusterbean was due to higher complementarity between these two component crops which produced higher yield and their by higher net returns. Though, intercrops yields were lower than their respective sole crops yield, but

they produced higher equivalent yield and income in combination. The higher B : C ratio with these treatment combination crops, which gave higher productivity and net returns helping in getting higher benefit : cost ratio. The results are also in close proximity with the finding of Neginhalet *al.* (2011). Among the sulphur levels, the highest gross return with (125925 Rs. ha⁻¹) net return (108405 Rs. ha⁻¹), and B : C ratio (6.19) was obtained with S₂ (50 kg ha⁻¹) treatment. The application of 50 kg ha⁻¹ provided favorable environment for the production and economics value of castor and clusterbean.

Table 1. Effect of different planting system and sulphur level on yield and yield attributes of castor and clusterbean.

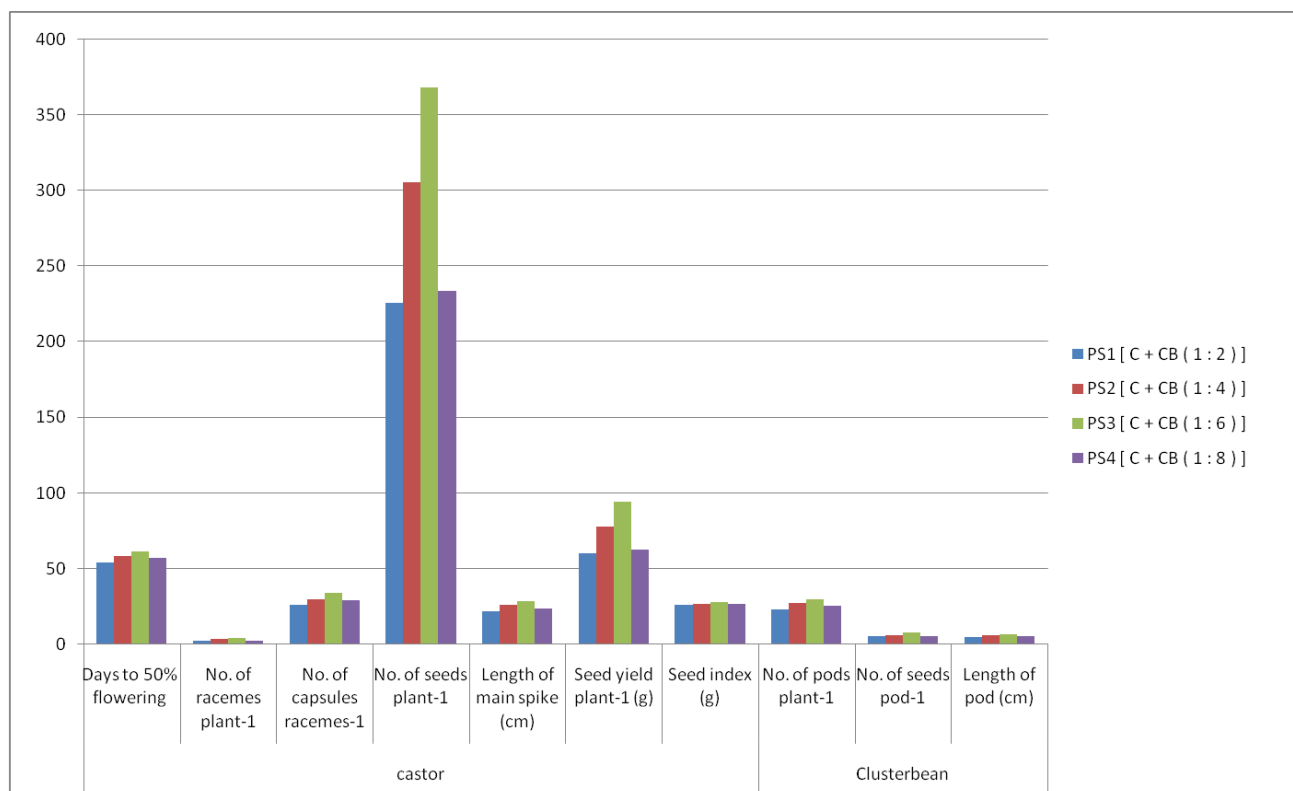
Treatments	Castor							Clusterbean		
	Days to 50% flowering	No. of racemes plant ⁻¹	No. of capsules racemes ⁻¹	No. of seeds plant ⁻¹	Length of main spike (cm)	Seed yield plant ⁻¹ (g)	Seed index (g)	No. of pods plant ⁻¹	No. of seeds pod ⁻¹	Length of pod (cm)
A) Different Planting System										
PS ₁ [C + CB (1:2)]	54.3	2.5	25.9	225.8	22.1	60.0	26.4	22.8	5.3	5.0
PS ₂ [C + CB (1:4)]	58.5	3.4	30.0	305.2	26.4	77.7	26.8	27.3	6.3	5.8
PS ₃ [C + CB (1:6)]	61.3	4.0	34.1	367.5	28.4	94.0	28.1	29.5	7.7	6.4
PS ₄ [C + CB (1:8)]	57.0	2.7	29.1	233.6	23.8	62.9	26.5	25.3	5.6	5.3
SEm±	2.13	0.06	1.12	9.60	0.39	2.94	0.48	0.22	0.07	0.08
C.D. (P=0.05)	NS	0.21	3.89	33.23	1.34	10.16	NS	0.75	0.24	0.29
B) Sulphur Level (kg ha⁻¹)										
S ₁ (25)	54.8	2.9	27.7	247.1	23.3	64.0	25.8	25.2	5.8	5.1
S ₂ (50)	59.6	3.3	31.8	319.3	27.2	80.8	28.2	27.2	6.6	6.1
S ₃ (75)	58.9	3.2	29.8	282.7	25.0	76.2	27.0	26.3	6.3	5.6
SEm±	1.84	0.09	0.26	9.62	0.27	2.23	0.47	0.10	0.05	0.01
C.D. (P=0.05)	NS	0.27	0.77	28.83	0.82	6.69	1.40	0.31	0.15	0.02

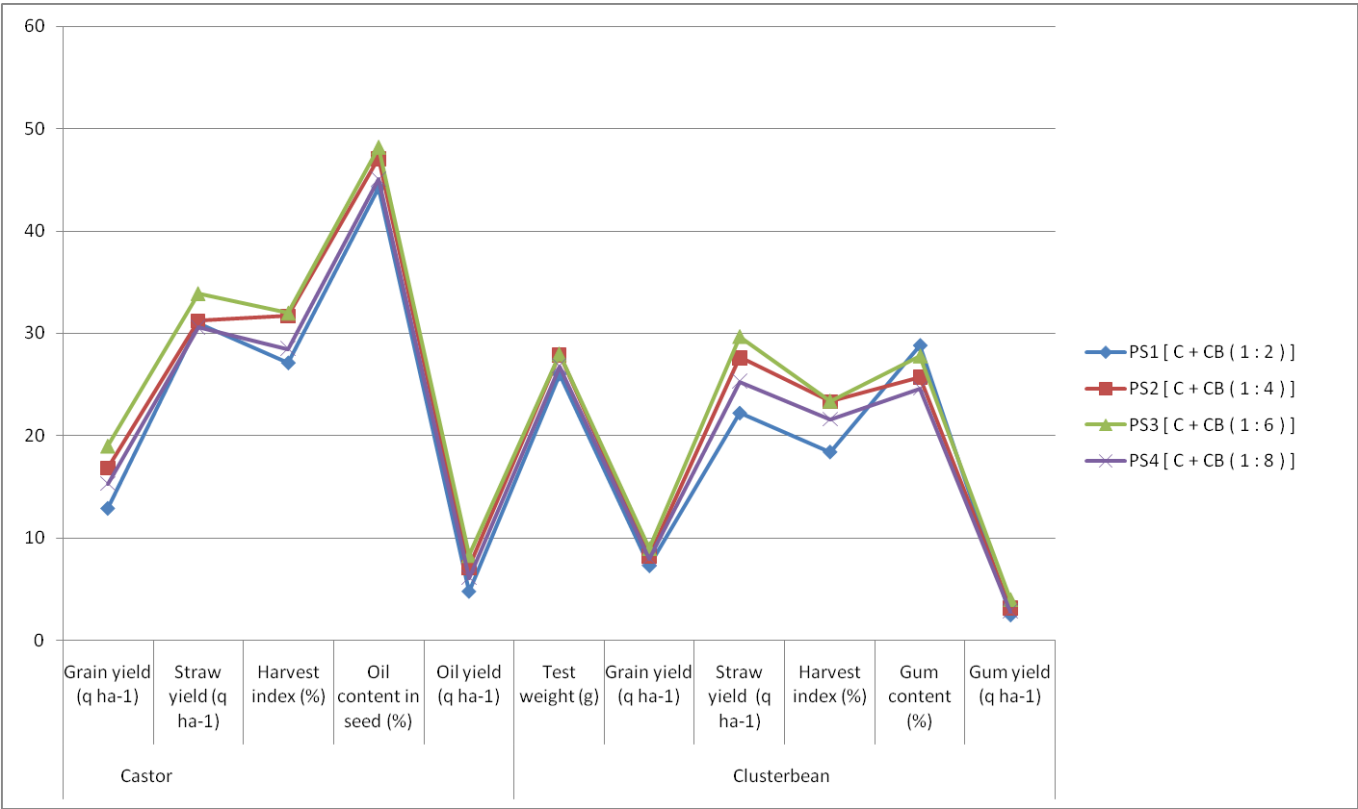
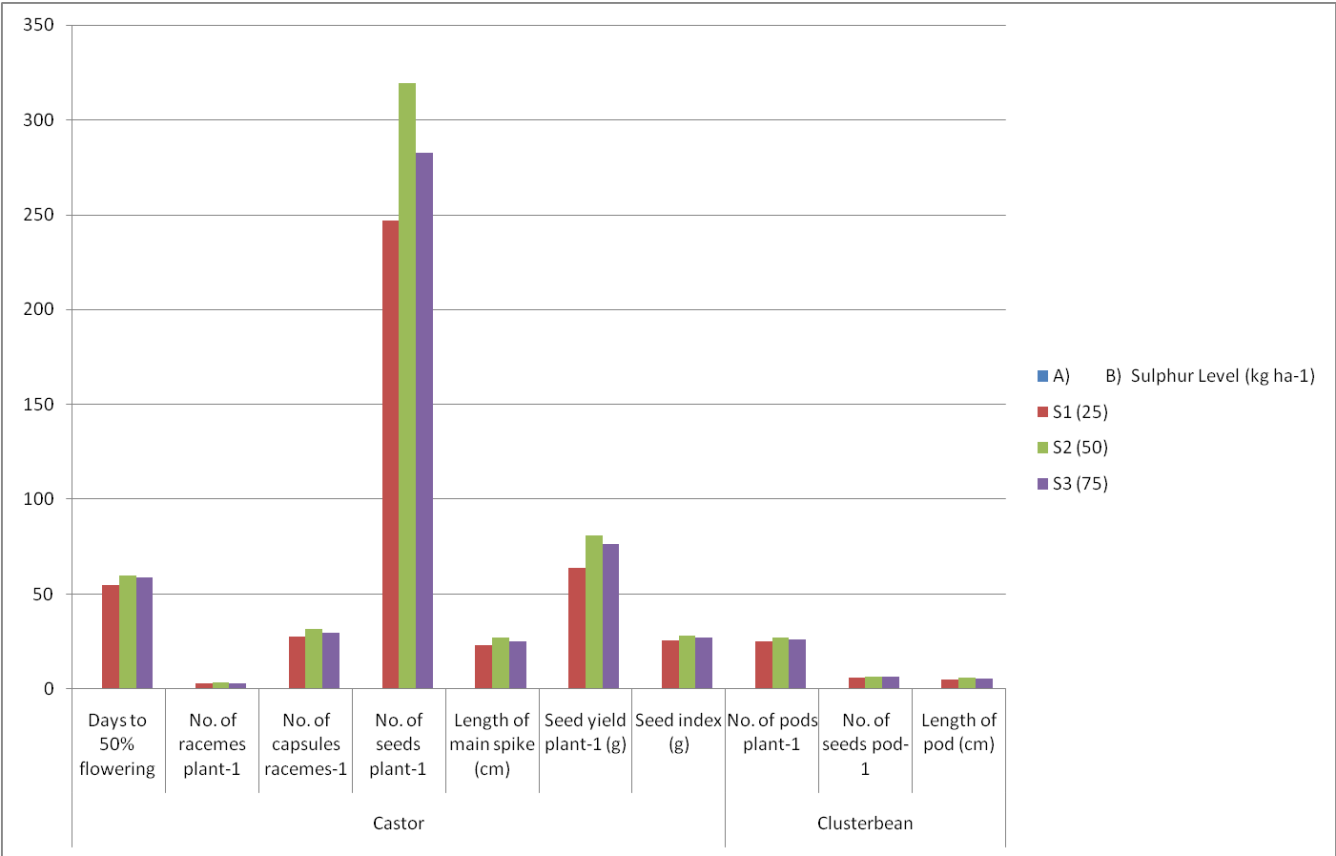
Table 2. Effect of different planting system and sulphur level on yield and quality of castor and clusterbean.

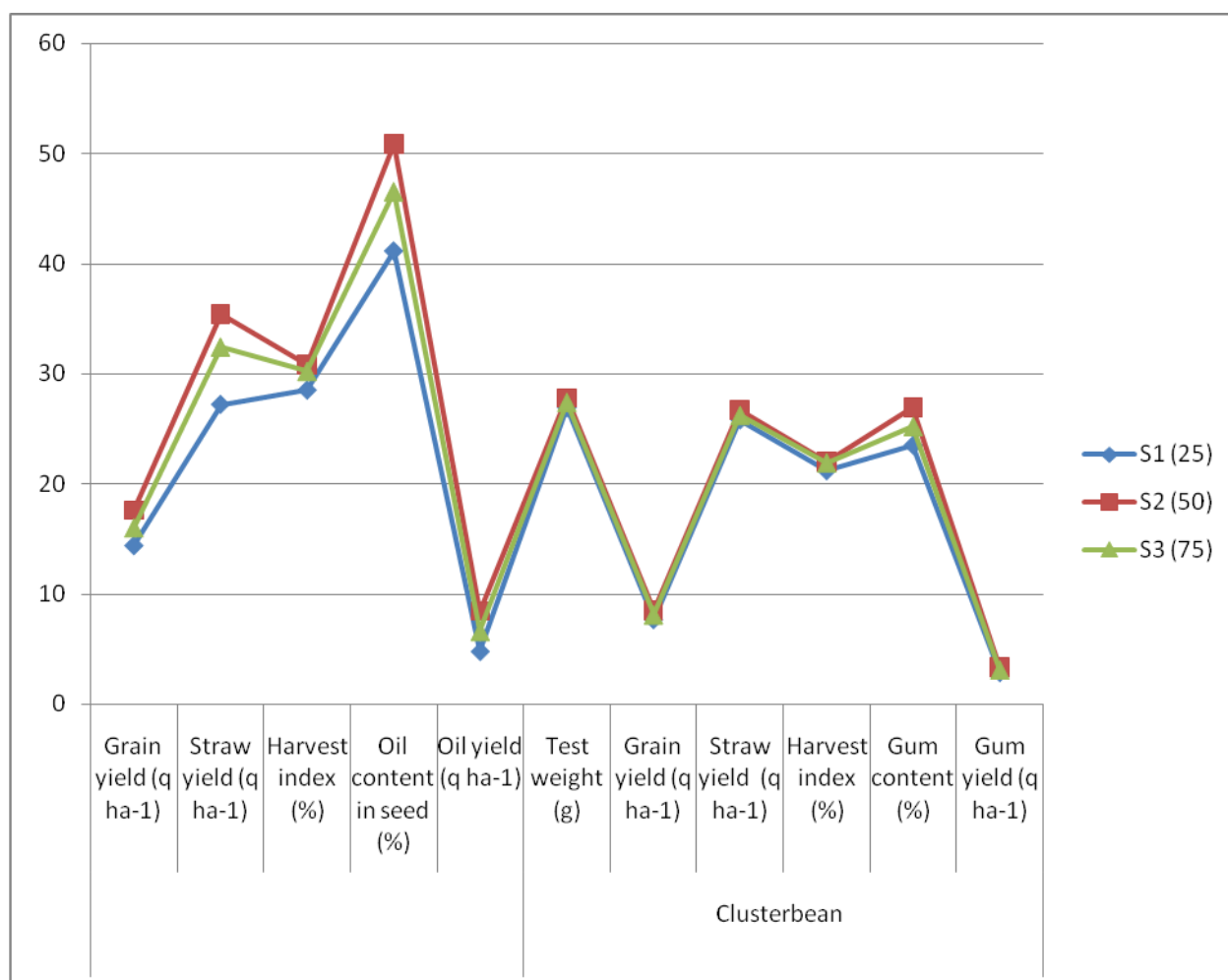
Treatment	Castor					Clusterbean					
	Grain yield (q ha ⁻¹)	Straw yield (q ha ⁻¹)	Harvest index (%)	Oil content in seed (%)	Oil yield (q ha ⁻¹)	Test weight (g)	Grain yield (q ha ⁻¹)	Straw yield (q ha ⁻¹)	Harvest index (%)	Gum content (%)	Gum yield (q ha ⁻¹)
A) Different Planting System											
PS ₁ [C + CB (1:2)]	12.9	31.0	27.1	44.2	4.8	26.0	7.3	22.2	18.4	28.8	2.5
PS ₂ [C + CB (1:4)]	16.8	31.2	31.7	47.1	7.1	27.9	8.2	27.6	23.3	25.7	3.1
PS ₃ [C + CB (1:6)]	19.0	33.9	32.0	48.2	8.3	28.0	9.0	29.7	23.4	27.8	4.0
PS ₄ [C + CB (1:8)]	15.3	30.6	28.5	45.1	6.1	26.8	8.0	25.3	21.6	24.6	2.8
SEm±	0.90	1.38	1.34	1.74	0.30	0.11	0.07	0.23	0.59	0.19	0.06
C.D. (P=0.05)	3.10	NS	NS	NS	1.03	0.38	0.24	0.79	NS	0.67	0.20
B) Sulphur Level (kg ha⁻¹)											
S ₁ (25)	14.4	27.2	28.5	41.1	4.8	26.9	7.7	25.8	21.2	23.5	2.9
S ₂ (50)	17.6	35.4	30.8	50.9	8.4	27.8	8.5	26.7	22.0	26.9	3.3
S ₃ (75)	16.0	32.4	30.2	46.5	6.6	27.4	8.1	26.2	21.9	25.2	3.1
SEm±	0.84	1.02	0.88	0.84	0.62	0.05	0.01	0.04	0.54	0.11	0.01
C.D. (P=0.05)	2.52	3.06	NS	2.51	1.85	0.15	0.03	0.11	NS	0.32	0.03

Table 3. Effect of different planting system and sulphur level on N, P₂O₅, K₂O and S total uptake [(kg ha⁻¹) Grain + Straw] and Economics of castor and clusterbean

Treatment	Castor		Clusterbean				Economics (ha ⁻¹)		
	N	S	N	P	K	S	Gross return	Net return	B : C Ratio
A) Different Planting System									
PS ₁ [C + CB (1 : 2)]	40.5	6.2	42.9	6.5	26.8	5.9	102100	84964	4.96
PS ₂ [C + CB (1 : 4)]	56.5	8.1	57.6	8.8	30.8	9.6	121660	104290	6.00
PS ₃ [C + CB (1 : 6)]	67.7	9.2	74.2	10.3	36.6	11.8	133955	116285	6.58
PS ₄ [C + CB (1 : 8)]	48.6	7.2	50.1	8.0	29.6	7.8	114805	96835	5.39
SEm±	1.55	0.23	0.68	0.08	1.63	0.14			
C.D. (P=0.05)	5.38	0.81	2.36	0.29	5.65	0.49			
B) Sulphur Level (kg ha⁻¹)									
S ₁ (25)	43.8	6.5	50.6	7.8	30.5	7.6	110110	94840	6.21
S ₂ (50)	61.9	8.7	62.0	9.0	31.3	10.0	125925	108405	6.19
S ₃ (75)	54.4	7.8	55.9	8.5	31.0	8.7	118010	98190	4.95
SEm±	1.94	0.25	0.48	0.05	1.35	0.04			
C.D. (P=0.05)	5.82	0.74	1.45	0.16	NS	0.11			







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