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Determination of optimum rates of nitrogen and phosphorus fertilization for white cumin (*Trachyspermum ammi (I) sprague*) in Takusa Woreda of North Gondar Zone

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Abstract- Cultivation practices of white cumin (ajowan) particularly nutrient requirement differ to a certain extent in various soil and climatic conditions. A field experiment was conducted during 2007 to 2008 to determine economically feasible rate of nitrogen and phosphorus fertilization on white cumin. A treatments consisted of 4 nitrogen rates (0, 15, 30 and 45kg/ha) and 4 phosphorus rates (0, 10, 20 and 30kg/ha) was laid out in randomized complete block design with three replications planted at two locations per year. The seeds were sown in the second week of July and harvested on the last week of December. Data on plant height, and seed yield. Statistical analysis was carried out using SAS Statistical Software V8. The pooled data revealed that 45/30 N/P_2O_5 kg/ha fertilization recorded highest yield (whole part grounded) of 4.5t/ha over the unfertilized (2.7t/ha). Application of 45/30 N/P_2O_5 kg/ha gave highest net benefit (12122birr/ha) with acceptable marginal rate of return (208). Sensitivity analysis also revealed that 45/30 NP application gave the highest net benefit (9281birr/ha) with acceptable marginal rate of return (105). Fertilizer rate of 45/30 N/P_2O_5 kg/ha were economical rate and recommended to Takusa and similar white cumin growing areas based on this research output, but to come up with optimum rates, further study will be conducted of higher rates of nitrogen and phosphorus fertilizers.

Index Terms- White cumin, seed yield, economic analysis

I. INTRODUCTION

The great mystery and beauty of spices is their use, blending and ability to change and enhance the character of food. Spices and condiments have a special significance in various ways in human life because of its specific flavors, taste, and aroma. They play an important role in the national economies of several spice producing, importing and exporting countries (NIIR Board of Consultants and Engineers, 2006). The contribution of spice to the Ethiopian economy is not significant however the past four years (2001-2004) export trained from 3.7 to 6.8 million USD is an encouraging progress (Johannes, 2005).

White cumin (*Trachyspermum ammi* [L.] *sprague*) described as erect, smooth or slightly hairy branched annual, reaching a height of 0.9-1.6 m, small white flowers in compound umbels bearing grayish-brown aromatic seeds. The flowers are hermaphrodite, the plant is self-fertile. It is an annual herb, flowering after 90-120 days after sowing and ready for harvest after 150-180 days. Originated in Eastern Mediterranean, may be Egypt. In Ethiopia, cumin is often grown together with barley and teff at altitudes between 1700-2200 m (Johannes, 2005).

The main cultivation areas today are Persia and India, but the spice is of little importance in global trade. It enjoys, however, some popularity in the Arabic world and is found in *berbere*, a spice mixture of Ethiopia which both shows Indian and Arabic heritage. Its leaves, stems and roots are aromatic. It is used whole or ground and has a natural affinity with starchy foods, such as root vegetables, legumes, breads, snacks and green beans. Aliza (2006) reported white cumin makes starch and meats easier to digest and is added to legumes to prevent gaseous effects. The fruits find its use as an antispasmodic, anti-flatulent, anti-rheumatic, diuretic and antimicrobial (Malhotra and Vashishta, 2004).

Channabasavanna (2008) found increase in fertilizer levels from 20:10:10 to 40:20:20 NPK kg/ha increased the seed yield of ajowan significantly during individual years and pooled analysis. Further increase in fertilizer levels to 80:40:40 NPK kg/ha did not increase the seed yield (475 kg/ha). The highest net returns (Rs. 2840/ha) and B: C ratio (1.77) were recorded in 40:20:20 NPK kg/ha. Krishnamurthy (1998) recorded higher growth and yield of yield at higher nitrogen (100 kg/ha) and phosphorus (50 kg/ha) levels.

Cultivation practices of cumin, particularly spacing and nutrient requirement differs to a certain extent in various parts of India according to soil and climatic conditions. Cumin being a comparatively new crop, its response to spacing and fertilizer and its impact on productivity and profitability in dry lands needs to be studied (Channabasavanna, 2008). With these back ground the investigation to determine economically feasible rate of nitrogen and phosphorus fertilization was under taken.

II. MATERIALS AND METHODS

A field experiment was conducted at Takusa District, Delgi under moist land conditions during 2007-08 to 2008-09at Takusa Woreda located at 12º10´N and 37 º01´E with an altitude of 1780 m a.s.l. The dominant soil type of the area is light vertisol. The Woreda received an annual rain fall of 730mm. The average temperature of the areas was 21.65º C. The treatments consist of 4 nitrogen rates (0, 15, 30 and 45kg/ha) and 4 phosphorus rates

(0, 10, 20 and 30kg/ha). These treatments were tested in randomized complete block design with three replications planted at two locations per year. The seeds were sown in the second week of July and harvested on the last week of December. The statistical analysis was carried out using SAS Statistical Software V8. Least Significance Difference (LSD) test was used to compare the means of treatments.

Partial budget analysis was made following CIMMYT methodology (CIMMYT, 1988). The cost of and pod were used for the benefit analysis. Marginal rate of return was calculated as change of benefit divided by change of cost. To assess the costs and benefits associated with different treatments the partial budget technique as described by CIMMYT (1988) was applied on the yield results. The economics were calculated based on the market rates prevailing at the current situation (May, 2009 market price). Cost of produce is 3.25Birr/kg, cost of DAP 8.75Birr/kg and cost of urea 6.50Birr/kg. All costs and benefits were calculated on hectare basis in Ethiopia birr (Birr ha-1).

Marginal rate of return (MRR), was calculated by the following formula:

$$MRR\ (\text{between treatments, a \& b}) = \frac{\text{Change in NB (NBb-NBa}}{\text{Change in TCV(TCVb - TCVa)}} \times 100$$

Thus, a MRR of 100% implies a return of one birr on every birr of expenditure in the given variable input.

III. Results and Discussion

The analysis of variance (Table 1) indicated that the fertilizer response mean square values were significant for the three parameters, implying that the application of Nitrogen and phosphorus fertilizer were highly significant difference for the tested parameters. The coefficient of variation ranged from 9.57 % for plant height (cm) to 14.17 % for seed yield.

Table 1. Analysis of variance on yield of white cumin at Takusa

Source of variation	Plant Height (cm)	**Biomass Yield**	**Seed yield**
Year	NS	**	**
Site	**	**	NS
N/P_2O_5 fertilizer	**	**	**
Year * Site	**	**	**
Year * N/P_2O_5 fertilizer	NS	*	**
Site * N/P_2O_5 fertilizer	NS	NS	**
Year * Site * N/P_2O_5 fertilizer	NS	*	**
Mean value	49.1	34.78	13.14
Least Significant Difference	3.8	3.09	1.5
CV (%)	9.57	11.01	14.17

NS= non significant difference, ** significant at 1% probability level and * significant at 5% probability level

Plant Height

The effective treatments on increasing plant height were fertilization at 45/30kg/ha N/P_2O_5 which produced the highest plant height of 53.9cm (Table 2). Plant height has a positive relation with yield, number of branch and other yield contributing traits.

Yield

Nitrogen phosphorous fertilization significantly influences the yield of white cumin during all the years, sites and pooled analysis (Table 1). The pooled data revealed that 45/30 N/P_2O_5 kg/ha fertilization recorded significantly highest yield of 4.5t/ha over the unfertilized 2.7t/ha (Table 2). Increase in fertilizer levels from 0: 0: to 45:30NP kg/ha increased the yield of white cumin significantly during pooled analysis. The obtained results are in line with those obtained by Abdel-El-Latif (1999) on *Pimpinella anisum* L. and Swaefy (2002) of *Trachyspermum ammi* L. This may assure the need of the NP elements to enhance the metabolic processes, which reflect on growth and flowering.

Seed yield

Seed yield of white cumin was significantly influenced by growing environment, year and fertilizer rate (Table2). The maximum yield of 1.91t/ha was produced from treatments received 43/30kg/ha N/P_2O_5 whereas the unfertilized treatment gave a yield of 0.73t/ha. Seed yield increases progressively as the rate of NP increases. Krishnamurthy (1998) recorded higher growth and yield of ajowan at higher nitrogen (100 kg/ha) and phosphorus (50 kg/ha) levels. On the other hand further increase in fertilizer levels to 80:40:40 NPK kg/ha did not increase the seed yield (Channabasavanna, 2008)

Economic Analysis

Application of 45/30 N/P_2O_5 kg/ha gave highest net benefit (12122birr/ha) with acceptable marginal rate of return (208). Sensitivity analysis also revealed that 45/30 NP application gave the highest net benefit (9281birr/ha) with acceptable marginal rate of return (105). Thus fertilization at the rate of 45/30 N/P_2O_5 kg/ha is economically feasible both at the current situation and in the future until the price of the produce decreased by 20% and the input price increased by 20%.

IV. Conclusion and Recommendation

In all the treatments significant difference was observed across the year and sites. Fertilizer rate of 45/30 N/P_2O_5 kg/ha were economical rate and recommended to Takusa and similar white cumin growing areas. Further study on time of application, seed rate and sowing date shall to be conducted.

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Author Profile

Mr. Tesfaye Wossen received his B.S c. and MSc. degrees in Plant Sciences and Agronomy at Haramaya University of Ethiopia in 2001 and 2010, respectively. He has worked at Ministry of Agriculture as a crop expert at Guangua district of Awi Adminstrative Zone of Amhara Region, and Amhara Agricultural Research Institution at Gondar Agricultural Research Center as an agronomy researcher. Right now he is working as a lecturer and researcher at College of Agriculture and Rural Transformation, University of Gondar since August 2013. The author teaches the courses field crop production, research methods in plant sciences and drought and risk management for undergraduate plant sciences and other department students. His research interests are climate and crop production in field crops.

Table 2. Response of yield and other agronomic traits to NP fertilizer application on white cumin

N / P_2O_5 (kg/ha)	Plant Height (cm)	Yield (qt/ha)	Seed yield (qt/ha)
0/0	47.5^{CDE}	27^{I}	7.3^{L}
0/10	$44.^{7E}$	29^{HI}	9.4^{K}
0/20	45.7^{DE}	29^{HI}	10.6^{JK}
0/30	46.4^{DE}	32^{FGH}	11.6^{HIJ}
15/0	46.2^{DE}	31^{FGH}	10.5^{JK}
15/10	47.4^{CDE}	30^{HI}	11.5^{HIJ}
15/20	47.6^{CDE}	30^{HI}	10.9^{IJ}
15/30	48.1^{BE}	33^{EFG}	12.9^{FGH}
30/0	48.6^{BE}	34^{EF}	13.1^{EF}
30/10	50.3^{ABC}	35^{ED}	12.3^{GHI}
30/20	51.7^{AB}	38^{C}	14.8^{DE}
30/30	50.5^{ABC}	39^{BC}	16.0^{CD}
45/0	50.8^{AB}C	39^{BC}	14.4^{EF}
45/10	51.9^{AB}	41^{B}	17.4^{AB}
45/20	53.9^{A}	41^{B}	17.9^{BC}
45/30	53.9^{A}	45^{A}	19.4^{A}
Mean	49.1	35	13.14
LSD	3.8	3	1.5
CV (%)	9.57	11.01	14.17

Table 3.Economic analysis of NP fertilizer application on white cumin at Takusa

N / P_2O_5 (kg/ha)	Current situation (Biological yield)			Sensitivity (Biological yield)		
	TVC(Birr)	NB(Birr)	MRR (%)	TVC(Birr)	NB(Birr)	MRR (%)
0/0	0	7898		0	6318	
15/0	157	8911	645	188	7066	397
0/10	190	8292D		228	6558D	
30/0	313	9632	460	376	7580	273
15/10	347	8428D		416	6604D	
0/20	380	8102D		457	6329D	
45/0	470	10938	6148	564	8562	522
30/10	504	9734D		604	7586D	
15/20	537	8238D		645	6375D	
0/30	571	8789D		685	6803	
45/10	660	11332	208	792	8802	105
30/20	694	10421D		833	8059D	
15/30	727	8925D		873	6849D	
45/20	850	11142D		1021	8573	
30/30	884	10524D		1061	8065D	
45/30	1041	12122	208	1249	9281	105

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