Dry root yield, nutrient uptake and economics of Ashwagandha (*Withania somnifera* L. Dunal) as influenced by planting layouts, spacings and nutrient management under drip irrigation

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ABSTRACT

A field experiment was conducted during rabi *season for two years to study the response of Ashwagandha [Withania somnifera (L.) Dunal] to planting layouts, spacings and nutrient management levels under drip irrigation at Rahuri (Maharashtra). There were twenty four treatment combinations consisting of three planting layouts (broad bed furrow, ridges and furrow, flat bed) along with two treatments of spacings (30 cm x 20 cm, 45 cm x 20 cm) were embedded in main plots. Four levels of nutrient management (75 : 37.5 : 37.5 kg N, P_2O_5, K_2O + 5 t FYM/ha, 50 : 25 : 25 kg N, P_2O_5, K_2O + 5 t FYM/ha, 25 : 12.5 : 12.5 kg N, P_2O_5, K_2O + 5 t FYM/ha and control) were taken in sub plots. Broad bed furrow planting layout recorded significantly higher values of yield attributes* viz., *number of roots, root length, root diameter, dry root weight, number of berries and seed yield per plant and consequently recorded higher dry root (790 kg/ha) and seed yield (11.46 q/ha), nutrient uptake and harvest index (18.86%) as compared to ridges furrow and flat bed. The closer spacing of 30 cm x 20 cm registered significantly high dry root yield, seed yield, nutrient uptake and harvest index than wider spacing of 45 cm x 20 cm. At 30 cm x 20 cm spacing, the increase in dry root yield and seed yield was 19.89 and 15.20% over 45 cm x 20 cm, respectively. Significant increase in dry root yield, seed yield and nutrient uptake was noticed with increase in fertilizer levels from control to 75 : 37.5 : 37.5 kg N, P_2O_5 K_2O + 5 t FYM/ha. Application of 75 : 37.5 : 37.5 kg N, P_2O_5, K_2O + 5 t FYM/ha recorded significantly higher yield attributes as well as dry root yield (837 kg/ha), seed yield (13.29 q/ha), N (130.34 kg/ha), P (30.07 kg/ha) and K (159.49 kg/ha) uptake and harvest index (21.33%) than rest of fertilizer levels. Economic evaluation indicated that broad bed furrow planting method produced higher gross returns (‘ 2,20,379/ ha), net returns (‘ 1,60,796/ha) and B:C ratio (3.67) followed by ridges furrow and flat bed. The spacing of 30 cm x 20 cm and fertilized with 75:37.5:37.5 kg N, P_2O_5, K_2O + 5 t FYM/ha obtained maximum gross returns (‘ 2,56,946/ha), net returns (‘ 1,92,496/ha), and B:C ratio than others.*

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INTRODUCTION

Medicinal plants have attained high significance in recent years due to their demand for industrial use in herbal health care [9]. Ashwagandha is one of the important medicinal plants used in the traditional Indian medicine since ancient times. The roots of ashawagandha are the economic part of the plants and are used in the preparation of Ayurvedic and Unani medicines [10]. Occasionally the leaves and seeds are also used for medicinal purpose. In US market, ashwagandha has recently acquired considerable significance on account of its large demand due to its reported male sex stimulating properties. Ashwagandha has been a prized top-notch adaptogenic tonic in India since 3000 to 4000 years. The plants contain alkaloids and withanolides, which are used to treat nervous disorders, intestinal infection and leprosy [1]. It is native to the drier parts of India. It is cultivated over an area of 10,780 ha giving a production of 8,429 tonnes in India. The present market demand of *Withania* root in Indian herbal trade is about 15 million tones. The annual production, however is only 7.0 million tones [16] necessitating the increase in its cultivation and higher production. In rainfed areas, the productivity of traditional crop is at stake due to vagaries of weather. Cultivation of medicinal crops either in sequence or as crops may help in sustaining the productivity and profitability of the farmers. The method of transplanting seedlings is considered to be one of the important factors in the raising of Ashwagandha crop. Proper planting layout helps to maintain optimum moisture level resulting in better growth and yield. There is very meager scientific information available on planting techniques of ashwagandha. Diversified responses of ashwagandha to spacing and fertilizer levels were reported by different workers including Kubsad *et.al* [8]. Drip irrigation is considered to be most efficient in improving the yield, quality and saving of water. Ashwagandha crop irrigated at 70% of pan evaporation through drip at alternate day produced higher root yield than micro sprinkler and surface irrigation during *rabi* season [2]. Thus, the economic potential of the crop could be realized by expanding its cultivation to better agricultural lands with scientific production technologies. Considering the medicinal value of the crop, its increasing demand and meager scientific information on the cultivation of ashwagandha under drip, in view altogether, the present investigation was carried out to study the response of ashwagandha to planting layouts, spacings and nutrient management under drip irrigation for Maharashtra region.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* season of 2010-11 and 2011-12 at AICRP on Water Management, M.P.K.V., Rahuri (M.S.) without changing randomization. The soil of the experimental site was clayey in texture with pH 8.10, medium in organic carbon (0.50%), low in available N (194.43 kg/ha), medium in available P_2O_5 (16.64 kg/ha) and high in available K_2O (616.00 kg/ha). The experiment was laid out in split plot design with three replications. There were twenty four treatment combinations. Three treatments of planting layouts *viz.,* broad bed furrow, ridges and furrow, flat bed along with two treatments of spacing *viz.,* 30 cm x 20 cm, 45 cm x 20 cm were embedded in main plots. While four levels of nutrient management *viz.,* 75 : 37.5 : 37.5 kg N, P_2O_5, K_2O + 5 t FYM/ha, 50 : 25 : 25 kg N, P_2O_5, K_2O + 5 t FYM/ha, 25 : 12.5 : 12.5 kg N, P_2O_5, K_2O + 5 t FYM/ha and control (no nutrient) treatment were assigned in sub plots. Half N, full P_2O_5 and K_2O applied at planting and half N applied at 45 days after transplanting through conventional fertilizer as per treatment. The FYM was applied and mixed in soil as per treatment 15 days prior to planting. The gross plot size was 5.00 m x 3.60 m and net plot size was 4.20 m x 2.70 m. The variety used for experimentation was 'Nagori'. The crop was transplanted on 28th October 2010 during first year and 5th November 2011 during second year. First irrigation was given at planting and subsequent irrigation was applied through drip at 70% of pan evaporation at every alternate day common to all treatments. Rainfall, if any between irrigation cycles, then the rainfall amount was deducted and irrigation water was applied accordingly. The total amount of rainfall received during cropping period were 103.2 mm and 7.4 mm in 6 and 2 rainy days during 2010-11 and 2011-12, respectively. The crop was sprayed with Dimethoate 30% EC @ 1ml per liter of water for control of aphids and Omite a.i. propargite 57% EC @ 1.5 ml per liter of water for control of mites. The crop was harvested on 16 and 27 April during first year and second year, respectively. At harvest, five plants were randomly selected in each treatment for recording growth and yield parameters. These samples were oven dried at 70 ^{0}C temperature, powdered and analyzed for N, P and K concentrations by standard methods as suggested by Jackson [5] and the total uptake was calculated. The plants from each net plot were uprooted and the roots and shoots were separated and sun dried for a week. The root yield was recorded and expressed in kg/ha. Cost of laying-out of drip irrigation system and cultivation charges were worked out per hectare. The life of drip system was assumed to be ten seasons. For working out the economics, prevailed market price for ashwagandha seeds (` 50 and 55/kg during 2010-11 and 2011-12, respectively, dry roots (₹ 200 and 205/kg during 2010-11 and 2011-12, respectively), urea (₹ 12.15/kg N), SSP (₹ 50/kg P) MOP (₹ 28.40/kg K) and cost of labour (₹ 150/day) were considered. The data were statistically analyzed and pooled data of two years were presented.

RESULTS AND DISCUSSION

Dry root, seed and other yield attributes

Dry root yield was significantly influenced by planting layouts, spacing and nutrient management levels. Broad bed furrow planting method recorded maximum dry root yield (790 kg/ha) followed by ridges furrow (712 kg/ha) and flat bed (594 kg/ha), which was 10.92 and 33.09% higher than ridges furrow and flat bed, respectively. The dry root yield was maximum in broad bed furrow due to higher number of roots, root length, root diameter and dry root weight per plant than ridges furrow and flat bed. Similarly, significantly higher seed yield (11.46 q/ha) obtained in broad bed furrow followed by ridges furrow (10.77 q/ha) and minimum in flat bed (10.04 q/ha) due to higher number of berries and seed yield per plant (Table 1 and 2). In broad bed furrow planting maximum dry root and seed yield was obtained due to physical modification of soil but these modification also helped in better physiological process of plants such as root respiration and absorption of nutrients and moisture through easy penetration of roots, better root development and root activities in properly aerated and moist soils. Pandey *et al* [11] reported that safed musli produced higher root yield (4.90 q/ha) on raised bed planting than ridges and furrow (3.89 q/ha) and flat bed (3.28 q/ha). Similar results were also obtained by Ardeshna *et al* [3] in turmeric. They reported higher rhizome yield of turmeric under raised bed planting than ridge furrow and flat bed. The harvest index was significantly higher (20.77%) in broad bed furrow followed by ridges furrow (20.10) and the lowest in flat bed (18.86) due to higher root and seed yield.

The wider spacing produced significantly higher yield and yield parameters per plant except root length, which was mainly due to better resource availability and reduced interplant competition in the community. While there was significantly higher dry root yield (762 kg/ha) of ashwagandha at closer spacing of 30 cm x 20 cm which was 19.89% higher than 45 cm x 20 cm spacing. The yield increment at closer spacing is attributed to improvement in root length and higher plant population per unit area compared to wider spacing of 45 cm x 20 cm (Table 1 and 2). Saudan Singh *et al* [15] also reported 53.8% higher root yield of ashwagandha at higher plant density when compared with lower plant density. The seed yield per hectare of closer spacing 30 cm x 20 cm was (11.29 q/ha) which was 15.20% more than the spacing 45 cm x 20 cm. It was mainly attributed to the higher plant population per unit area at closer spacing which cumulatively increased the growth and seed yield attributes. Similar results were reported by Karad *et al* [7] and Shukla and Shukla [17]. The harvest index was significantly higher (20.57%) in 30 cm x 20 cm compared to 45 cm x 20 cm spacing due to higher root and seed yield.

There was liner increase in yield attributes and dry root yield of Ashwagandha with increase in

Table 1. Yield attributes of Ashwagandha at harvest as influenced by different treatments (Pooled data of two years)

Treatment	No. of roots per plant	Root length per plant (cm)	Root diameter per plant (cm)	Dry root weight per plant (g)	No. of berries per plant	Seed yield per plant (g)
A. Planting layouts (L)						
L_1- Flat bed	3.90	28.48	1.58	5.67	253.37	13.64
L_2 - Ridges and furrow	4.28	30.90	1.69	6.86	289.27	16.17
L_3 - Broad bed furrow	4.64	32.21	1.76	7.55	309.72	17.44
SE (m) ±	0.07	0.22	0.02	0.07	2.55	0.16
CD at 5%	0.22	0.81	0.06	0.21	9.24	0.60
B. Spacings (S)						
S_1- 30 cm X 20 cm	4.04	31.39	1.63	6.40	266.61	14.56
S_2- 45 cm X 20 cm	4.50	29.67	1.73	7.00	301.64	16.94
SE (m) ±	0.06	0.18	0.02	0.06	2.08	0.13
CD at 5%	0.18	0.66	0.05	0.18	7.55	0.49
C. Nutrient management levels (F)						
F_1- 75 : 37.5 : 37.5 kg NPK + 5 t FYM ha^{-1}	4.84	33.36	1.85	7.62	332.36	19.30
F_2 -50 : 25 : 25 kg NPK + 5 t FYM ha^{-1}	4.56	31.73	1.75	7.20	308.71	17.99
F_3- 25 : 12.5 : 12.5 kg NPK + 5 t FYM ha^{-1}	4.12	29.67	1.63	6.54	273.89	14.83
F_4- Control	3.57	27.36	1.48	5.43	221.44	10.87
SE (m) ±	0.04	0.10	0.01	0.05	1.34	0.17
CD at 5%	0.10	0.30	0.03	0.15	3.98	0.50
Interactions						
L X S	NS	NS	NS	NS	NS	NS
L X F	NS	NS	NS	NS	NS	NS
S X F	NS	NS	NS	NS	NS	NS
L X S X F	NS	NS	NS	NS	NS	NS
General mean	**4.27**	**30.53**	**1.68**	**6.70**	**284.12**	**15.75**

fertilizer levels. The dry root yield of 836 kg/ha was significantly higher with the application of 75:37.5:37.5 kg N, P_2O_5, K_2O + 5 t FYM/ha which was 8.89, 24.03 and 62.07% higher over 50:25:25 kg N, P_2O_5, K_2O with 5 t FYM/ha, 25:12.5:12.5 kg N, P_2O_5, K_2O with 5 t FYM/ha and control treatment (Table1and 2). Karad *et al* [7] recorded higher dry root yield of ashwagandha at higher fertilizer level of 10 t FYM with 60:30:15 kg NPK/ha. The higher dry root yield was mainly due to higher values of yield attributes like number of roots (4.84), root length (33.36 cm), root diameter (1.85 cm) and dry root weight (7.62 g) per plant. The application of 75:37.5:37.5 kg N, P_2O_5, K_2O with 5 t FYM/ha proved its superiority by recording significantly higher seed yield (12.75 q/ha) than rest of the fertilizer levels. It gave 9.53, 25.99 and 66.01 per cent higher seed yield over 50:25:25 kg N, P_2O_5, K_2O with 5 t FYM/ ha, 25:12.5:12.5 kg N, P_2O_5, K_2O with 5 t FYM/ha and control treatment, respectively. The higher seed yield was mainly due to higher values of yield attributes like number of berries and seed yield per plant compared to other fertilizer levels. This might be due to supply of balanced nutrients in appropriate quantity which enhance the use efficiency of added nutrients and create favourable environment for increasing microbial population which increase the nutrient availability and thereby increases the uptake of nutrients by crop. Ultimately enhance all the growth and yield attributes of crop coupled with increase in physiological processes and efficient translocation of photosynthates towards reproductive organs which reflected into higher dry root yield and seed yield of ashwagandha compared to lower fertilizer levels. In the absence of the fertilizer the dry root and seed yield as well as yield parameters were reduced significantly. These results are in close vicinity to those reported by

Table 2. Dry root yield, seed yield, biological yield and harvest index of Ashwagandha as influenced by different treatments (Pooled data of two years)

Treatment	Dry root yield (kg/ha)	Seed yield (q/ha)	Biological yield (q/ha)	Harvest index (%)
A. Planting layouts (L)				
L_1- Flat bed	593.89	9.41	80.54	18.86
L_2 - Ridges and furrow	712.47	10.77	88.23	20.10
L_3 - Broad bed furrow	790.30	11.46	92.43	20.77
SE (m) ±	10.46	0.10	0.22	0.13
CD at 5%	37.87	0.38	0.74	0.48
B. Spacings (S)				
S_1- 30 cm × 20 cm	762.10	11.29	91.04	20.57
S_2- 45 cm × 20 cm	635.67	9.80	83.09	19.25
SE (m) ±	8.54	0.08	0.18	0.11
CD at 5%	30.92	0.31	0.60	0.39
C. Nutrient management levels (F)				
F_1- 75 : 37.5 : 37.5 kg NPK + 5 t FYM ha^{-1}	836.57	12.75	98.64	21.33
F_2 -50 : 25 : 25 kg NPK + 5 t FYM ha^{-1}	768.30	11.64	92.99	20.69
F_3- 25 : 12.5 : 12.5 kg NPK + 5 t FYM ha^{-1}	674.49	10.12	85.76	19.59
F_4- Control	516.19	7.68	70.86	18.04
SE (m) ±	5.11	0.08	0.49	0.10
CD at 5%	15.19	0.23	1.46	0.29
Interactions				
L X S	NS	NS	NS	NS
L X F	NS	NS	NS	NS
S X F	Sig	NS	NS	NS
L X S X F	NS	NS	NS	NS
General mean	698.89	10.55	87.06	19.91

Table 2(a). Interaction effect between spacing and nutrient management on dry root yield kg/ha at harvest

Spacing \ Nutrient Management	Dry root yield (kg/ha)			
	F_1- 75:37.5: 37.5 kg NPK + 5 t FYM ha^{-1}	F_2- 50: 25: 25 kg NPK + 5 t FYM ha^{-1}	F_3- 25:12.5:12.5 kg NPK + 5 t FYM ha^{-1}	F_4- Control
S_1-30 cm X 20 cm	915.88	841.42	731.63	559.47
S_2- 45 cm X 20 cm	757.25	695.18	617.35	472.92
Source			**SE (m) ±**	**CD at 5%**
Between sub plot (F) means at same level of main plot (S) means			7.23	21.48
Between main plot (S) means at same level of sub plot (F) means			11.27	32.36

Pandey *et al* [12] and Karad *et al* [7]. The harvest index was significantly higher (21.33%) in 75:37.5:37.5 kg N, P_2O_5, K_2O + 5 t FYM/ha compared to other fertilizer levels.

The crop responded to higher fertilizer levels with closer spacing of 30 cm x 20 cm. The spacing 30 cm x 20 cm and fertilized with 75:37.5:37.5 kg N, P_2O_5, K_2O + 5 t FYM/ha found significantly superior in respect to dry root yield (916 kg/ha) over other treatment combinations (Table 2a). This was mainly attributed to more number of plants per unit area, higher values of yield parameters and dry matter accumulation in roots per ha at harvest due to more availability of nutrients to the plants through fertilizers.

Nutrient uptake

Broad bed furrow planting method removed 113.85 kg N, 26.15 kg P and 139.96 kg K which was significantly higher than ridges and furrow and flat bed (Table 3). Broad bed furrow planting layout helped in maintaining better moisture situation in loose and porous soil mass throughout the crop growth period. It was increased the availability of nutrients and also due to higher total dry matter production (straw, seed and dry root yield) per hectare resulted into increase the uptake of nutrients by crop in broad bed furrow. Similar findings were reported by Chandra *et al* [4] in turmeric. Maximum uptake of 106.78 kg N, 24.41 kg P and 129.61 kg K by the crop was noticed at a spacing of 30 cm x 20 cm which was significantly higher than 45 cm x 20 cm spacing (Table 3). The higher uptake of N, P and K can be related to higher dry root, seed yield and higher total dry matter. The uptake of N, P and K increased with application of every additional unit of fertilizer from control to 75:37.5:37.5 kg N, $P_2O_5,$ K_2O + 5 t FYM/ha. The significantly maximum uptake of N (130.34 kg/ha), P (30.07 kg/ha) and K (159.49 kg/ha) was recorded by crop due to fertilizer level of 75:37.5:37.5 kg N, $P_2O_5,$ K_2O with 5 t FYM/ha compared to remaining fertilizer levels. It was followed by application of 50:25:25 kg N, $P_2O_5,$ K_2O with 5 t FYM/ha and significantly minimum in control treatment (Table 3). This increase in uptake of nutrients may be attributed to higher N, P, K content, higher dry matter production and higher root and seed yield per ha which was due to continuous supply of essential plant nutrients throughout crop growth period to

Table 3. Nutrient uptake and economics based on dry root and seed yield of Ashwagandha as influenced by different treatments (Pooled data of two years)

Treatment	Nutrient uptake (kg/ha)			Cost of cultivation (₹/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	B: C ratio
	N	P	K				
A. Planting layouts (L)							
L_1- Flat bed	89.76	20.85	110.15	57230	169963	112732	2.94
L_2 - Ridges and furrow	104.51	24.16	129.24	58879	200948	142069	3.38
L_3 - Broad bed furrow	113.85	26.15	139.96	59583	220379	160796	3.67
SE (m) ±	0.48	0.04	0.48	-	2143	2115	0.03
CD at 5%	1.64	0.16	1.78	-	7763	7661	0.10
B. Spacings (S)							
S_1- 30 cm X 20 cm	106.78	24.41	129.61	61482	213822	152340	3.45
S_2- 45 cm X 20 cm	98.63	23.04	123.29	55646	180371	124725	3.21
SE (m) ±	0.39	0.03	0.39	-	1750	1727	0.02
CD at 5%	1.17	0.09	1.18	-	6338	6254	0.08
C. Nutrient management levels (F)							
F_1- 75 : 37.5 : 37.5 kg NPK + 5 t FYM ha^{-1}	130.34	30.07	159.49	61543	236548	175005	3.83
F_2 -50 : 25 : 25 kg NPK + 5 t FYM ha^{-1}	114.60	26.64	141.29	60256	216897	156640	3.58
F_3- 25 : 12.5 : 12.5 kg NPK + 5 t FYM ha^{-1}	94.73	22.19	118.38	58878	189869	130992	3.21
F_4- Control	71.16	15.98	86.63	53579	145072	91493	2.70
SE (m) ±	0.97	0.24	1.08	-	1521	1527	0.02
CD at 5%	2.96	0.73	3.30	-	4520	4538	0.06
Interactions							
L X S	NS	NS	NS	-	NS	NS	-
L X F	NS	NS	NS	-	NS	NS	-
S X F	NS	NS	NS	-	Sig	Sig	-
L X S X F	NS	NS	NS	-	NS	NS	-
General mean	3.26	6.59	2.95	**58564**	**197096**	**138533**	**3.33**

plants at higher fertilizer levels. Ramesh Babu [14] and Patel [13] observed significantly higher uptake of N, P and K by ashwagandha with 90 and 75 kg N per ha, respectively as compared to control treatment.

Economics

An economics of the crop based on dry root yield and seed yield revealed that broad bed furrow planting method obtained significantly higher gross returns (₹ 2,20,379/ha), net returns (₹ 1,60,796/ha) and B:C ratio (3.67). It was followed by ridges and furrow and the lowest gross and net returns and B:C ratio was obtained in flat bed (Table 3). The closer spacing of 30 cm x 20 cm realized higher gross returns (₹ 2,13,822/ha), net returns (₹ 1,52,340/ha) and B:C ratio (3.45) than 45 cm x 20 cm spacing due to maximum dry root and seed yield. The highest nutrient management level i.e. 75:37.5:37.5 kg N, P_2O_5, K_2O + 5 t FYM/ha realized the maximum gross returns (₹ 2,36,548/ha), net returns (₹ 1,75,005/ha) and B:C ratio (3.83), which was significantly higher than other fertilizer levels. The gross returns were 9.06, 24.58 and 63.05% as well as net returns were 11.72, 33.60 and 91.27% higher at 75:37.5:37.5 kg N, P_2O_5, K_2O + 5 t FYM/ha over 50:25:25 kg N, P_2O_5, K_2O + 5 t FYM/ha, 25:12.5:125 kg N, P_2O_5, K_2O + 5 t FYM/ha and control, respectively. Interaction effect between spacing and nutrient management found significant in respect to gross and net returns. The gross returns (₹ 2,56,946/ha) and net returns (₹ 1,92,496/ha) was significantly superior in the treatment combination of 30 cm x 20 cm spacing and fertilized with 75:37.5:37.5 kg N, P_2O_5, K_2O + 5 t FYM/ha than rest of treatment combinations. This was due to fact that maximum dry root and seed yield was produced under 30 cm x 20 cm spacing with application of 75:37.5:37.5 kg N, P_2O_5, K_2O + 5 t FYM/ha (Table 3a and b). These results agreed with findings of Karad *et al* [7] in ashwagandha.

Thus, it could be concluded that, planting of ashwagandha on broad bed furrow at 30 cm x 20 cm spacing and fertilized with 75:37.5:37.5 kg N, P_2O_5, K_2O + 5 t FYM/ha was found beneficial for achieving maximum dry root yield, seed yield and net monetary returns under drip irrigation during *rabi* season in medium deep soils of Western Maharashtra.

Table 3 (a). Interaction effect between spacing and nutrient management on gross returns

Spacing \ Nutrient Management	Gross returns (₹/ha)			
	F_1- 75:37.5: 37.5 kg NPK + 5 t FYM ha^{-1}	F_2- 50: 25: 25 kg NPK + 5 t FYM ha^{-1}	F_3- 25:12.5:12.5 kg NPK + 5 t FYM ha^{-1}	F_4- Control
S_1-30 cm X 20 cm	256946	236027	205211	157106
S_2- 45 cm X 20 cm	216150	197767	174528	133038
Source			**SE (m) ±**	**CD at 5%**
Between sub plot (F) means at same level of main plot (S) means			2151	6392
Between main plot (S) means at same level of sub plot (F) means			2769	7948

Table 3 (b). Interaction effect between spacing and nutrient management on net returns

Spacing \ Nutrient Management	Net returns (₹/ha)			
	F_1- 75:37.5: 37.5 kg NPK + 5 t FYM ha^{-1}	F_2- 50: 25: 25 kg NPK + 5 t FYM ha^{-1}	F_3- 25:12.5:12.5 kg NPK + 5 t FYM ha^{-1}	F_4- Control
S_1-30 cm X 20 cm	192496	172818	143427	100621
S_2- 45 cm X 20 cm	157514	140463	118557	82366
Source			**SE (m) ±**	**CD at 5%**
Between sub plot (F) means at same level of main plot (S) means			2156	6408
Between main plot (S) means at same level of sub plot (F) means			2741	7865

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