International J. Seed Spices 7(2), July 2017:66-71

Effect of cropping sequence and nutrient management on cumin yield and fertility of soil

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Abstract

An experiment was conducted during *Rabi* season of 2011-12 to 2012-13 to find out the suitable cumin based cropping sequence on yield of cumin and fertility of soil. An experiment was laid out in split plot design with nine treatment combinations *viz.*,three levels each of cropping sequence as in main plot and fertility level as in sub-plot treatments with four replications. The maximum growth, yield and quality attributes were recorded when cumin grown after greengram. Among the different attributes, only number of branches, umbels per plant and test weight were influenced significantly due to different fertility levels. Cumin equivalent yield was higher in green gram – cumin crop rotation over rest of sequences. Application of 100 per cent RDF to *Kharif* crop and 50 per cent to *Rabi* crop recorded the maximum cumin equivalent yield and was statistically near to equal when *Kharif* and *Rabi* crops received 100 per cent RDF. Improvement in soil physical and chemical properties by inclusion of greengram as *Kharif* crop in cropping sequence might be reduced fertilizer requirement of cumin during *Rabi* season. Similarly,the maximum net realizations and BCR values were recorded higher with same the cropping sequence and nutrient application. The maximum uptake of nitrogen and phosphorus by seed were registered under greengram-cumin sequence with application of fertilizer as 100 per cent to *Kharif* and 50 per cent to *Rabi* crops.

Key words : cropping sequence, cumin, nitrogen, phosphorus, potassium

Introduction

Agronomic research has established that proper agronomic management includes the dates of planting, crop rotation, seeding rates and labour demand, as well as fertilizer use (Sumamad, 2004). The cropping systems play an important role in crop diversification and intensification by selecting the important crops and inclusion of cash crop for making the best use of leftover of each crop in synergistic manner (Gill *et al.,* 2014). The yield of crops can be significantly affected by the crop rotation. Including legumes in a rotation usually increases soil nitrogen availability for crops. The best cropping systems should be cost effective, increasing the efficiency of inputs and suit the local climate based on soil, water, temperature and rainfall *etc*. Choice of the component crops needs to be suitably plan to harvest the synergism among them towards efficient utilization of resource base and to increase overall productivity (Anderson,2005). A traditional element of crop rotation is the replenishment of nitrogen through the use of pulses in sequence with other crops. Soil tends to erode less on rotated fields because rotated crops produce more biomass, or crop residue, compared with monoculture systems. North Gujarat Agro climatic Zone is characterized by erratic monsoon with extreme cold winter, hot and dry windy summer. Sesamum, pearl millet, green gram and forage jowar are the important *Kharif* crops, whereas, cumin, fennel, mustard, wheat *etc*. are vital *Rabi* crops, which fulfill the needs of farmer. Cumin is an important short duration and cash but risky crop of these regions and requires less inputs *i.e*. fertilizer, irrigation, labour *etc*. as compared to other *Rabi* crops. Escalating demand-supply gap of fertilizers and harmful effect on soil health necessitate to reduce the use of fertilizer. Application of manures with fertilizers to *Kharif* pulses, cereals and oilseeds not only improve the soil health but reduced fertilizer requirement of succeeding *Rabi* crops also. Therefore, the present investigation on performance of cumin based crop rotation was undertaken with an object to find out best crop rotation for realizing higher system productivity, net return and fertility of soil.

Material and methods

In order to evaluate the nutrient requirement of cumin based cropping sequence an experiment was conducted

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for three consecutive years from 2011-12 to 2013-14 at Seed Spice Research Station, Sardarkrushinagar Dantiwada Agricultural University, Jagudan (Gujarat). Soil texture was loamy sand in nature with low in organic carbon (0.12 per cent), medium in available phosphorus (32 Kg P_2O_5 ha^{-1}) and potassium (255 kg K_2O ha^{-1}). An experiment was laid out in split plot design by comprising three levels each of cropping sequence (Green gram-cumin, Sesame-cumin and Sorghum (forage)-cumin) as in main plot and fertility level as in sub-plot treatments with four replications. The recommended dose of fertilizer used for greengram, sesamum, jowar and cumin crops were 20:40:00, 40:40:00, 80:40:00 and 30:15:00 kg NPK ha^{-1}, respectively. All the recommended cultural operations according to *Kharif* crops and cumin crop were adopted as per needs of crops during crop period. The yields of *Kharif* crops and respective cumin crops were recorded and converted them in to equivalent basis *i.e.* cumin equivalent yield. The treatments of fertility levels under study were implemented as pre-decided doses of RDF. Observations on growth and yield attributes as well as yields were recorded at harvest. Composite soil sample from 0-15 cm soil depth was collected from each treatments in all the three replications. The soil samples were chemically analyzed for available nitrogen, phosphorus and potassium in soil. The estimation of nitrogen and phosphorus in seed was carried out by method of Jackson (1978). The volatile oil content (per cent) of seed was estimated as per steam distillation method (A.O.C.A., 1970). The data have been analyzed for individual years as well as pooled as per standard statistical procedure.

Results and discussion

Growth and yield attributes

Effect of different cropping sequences on growth attributes of cumin was non significant however, yield attributes of cumin were significant only in case of number of umbels per plant and umbellates per umbel (Table 1). The maximum growth and yield attributes were recorded when cumin grown after greengram and these were the minimum under sorghum (F) – cumin crop sequence. Among the different attributes, only number of branches and umbels per plant as well as test weight were influenced significantly due to different fertility levels applied to *Kharif* and *Rabi* crops. All the attributes were the maximum and minimum when *Kharif* and *Rabi* crops received 100 percent RDF + 50 percent RDF (F_1) and 50 percent RDF+ 100 percent RDF (F_3), respectively. Growing of greengram as *Kharif* crop fixed more available nitrogen in soil might

Table 1. Growth and yield attributes, quality, yield and economics of cumin crop as influenced by different cropping sequence and fertility levels (Mean data of three years)

Treatments	Plant height (cm)	Branches plant^{-1}	Umbels plant^{-1}	Umbellates umbel^{-1}	Seeds umbellate^{-1}	Test weight (g)	Volatile oil (%)	Equivalent seed yield (Kg ha^{-1})	Net realization (Rs. ha^{-1})	BCR
Main plot : Cropping sequence										
C1 : Greengram - cumin	26.60	5.30	17.43	5.50	5.98	4.66	4.68	822	47007	1.9
C2 : Sesamum - cumin	26.17	4.97	14.98	5.22	5.85	4.55	4.64	624	25682	1.5
C3 : Sorghum - cumin	26.11	4.89	13.52	5.27	5.91	4.48	4.73	638	28329	1.5
C.D. at 5 %	NS	NS	1.77	0.34	NS	NS	NS	62.0	--	--
C.V. (%)	4.05	15.10	13.83	11.42	12.29	9.56	8.14	9.8	--	--
Sub plot : Fertility (N:P) levels										
F1 :100 per cent RDF + 100 per cent RDF	25.83	5.03	15.09	5.34	5.93	4.62	4.71	709	34576	1.6
F2 :100 per cent RDF + 50 per cent RDF	27.39	5.29	16.49	5.37	6.06	4.64	4.69	712	36745	1.7
F3 : 50 per cent RDF + 100 per cent RDF	25.75	4.83	14.73	5.37	5.75	4.44	4.65	662	30600	1.6
C.D. at 5 %	NS	0.28	0.87	NS	NS	0.16	NS	27.0	--	--
CV %	8.44	11.81	11.87	7.38	12.10	7.59	7.83	8.2	--	--

be readily available to succeeding crop of cumin, enhanced growth and yield attributes positively. The maximum numbers of branches and umbels per plant as well as test weight were recorded when 100 percent RDF given to *Kharif* and 50 percent RDF given to *Rabi* crop (F_2) being at par with the treatment F_1 (100 percent RDF + 100 percent RDF), but significantly higher than under treatment F_3 (50 per cent RDF+ 100 per cent RDF).

Cumin equivalent yield

Effect of different cropping sequences was found significant on cumin equivalent yield (Table 1) and found significantly maximum under green gram – cumin crop sequence. Application of 100 per cent RDF to *Kharif* crop and 50 per cent to *Rabi* crop (F_2) recorded the maximum cumin equivalent yield and was statistically near to equal when *Kharif* and *Rabi* crops received 100 per cent RDF (F_1) were statistically superior than treatment F_3 (50 per cent RDF + 100 per cent RDF). Higher values of growth and yield attributes recorded with this treatments enhances the yield of cumin crop. The rotation benefit in addition to nitrogen effects probably was the result of improved soil physical properties and fewer incidences of diseases and pests. Improvement in available status of nitrogen in soil by inclusion of pulses as *Kharif* crop in cropping sequence might be reduced nitrogen requirement of succeeding cumin and fennel during *Rabi* season. Results are consistent with the results of the work of many researchers. The similar trend was obseved for cumin (SDAU, 2006) and fennel (SDAU, 2007) crops grown successfully after harvesting of different *Kharif* crops viz; groundnut, sesamum, forage Jowar, green gram, cowpea and maize.

Seed yield of cumin

The cumin yield (Table 2) was significantly influenced by different cropping sequence. Seed yield was the significantly highest in greengram-cumin cropping sequence. Different fertility levels did not emerge any significant effect on cumin yield during individual years as well as on polled basis.

Volatile oil

Effect of different cropping sequence as well as fertility levels did not emerge any significant effect on volatile oil content of cumin seed (Table 1).

Economics

The maximum net realizations and BCR values (Table 1) were achieved higher in the greengram – cumin crop sequence and was closely followed by sorghum-cumin sequence. Whereas, these values were the highest when crop was fertilized with 100 per cent RDF to *Kharif* and 50 per cent RDF to *Rabi* crops followed by the treatment 100 per cent RDF to both the crops in sequence.

Chemical study

Uptake of nitrogen

The maximum uptake of nitrogen (Table 3) was recorded

Table 2. Seed yield of cumin crop as influenced by different treatments of cropping sequence and fertility levels

Treatments	Cumin yield (Kg ha^{-1})			
	2011-12	2012-13	2013-14	Pooled
Main plot (Cropping sequence)				
C_1 : Green gram - cumin	501	344	555	467
C_2 : Sesamum - cumin	406	270	417	364
C_3 : Sorghum - cumin	373	271	405	350
SEm ±	7.5	15.2	17.1	12.8
C.D. at 5 %	25.8	52.5	59.1	37.9
C.V. (%)	4.9	15.2	9.2	12.2
Sub plot (Fertility levels)				
F_1 : 100 % RDF + 100 % RDF	438	297	464	400
F_2 : 100 % RDF + 50 % RDF	428	294	479	400
F_3 : 50 % RDF + 100 % RDF	413	293	435	381
S. Em. ±	9.1	12.2	18.9	8.1
C.D. at 5 %	NS	NS	NS	NS
CV%	7.4	14.3	14.2	12.3
Y x C	-	-	-	NS
Y x F	-	-	-	NS
C x F	-	-	-	NS
Y x C x F	-	-	-	NS
CV %	-	-	-	12.3

Table 3. Uptake of nitrogen and phosphorus by crop as influenced by different treatments of cropping sequence and fertility levels (Mean data of three years)

Treatments	Uptake of nitrogen by crop (Kg ha^{-1})				Uptake of phosphorus by crop (Kg ha^{-1})			
	2011-12	2012-13	2013-14	Pooled	2011-12	2012-13	2013-14	Pooled
Main plot (Cropping sequence)								
C1 : Green gram - cumin	13.62	7.15	12.38	11.05	5.31	4.21	5.32	4.95
C2 : Sesamum - cumin	12.88	6.47	11.64	10.33	4.83	3.77	4.56	4.39
C3 : Sorghum - cumin	11.37	5.62	10.67	9.22	4.91	3.33	4.27	4.17
SEm ±	0.48	0.24	0.29	0.12	0.07	0.11	0.10	0.11
C.D. at 5%	1.67	0.85	1.01	0.36	0.25	0.38	0.36	0.33
C.V. (%)	10.67	10.30	8.48	12.04	4.25	8.01	6.32	7.48
Sub plot (Fertility levels)								
F1 : 100 per cent RDF + 100 per cent RDF	12.50	6.72	11.61	10.28	5.01	3.76	4.92	4.56
F2 : 100 per cent RDF + 50 per cent RDF	13.88	6.95	12.21	11.01	5.55	4.01	5.03	4.86
F3 : 50 per cent RDF + 100 per cent RDF	11.50	5.57	10.88	9.31	4.50	3.54	4.20	4.08
S. Em. ±	0.43	0.20	0.34	0.19	0.20	0.12	0.11	0.09
C.D. at 5%	1.28	0.59	1.01	0.55	0.59	0.35	0.33	0.24
CV %	11.79	10.81	10.21	11.45	13.70	10.80	8.13	11.37

Table 4. Soil fertility status as influenced by different treatments of cropping sequence and fertility levels (0-15cm) (Mean data of three years

Treatments	Available nitrogen (Kg ha^{-1})			Available P_2O_5 (Kg ha^{-1})			Available K_2O (Kg ha^{-1})		
	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14
Main plot (Cropping sequence)									
C1 : Green gram - cumin	159	154	158	28.78	27.40	30.15	270	257	264
C2 : Sesamum - cumin	147	145	148	28.44	27.15	27.88	268	257	262
C3 : Sorghum - cumin	142	139	146	26.77	25.01	25.21	269	255	261
SEm +	1	1	1	0.42	0.46	0.74	3.0	2	5
C.D. at 5 %	3	4	5	1.44	1.59	2.54	NS	NS	NS
C.V. (%)	2.08	2.7	2.8	5.00	5.52	8.69	3.84	2.73	7.20
F1 : 100 per cent RDF + 100 per cent RDF	151	146	150	28.51	27.00	28.16	270	260	265
F2 : 100 per cent RDF + 50 per cent RDF	142	140	147	26.43	24.69	25.57	267	255	259
F3 : 50 per cent RDF + 100 per cent RDF	156	151	155	29.05	27.87	29.52	270	254	263
S. Em. ±	1	2	2	0.36	0.66	0.70	3	2	4
C.D. at 5 %	4	5	4	1.06	1.97	2.08	NS	NS	NS
CV %	3.26	4.01	3.5	4.41	8.68	8.64	3.23	2.76	5.63
Initial status	138	137	142	27	24	26	268	247	255

by adopting greengram-cumin sequence during individual years under study and in pooled data, being at par with the crop sequence sesamum - cumin crops. This might be due to higher cumin equivalent yield produced under these treatments. However, it was the minimum with sorghum - cumin sequence. Application of fertilizer as 100 per cent to *Kharif* and 50 per cent to *Rabi* crops recorded significantly higher uptake during 2011-12 and on pooled basis.

Uptake of phosphorus

Uptake of phosphorus was considerably inclined by different treatments of cropping sequence and fertility levels (Table 3).The highest uptake of phosphorus was recorded by green gram-cumin crop sequence in all the years of experimentation and on pooled basis. Fertilizer levels influence significantly on phosphorus uptake during course on investigation and on pooled basis. The maximum uptake was recorded when fertilizer applied at 100 per cent to *Kharif* and 50 per cent *Rabi* crops during all the years and on pooled basis and was at par with 100 per cent to *Kharif* and 100 per cent *Rabi* crops except in pooled data, but significantly higher than rest of the treatments. The maximum uptake of phosphorus by green gram-cumin cropping along with fertilizer applied at 100 per cent to *Kharif* and 50 per cent *Rabi* crops might be due higher cumin seed yield.

Soil fertility status

The soil fertility status was significantly influenced by different cropping sequences and fertility levels during individual years and on pooled basis (Table 4). Significantly the highest available nitrogen was recorded under green gram-cumin crop sequence during individual years. Application of fertilizer at 50 per cent to *Kharif* + 100 per cent *Rabi* crop and 100 per cent to *Kharif* + 100 per cent RDF to *Rabi* crops were recorded maximum available nitrogen over rest of the treatments during all the years of experimentation. The available phohprous content was significantly higher under treatment green gram-cumin crop sequence and was remained at par with sesame-cumin crop sequence during all the years of experimentation. Application of 50 per cent to *Kharif* and 100 per cent *Rabi* crops recorded maximum content of phosphorus over all the treatments except when crop was fertilized with 100 per cent to *Kharif* and 100 per cent to *Rabi* crops. Availability of nutrients in soil under these treatments might be due to inclination of pulses in crop rotation. Availability of potassium was not significantly influenced by different cropping sequences as well as fertility levels during all the years of experimentation. But greengram – cumin crop sequence and application of 100 per cent RDF to the both crops improve potash content.

Conclusion

Thus it can be inferred that a cumin grown after green gram crop fertilized with 100 per cent RDF to *Kharif* (Green gram) and 50 per cent RDF to *Rabi* (Cumin) maintain the soil fertility and health status, also enhance the productivity and quality of produce. Additionaly, under this cropping sequence there is 50 per cent saving of RDF for cumin crop in *Rabi* season.

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Received : April 2017; Revised : June 2017; Accepted : June 2017.