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The Beneficial Effects of Minimizing Mineral Fertilization on Four Walnut Selections by Different Sources of Organic Manures in Relation To Yield and Quality

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A B S T R A C T

Minimizing mineral fertilization through use of different sources of organic manure was studied on four walnut selections in temperate region of India (Kashmir) The experiment consisted of four selections [SKAU/002 (S_1), SKAU/008 (S_2), SKAU/024 (S_2) and SKAU/040 (S_2)] and six treatments [T_1 (NPK recommended as per package of practices through inorganic fertilizers), T_2 [100 % through manure (FYM 50% + vermicompost 25% + poultry manure 25%)], T_3 (75% NPK through inorganic fertilizers + 25 % through FYM), T_4 (75 % NPK through inorganic fertilizers + 25 % through vermicompost), T_5 (75 % NPK through inorganic fertilizers + 25 % through poultry manure) and T_6 [75 % NPK through inorganic fertilizers + 25 % through manure (1/3 FYM + 1/3 vermicompost + 1/3 poultry manure)] replicated five times and three tree in each replication in Factorial Randomized Block Design. All fertilizers and manures were applied in the first week of December beneath the tree canopy and mixed well with soil. There were significant differences in yield and nut quality parameters among different walnut selections under different treatments. Maximum yield (5.53 kg/tree) was found in selection S_2 while treatment T_4 showed maximum yield of 5.87kg/tree. The quality parameters of walnut were found improved by combined effect of inorganic fertilisers and vermicompost. Maximum nut length (38.65 mm), nut diameter (35.54 mm), nut weight (13.16 g), kernel length (30.77 mm), kernel breadth (23.64 mm), kernel weight (7.17 g), kernel percentage (55.56%) kernel protein content (18.31%), kernel fat content (60.39%), kernel fill (6.15 points) and kernel colour (3.32 points) was found in treatment T_4. Among selections highest nut length (41.00 mm), kernel length (33.16 mm), nut weight (12.5 g) was found in S_4 while as nut diameter (36.18 mm), kernel breadth and (24.01 mm) was found in S3 selection. So it seems that yield and nut quality of walnut selections could be greatly improved through fertilization of 75% fertilizer through inorganic coupled with 25% vermicompost followed by 75 % NPK through inorganic fertilizers + 25 % through poultry manure . Among the selections, S_2 showed better performance with respect to yield and quality followed by selection S_1.

Introduction

Jammu and Kashmir State has created a special place in the international trade of walnuts. The entire export of the country comes from Jammu and Kashmir state. In Jammu and Kashmir state walnut is grown on an area of about 89788 ha with annual production of

about 163745 metric tons (Anonymous, 2014) with the productivity of 1.823 metric tons per hectare. It produces about 98 per cent of the total production in India.

The demand of quality walnuts is increasing day by day in the national and international market, but production of walnut is still low as compared to China, USA, France and other developed countries. Production of horticultural crops has undergone enormous changes in the recent years due to the development of innovative technologies including nutrient management practice. The nutrient management of walnut is one of the important factors to boost the yield and improve the quality of nuts. The application of fertilizers to add N, P and K have influenced the growth of tree and production of fruits like chestnut, grapes, pears, figs and walnut trees (Shi *et al.,* 2001; Zhang *et al.,* 2004a; Zhang *et al.,* 2004b). Fertilization treatments have the potential for increasing growth and nut production of walnuts (Ponder and Van-Sambeek, 1997). Though the chemical farming helped the farmers to accomplish new strides in horticulture, but their indiscriminate and unscrupulous use in horticulture/agriculture has led to deterioration of soil health. The increased use of fertilizers in non-judicious manner, has led to diminishing soil productivity and multiple nutrient deficiencies. The gravity of environmental degradation caused by the faulty cultivation practices has led to focus on ecologically sound, viable and sustainable farming systems.

Minimizing use of chemical fertilizers in fruit growing is a goal of integrated fruit production (Reganold *et al.,* 2001; Forge *et al.,* 2002). Recently, environmental aspects of plant nutrient application have received much interest. The organic manures, when applied to soil increases the fertility status of soil and favourably influence the crop yield for several years. It has been reported that farm yard manure, vermicompost and poultry manure have increased growth, yield and quality in different crops (Ingle *et al.,* 2003; Ram and Rajput, 2002; Arancon *et al.,* 2003). Thus it has been realised that use of chemical fertilisers must be integrated through more economic and eco-friendly organic manures in order to achieve the substantial productivity with minimum deleterious effect of chemical fertilisers on soil health and environment. One such alternative horticulture system, which will help to overcome the problem of soil degradation and declining soil fertility and crop yield, is integrated nutrient management (INM). The target of this investigation was to minimize the use inorganic fertilizers with organic sources on four walnut selections.

Materials and Methods

The experimental orchard is located at Ambri Apple Research Station Pahnoo Shopian. This experimental farm is located at 33.72^{o}N latitude and 74.83^{0} E longitudes, at an elevation of 2057 m above msl, representing high hill zone of the state. The climate of the area is typically temperate. Before application of manures and chemical fertilisers a composite soil sample of the experimental orchard was drawn and analysed orchard contain available Nitrogen (308Kg/ha), Phosphorus (17.5Kg/ha), Potassium (230Kg/ha), exchange Calcium (1197.45ppm), Magnesium (160.23ppm), Iron (48.90), Zinc(0.98 ppm), Copper (2.58 ppm), Manganese (64.20 ppm)and organic carbon (0.98) with pH of 6.82.. The studies were conducted on 9 years old four bearing selections {SKAU/002 (S_1), SKAU/008 (S_2), SKAU/024 (S_3), and SKAU/040 (S_4), of walnut grafted on seedling rootstock. For the conduct of experiment, trees with uniform age and vigour, placed at 6m×6mwere selected. The treatments were laid out in randomised

block design (Factorial), containing five replications of three tree each The details of treatment are T_1 (NPK recommended as per package of practices through inorganic fertilizers), T_2 {100 % through manure (FYM 50% + vermicompost 25% + poultry manure 25%)}, T_3 (75% NPK through inorganic fertilizers + 25 % through manure (FYM), T_4 (75 % NPK through inorganic fertilizers + 25 % through manure (vermicompost), T_5 (75 % NPK through inorganic fertilizers + 25 % through manure (poultry manure) and T_6 (75 % NPK through inorganic fertilizers + 25 % through manure (1/3 FYM+ 1/3 Vermicompost +1/3poultry manure). The recommended dose during first year is 200g N, 50g P and 200g K and during second year 250g N, 60g P and 250g K using urea, DAP and MOP as inorganic fertilizer source. There were 24 treatment combinations. Farm yard manure, vermicompost; poultry manure and inorganic fertilizer were applied to each replication as per the treatment details. All fertilizers and manures were applied in the first week of December beneath the tree canopy and mixed well with soil. Chemical composition of organic fertilizers used for the experiment is given in table 1.

The observation was recorded at time of harvesting of nuts from all the experimental trees. After harvesting, the nuts from each tree were dehulled, dried, weighed and expressed in Kg per tree. The length and diameter of ten nuts randomly selected were measured with the help of digital vernier caliper and average length and diameter were expressed in millimeter (mm). The weight of ten nuts randomly selected was recorded on electronic balance and the average nut weight was expressed in grams (g). Shell thickness of ten randomly selected nuts was measured at the centre of the shell with the help of digital vernier caliper and average thickness was expressed in millimeter (mm). The length and breadth of kernels extracted from ten selected nuts were measured with the help of digital vernier caliper and average and breadth were expressed in millimeter (mm).The weight of kernels extracted from ten nuts was recorded on electronic balance and the average kernel weight was expressed in grams (g). Kernel percentage was calculated by dividing kernel weight with nut weight and expressed in percent. The shell kernel ratio was obtained by dividing weight of shell with the weight of kernel and expressed in per cent. Colour of kernel and kernel fill was evaluated by a panel of experts (judges) on a four point and seven point scale given by IPGRI (1994) respectively. The score for kernel colour was extra light: 4, light: 3, light amber: 2 and amber: 1. The score for kernel colour was well: 7, moderate:5 and poor:3. The Kjeldahl's method as described by Kanwar and Chopra (1967) for estimation of crude protein in plant samples was followed. The nitrogen percentage was multiplied by a factor 5.3 as suggested for tree nuts by Khanizadeh *et al*., (1995) to calculate the crude protein percentage. Oil content of the kernel was determined on the weight basis and expressed in percentage. The nuts were dried in an oven at 60^{o}C until they were moisture free. Petroleum ether (40-60^{o}) boiling point was used as a solvent for oil extraction in a Soxhlet apparatus (Ranganna, 1997). Statistical analyses were conducted using the SAS and means were compared by critical difference (C.D) at 0.05.

Results and Discussion

Effect of integrated nutrient management on yield parameters

The study revealed that fertilizer treatment had significant effect on yield (Table 2). Highest fruit yield was found in treatment T_4 (5.87 kg/tree) followed by T_5 (5.30 kg/tree) and T_6 (4.92 kg/tree). The higher yield with different combinations of organic and

inorganic sources might be attributed to sustained release and uptake of major as well as minor elements which is evident from higher accumulation of nutrient elements in walnut leaves (data not shown). Increase in yield might be on account of production of phytohormone like substances and increased uptake of micronutrients (Govindan and Purushothamam, 1984). The prolonged availability of nutrients during crop growth period from vermicompost might have enhanced plant growth and yield attributes (Rajkhowa *et al.,* 2000). Vermicompost also serve as base for establishment and multiplication of beneficial symbiotic microbes which help in fixing nitrogen in soil besides enhancing the availability of phosphate and nitrogen and uptake of phosphate by plants (Sinha *et al.,* 2005). Different workers have reported that yield increment with organic manures is due to improvement in soil aeration, better moisture storage and increased nutrient availability and uptake by plants (Shivaputra *et al.,* 2004 and Dutta *et al.,* 2010). The present findings are in agreement with those of Osman (2003), Hebbara *et al.,* (2006) and Singh (2007). Among selections maximum yield was observed in S_2 (5.53 kg/tree) followed by S_1 (5.11 kg/tree) and S_3 (4.96 kg/tree). The maximum yield in selection S_2 might be due to genetic constitution of selection.

Effect of integrated nutrient management on nut parameters

It is evident from tables 2, 3, 4 and 5 that that the effect of different fertilizer treatments on nut length, nut diameter, shell thickness, kernel length, kernel percentage and shell/kernel ratio attributes were found statistically non-significant. However, nut weight, kernel breadth and kernel weight were affected significantly by different fertilizer treatments. Maximum nut weight (13.16g) was found in treatment T_4, whereas minimum (11.68g) was observed in treatment T_2. Kernel breadth (23.64 mm) was recorded highest in treatment T_4 followed by treatment T_3 and T_5. Treatment T_4 recorded maximum kernel weight (7.17g) whereas lowest (5.97g) was found in T_2. This increase in nut parameter with combined application of vermicompost and inorganic fertilisers might be due to the fact that vermicompost would have improved soil texture and provided micronutrients such as zinc, iron, copper, manganese etc. and better microbial establishment in the soil. The biological activity of the micro-organism would have helped the soil to become ready to serve zone for essential nutrients to plant root system. Zinc is involved in the biochemical synthesis of the most important phytohormone IAA through the pathways of conversion of tryptophan to IAA. Iron is involved in the chlorophyll synthesis besides being part of co-enzymes of respiratory chain reaction. Copper and manganese are important activators of co-enzymes. Organic manures in combination with inorganic fertilisers must have helped in metabolic changes through the supply of such important micro-nutrients and enzyme activation which ultimately must have improved nut parameters (Hayworth *et al.,* 1996). The increase in fruit parameters have been reported by different workers in several crops, Khan *et al.,* (2002) in peach, Kumar *et al.,* (2003) in plum, and Raina *et al.,* (2011) in apple.

Different selections differ significantly with respect to nut length, nut diameter, nut weight, kernel length, kernel breadth, and kernel weight and kernel percentage. However, selections do not differ significantly with regard to shell thickness and shell kernel ratio. Selection S_4 recorded highest nut length (41 mm) and is significantly different from S_2 and S_3 but at par with S_1. Maximum nut diameter (36.18) was observed in selection S_3 followed by S_2, S_4 and S_1.

Table.1 Chemical composition of organic fertilizers used for the experiment

parameter / Manure	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu(ppm)	Organic carbon (%)
FYM	0.68	0.32	0.73	0.72	0.18	144.20	62.24	15.30	2.4	10.22
Vermicompost	2.48	0.89	1.67	0.82	0.17	162.15	71.50	22.00	3.72	17.85
Poultry manure	2.97	0.95	1.19	1.84	0.41	202.81	52.50	18.00	2.93	14.55

Table.2 Effect of integrated nutrient management on yield /tree (Kg), nut weight (g) and nut length (mm)in walnut

Treatment	Average of 2011 and 2012														
	Yield /tree (Kg)					Nut weight (g)					Nut length (mm)				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
T_1	4.89	5.11	4.60	4.22	**4.70**	11.45	12.97	11.22	12.52	**12.04**	40.75	35.16	34.70	40.27	**37.72**
T_2	4.87	5.19	4.59	4.20	**4.71**	11.35	11.70	11.23	12.43	**11.68**	39.53	34.2	34.09	40.43	**37.06**
T_3	4.88	5.33	4.94	4.24	**4.85**	11.23	12.43	11.72	12.59	**11.99**	40.29	34.86	34.68	41.42	**37.81**
T_4	6.00	6.82	5.41	5.27	**5.87**	12.93	13.66	12.87	13.19	**13.16**	41.06	35.14	36.07	42.32	**38.65**
T_5	5.19	5.79	5.03	5.18	**5.30**	12.70	12.50	12.13	12.21	**12.38**	40.65	34.36	34.9	40.93	**37.71**
T_6	4.85	4.97	5.21	4.64	**4.92**	12.15	12.09	12.03	11.95	**12.05**	40.22	33.1	33.88	40.63	**36.96**
Mean	**5.11**	**5.53**	**4.96**	**4.62**		**11.97**	**12.56**	**11.87**	**12.48**		**40.42**	**34.47**	**34.72**	**41.00**	
C.D≤0.05 (S)					**0.32**					**0.57**			**4.17**		
C.D≤0.05 (T)					**0.36**					**0.04**			**NS**		

T_1 = NPK (recommended as per package of practices) through inorganic fertilizers
T_2 = 100 % through manure (FYM 50% + vermicompost 25% + poultry manure 25%)
T_3 = 75% NPK through inorganic fertilizers + 25 % through manure (FYM)
T_4 = 75 % NPK through inorganic fertilizers + 25 % through manure (vermicompost)
T_5 = 75 % NPK through inorganic fertilizers + 25 % through manure (poultry manure)
T_6 = 75 % NPK through inorganic fertilizers + 25 % through manure (1/3 FYM + 1/3 vermicompost + 1/3 poultry manure)

S_1 = SKAU/002
S_2 = SKAU/008
S_3 = SKAU/024
S_4 = SKAU/040

Table.3 Effect of integrated nutrient management on nut diameter (mm), shell thickness (mm) and nut length (mm) in walnut

Treatment	Nut diameter (mm)					shell thickness (mm)				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
T_1	31.14	36.94	35.98	34.74	**34.70**	1.53	1.65	1.70	1.83	**1.68**
T_2	30.97	36.53	35.26	33.62	**34.09**	1.49	1.63	1.59	1.83	**1.63**
T_3	30.12	35.93	37.36	35.29	**34.68**	1.51	1.64	1.60	1.78	**1.63**
T_4	31.48	36.49	37.50	36.67	**35.54**	1.57	1.62	1.65	1.82	**1.66**
T_5	31.59	35.42	35.91	35.25	**34.54**	1.53	1.63	1.67	1.81	**1.66**
T_6	31.07	35.06	35.08	35.63	**34.21**	1.53	1.55	1.69	1.80	**1.64**
Mean	**31.06**	**36.06**	**36.18**	**35.20**		**1.52**	**1.62**	**1.65**	**1.81**	
C.D≤0.05 (S)			**4.10**					**NS**		
C.D≤0.05 (T)			**NS**					**NS**		

T_1 = NPK (recommended as per package of practices) through inorganic fertilizers

T_2 = 100 % through manure (FYM 50% + vermicompost 25% + poultry manure 25%)

T_3 = 75% NPK through inorganic fertilizers + 25 % through manure (FYM)

T_4 = 75 % NPK through inorganic fertilizers + 25 % through manure (vermicompost)

T_5 = 75 % NPK through inorganic fertilizers + 25 % through manure (poultry manure)

T_6 = 75 % NPK through inorganic fertilizers + 25 % through manure (1/3 FYM + 1/3 vermicompost + 1/3 poultry manure)

S_1 = SKAU/002

S_2 = SKAU/008

S_3 = SKAU/024

S_4 = SKAU/040

Table.4 Effect of integrated nutrient management on kernel length (mm), kernel breadth (mm) and kernel weight (g) in walnut

Treatment	Average of 2011 and 2012														
	Kernel length (mm)					Kernel breadth (mm)					Kernel weight (g)				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
T_1	32.68	26.30	28.06	32.91	**29.99**	22.65	23.14	24.42	20.87	**22.77**	6.47	6.73	5.77	6.40	**6.34**
T_2	31.93	25.10	26.50	32.59	**29.03**	22.90	23.08	23.63	21.20	**22.70**	6.38	6.10	5.62	5.80	**5.97**
T_3	32.97	25.96	27.19	33.62	**29.93**	23.02	23.39	24.18	22.02	**23.15**	6.37	6.62	5.78	6.23	**6.25**
T_4	33.94	27.32	27.93	33.91	**30.77**	23.88	24.45	24.39	21.85	**23.64**	7.50	7.45	6.92	6.83	**7.17**
T_5	33.02	26.39	26.83	33.31	**29.89**	23.45	23.75	23.55	20.97	**22.93**	7.21	6.64	6.60	5.99	**6.61**
T_6	31.37	26.50	26.12	32.60	**29.15**	21.96	24.16	23.87	20.66	**22.66**	6.58	6.27	5.88	5.84	**6.14**
Mean	**32.65**	**26.26**	**27.10**	**33.16**		**22.98**	**23.66**	**24.01**	**21.26**		**6.75**	**6.63**	**6.09**	**6.18**	
C.D≤0.05 (S)			**3.62**					**1.14**					**0.21**		
C.D≤0.05 (T)			**NS**					**0.41**					**0.45**		

T_1 = NPK (recommended as per package of practices) through inorganic fertilizers

T_2 = 100 % through manure (FYM 50% + vermicompost 25% + poultry manure 25%)

T_3 = 75% NPK through inorganic fertilizers + 25 % through manure (FYM)

T_4 = 75 % NPK through inorganic fertilizers + 25 % through manure (vermicompost)

T_5 = 75 % NPK through inorganic fertilizers + 25 % through manure (poultry manure)

T_6 = 75 % NPK through inorganic fertilizers + 25 % through manure (1/3 FYM + 1/3 vermicompost + 1/3 poultry manure)

S_1 = SKAU/002

S_2 = SKAU/008

S_3 = SKAU/024

S_4 = SKAU/040

Table.5 Effect of integrated nutrient management on Kernel percentage, Shell/kernel ratio and Kernel protein content (%) in walnut

Treatment	Average of 2011 and 2012														
	Kernel percentage					Shell/kernel ratio					Kernel protein content (%)				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
T_1	56.88	52.32	53.64	52.27	**53.78**	0.75	0.90	0.85	0.92	**0.86**	16.23	16.82	15.47	15.74	**16.06**
T_2	57.01	54.20	53.53	51.59	**54.08**	0.74	0.85	0.83	0.96	**0.84**	14.78	15.48	15.15	14.83	**15.06**
T_3	54.43	52.91	52.66	52.30	**53.07**	0.83	0.88	0.91	0.94	**0.89**	15.21	16.45	16.66	16.39	**16.18**
T_4	58.08	55.53	55.21	53.43	**55.56**	0.72	0.82	0.81	0.88	**0.81**	18.82	18.94	17.61	17.88	**18.31**
T_5	56.81	54.28	54.30	52.50	**54.47**	0.74	0.83	0.84	0.93	**0.84**	17.06	17.9	17.14	17.18	**17.32**
T_6	54.71	53.68	53.76	52.46	**53.65**	0.82	0.86	0.85	0.94	**0.87**	15.42	16.75	15.34	16.18	**15.92**
Mean	**56.32**	**53.82**	**53.85**	**52.43**		**0.77**	**0.86**	**0.85**	**0.93**		**16.25**	**17.05**	**16.23**	**16.37**	
C.D≤0.05 (S)			**1.18**					**NS**					**0.58**		
C.D≤0.05 (T)			**NS**					**NS**					**1.22**		

T_1 = NPK (recommended as per package of practices) through inorganic fertilizers

T_2 = 100 % through manure (FYM 50% + vermicompost 25% + poultry manure 25%)

T_3 = 75% NPK through inorganic fertilizers + 25 % through manure (FYM)

T_4 = 75 % NPK through inorganic fertilizers + 25 % through manure (vermicompost)

T_5 = 75 % NPK through inorganic fertilizers + 25 % through manure (poultry manure)

T_6 = 75 % NPK through inorganic fertilizers + 25 % through manure (1/3 FYM + 1/3 vermicompost + 1/3 poultry manure)

S_1 = SKAU/002

S_2 = SKAU/008

S_3 = SKAU/024

S_4 = SKAU/040

Table.6 Effect of integrated nutrient management on kernel fat content (%), kernel fill (seven point scale) and kernel colour (four point scale) in walnut

Treatment	Average of 2011 and 2012														
	Kernel fat content (%)					Kernel fill (seven point scale)					Kernel colour (four point scale)				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
T_1	57.47	58.13	56.01	56.62	**57.06**	6.02	6.30	6.03	5.87	**6.05**	3.00	3.07	3.18	3.15	**3.10**
T_2	56.11	57.19	54.02	56.03	**55.84**	5.50	5.73	5.73	5.47	**5.61**	3.05	3.07	3.13	3.35	**3.15**
T_3	59.38	59.1	57.1	57.52	**58.27**	5.70	5.97	5.85	5.75	**5.82**	3.13	3.17	3.07	3.17	**3.13**
T_4	61.62	62.99	57.57	59.37	**60.39**	6.04	6.33	6.18	6.05	**6.15**	3.25	3.23	3.28	3.50	**3.32**
T_5	59.01	60.43	57.27	58.28	**58.75**	5.70	5.98	5.87	5.65	**5.80**	3.22	3.32	3.00	3.48	**3.25**
T_6	58.28	58.27	53.65	56.49	**56.67**	5.98	6.03	5.70	5.35	**5.77**	3.12	3.23	3.10	3.32	**3.19**
Mean	**58.64**	**59.35**	**55.94**	**57.38**		**5.82**	**6.06**	**5.89**	**5.69**		**3.13**	**3.18**	**3.13**	**3.33**	
C.D≤0.05 (S)			**1.65**					**NS**					**NS**		
C.D≤0.05 (T)			**1.24**					**0.28**					**NS**		

T_1 = NPK (recommended as per package of practices) through inorganic fertilizers

T_2 = 100 % through manure (FYM 50% + vermicompost 25% + poultry manure 25%)

T_3 = 75% NPK through inorganic fertilizers + 25 % through manure (FYM)

T_4 = 75 % NPK through inorganic fertilizers + 25 % through manure (vermicompost)

T_5 = 75 % NPK through inorganic fertilizers + 25 % through manure (poultry manure)

T_6 = 75 % NPK through inorganic fertilizers + 25 % through manure (1/3 FYM + 1/3 vermicompost + 1/3 poultry manure)

S_1 = SKAU/002

S_2 = SKAU/008

S_3 = SKAU/024

S_4 = SKAU/040

With respect to nut weight S_4 differ significantly from S_1 and S_3 but is statistically at par with S_2. Among different selections S_4 recorded highest kernel length (33.16 mm) followed by S_1 and S_3. Kernel breadth (24.01 mm) was observed maximum in S_3 and minimum in S_4. S_1 showed highest kernel weight (6.75) which differed significantly from S_3 and S_4 but is at par with S_2. Kernel percentage was maximum in S_1 followed by S_3 and S_2. This difference in nut parameters among different selections might be due to their genetic makeup.

Effect of integrated nutrient management on nut quality parameters

The results obtained in present study indicate that kernel protein, kernel fat content and kernel fill were significantly affected by different fertilizer treatments (Table 6). Maximum kernel protein content (18.31%) was found in treatment T_4 which differ significantly from treatments T_1, T_2, T_3 and T_6 but is statistically at par with treatment T_5. The maximum fat content (60.39%) was observed in T_4 followed by T_5 and T_3. The maximum score for kernel fill was recorded in treatment T_4 followed by T_1, T_3, T_2 and T_6. However, effect of fertilizer treatments on was non-significant. The improvement in nut quality might be due to improvement in physical properties of soil and increase growth of micro-organisms (Chattopadhyay, 1994). The maximum kernel protein content in treatment T_4 might be due to the fact that protein is made up of amino acid which is mostly constituent of nitrogen. Treatment T_4 enhanced the uptake of nitrogen which must have assimilated in amino acid and finally into protein. The increase in oil content under combined fertiliser application may be due to increased availability of micronutrients and K that help in converting primary fatty acids to their end products by increased activity of acetyl CO-A. Tekin *et al.,* (1995) also found maximum protein and fat content in combined application of inorganic and organic fertiliser in pistachio. Sharma *et al.,* (2002) also reported higher protein content with the increased total nitrogen in plant. Muzaffar (2004) also found increased fat content in brown sarson with conjoint application of organic and inorganic fertilisers. Similar results were also found by Singh and Pal (2011) in mustard.

Different selections showed marked differences with regard to kernel protein content and maximum protein content was observed in selection S_2 which differed significantly from S_1, S_2 and S_3. Kernel fat content was highest in selection S_2 followed by S_1, S_4 and S_3. However, affect of selections on kernel fill and kernel colour were non-significant. This difference in quality parameters of nut may be due to genetic constitution of individual selections.

Thus it may concluded yield and nut quality of walnut selections could be greatly improved through fertilization of 75% fertilizer through inorganic coupled with 25% vermicompost followed by 75 % NPK through inorganic fertilizers + 25 % through poultry manure. Among the selections, S_2 showed better performance with respect to yield and quality followed by selection S_1.

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