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Effect of Variety, Levels of Fertilizer and Bio-fertilizer on Growth and Yield of Cumin (*Cuminum cyminum* L.)

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ABSTRACT

A field experiment was conducted during *rabi*, 2017-18 on loamy sand soil at Agronomy Instructional Farm, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to evaluate the effect of variety, chemical fertilizer and bio-fertilizers on growth and yield of cumin. Twelve treatment combinations comprising of two varieties (GC 3 and GC 4), two levels of fertilizer (100% and 50% RDF) and three levels of biofertilizers (*Azotobacter* + PSB, *Azospirillum* + PSB and NPK consortium) were laid out in randomized block design (factorial) with four replications. Significantly higher growth attributes (plant height at harvest and number of branches/plant), yield attributes (number of umbels/plant, number of umbellates/umbel, number of seeds/umbellate, test weight and harvest index) and seed and straw yield (kg ha^{-1}) were found when cumin variety GC 4 was fertilized with 100% RDF and inoculated with *Azospirillum* + PSB.

Introduction

Seed spices are known as an integral part of Indian culture that's why India is known as home of spices. The seed spices are annual herbs, whose dried seeds are known as spices and widely used in culinary, confectionary, perfumery, cosmetics and pharmaceutical industries. Cumin is extensively cultivated in India. Cumin aldehyde or cuminol is 36.31 per cent in cumin which attributes the specific value added aroma. It has carminative, stomatic, anti-diarrheal and dyspecial medicinal properties. Cumin occupies 47.0 per cent of total seed spices area but accounts for 35.7 per cent of total seed spices production in the country. Among different factors known to augment crop production, identification of new genotype having wider adaptability and responsiveness to input are considered essential for exploiting higher yield potential. The identification of such high yielding adaptable varieties as per crop growing situation is considered to be first and foremost step for development of production technology. This study will help in replacing older variety with newer one. It is an established fact that potential of the genotype is realised to the fullest extent when it is grown under optimum environment. Plant nutrients play specific and important role in growth and development of a plant. Adequate mineral fertilization is considered to be one of the most important pre-requisites in this respect. Nitrogen plays a key role in the synthesis of chlorophyll and amino acids, which contributes to the building units of protein and thus growth of plant. It also helps in early establishment of leaf area capable of photosynthesis and increased root development to enable more efficient use of water. Next to nitrogen, phosphorus is of paramount importance in crops for increasing yield. Phosphorus, apart from its role in root development and nodule formation, plays an important role in energy transfer in the living cell by means of high phosphate energy bonds ATP and ADP (Havlin *et al.,* 2003). Therefore, there is need to workout optimum combination of nitrogen and phosphorous for cumin. In recent years the rise in price of chemical fertilizers, scarcity of organic manures and poor nutrient use efficiency has led to search some alternative source of nutrition.

Biofertilizers facilitate economizing fertilizer nutrient use through utilizing BNF system, solubilising less mobile nutrients from fixed components and recycling of nutrients from crop residues. It is evidently clear that application of biofertilizers enhances the accumulation of soil enzymes, which is directly reflected on soil fertility index. The proper use of biofertilizers to crop not only provides economic benefit to the farmers, but also helps to improve and to maintain soil fertility and sustainability in natural ecosystem.

Materials and Methods

The present investigation was conducted during the *rabi* season in 2017-18 at Agronomy Instructional Farm of Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Dantiwada. It is situated in the North Gujarat Agro-climatic Zone. The soil of research farm was loamy sand in texture, poor in fertility and water holding capacity, having pH 7.61, EC 0.11 dS/m; low in organic carbon (0.31 %) and available N (136.56 kg/ha) and medium in available P_2O_5 (43.41 kg/ha) and K_2O (253.02 kg/ha). The experiment comprising of two varieties (GC 3 and GC 4) along with two levels of fertilizer (100 % RDF and 50 % RDF) and three levels of biofertilizers (*Azotobacter* + PSB, *Azospirillum* + PSB and NPK consortium) were applied in 12 different combinations (Table 1). The treatments were evaluated und randomized block design (factorial) with four replications. Seeds of cumin variety GC 3 and GC 4 were developed by Main Seed Spices Research Station, Jagudan. N and P_2O_5 applied through urea and DAP, respectively.

The seeds were inoculated with respective strains of *Azotobacter*, *Azospirillum*, PSB and NPK consortium @ 25 ml/kg seed according to the treatment procured from Department of Microbiology, Anand Agricultural University, Anand. The crop was raised as per standard recommended cultural practices. Cumin was sown on 8th November with seed rate of 10 kg ha^{-1} at 30 cm line spacing by broadcasting and harvested in last week of February. The data recorded during the course of investigation were subjected to statistical analysis as per method of analysis of variance (Panse and Sukhatme, 1978).

Results and Discussion

Effect of variety

Data presented in Table 2 indicated that different treatments had a significant influence on growth attributes, yield attributes and yield of cumin. Significantly higher plant height (28.66 cm) and number of branches/plant (7.79) were recorded with GC 4 as compared to GC 3 because it is a varietal character. Inherent characteristic of particular variety plays a vital role on growth and development of crop which might be responsible for plant growth in terms of plant height and number of branches/plant. These findings are in accordance with the results reported earlier by Singh *et al.,* (2003), Anonymous (2010) and Sengupta *et al.,* (2014) in fennel.

Variety GC 4 recorded significantly more yield attributes *viz*., number of umbels/plant (30.04), number of umbellate/umbel (5.79), number of seeds/umbellate (5.96), test weight (4.667 g), harvest index (37.92 %); seed yield (437 kg/ha) and straw yield (716 kg/ha) as compared to GC 3. The higher yield attributing characters recorded under GC 4 variety might be due to genetic potential of particular variety. Similar results were also observed by Singh *et al.,* (2003), Anonymous (2010) and Sengupta *et al.,* (2014) in fennel and Rawal *et al.,* (2014) in cumin. Better vegetative and reproductive growth of GC 4 is attributed to inherent build up and thereby produced higher number of umbels/plant, umbellate/umbel, seeds/umbellate and test weight. These components play a vital role and showed significant positive correlation with seed yield. Results are in concurrence with those of reported earlier by Anonymous (2010) and Meena and Singh (2013) in fennel and Rawal *et al.,* (2014) in cumin. The difference in yield at different locations might be due to the genotypic differences and ecological variations. Similar results were also reported by Phurailatpam *et al.,* (2016) in coriander.

Effect of levels of fertilizer

Significantly higher plant height (27.95 cm) and number of branches/plant (7.67) were recorded with An application of 100% RDF as compared to 50% RDF because it is a varietal character. The significant rise in growth parameters noticed under higher fertilizer level may be ascribed to the greater uptake of nutrients by the plants favoring better cell division, elongation, amino acid and protein synthesis and it might have produced more plant height, number of branches and plant dry matter production compared to lower fertilizer level. Similar finding was reported by Kumar *et al.,* (2015) in fenugreek.

An application of 100% RDF recorded significantly more yield attributes *viz*., number of umbels/plant (30.29), number of umbellate/umbel (5.54), number of seeds/umbellate (6.13), harvest index (37.19 %); seed yield (424 kg/ha) and straw yield (714 kg/ha) as compared to 50% RDF. Nitrogen and phosphorus fertilization plays a vital role in improving nutritional status of plant in both vegetative and reproductive part. These improvements suggest greater availability of metabolites and nutrients synchronized to demand for growth and development of each reproductive structure. These findings are in accordance with the results of Kumar *et al.,* (2009) in fenugreek. With increased supply of nitrogen, the process of tissue differentiation from somatic to reproductive meristemic activity and development of floral premordia might have increased, resulting in more yield attributing characters. The results are in close agreement with the findings reported by Bedse *et al.,* (2013) in cumin. The application of 100%

RDF probably ensured sufficient supply of nitrogen and phosphorus to plants for development of yield attributes, which ultimately resulted into higher seed and straw yield. These results confirm the findings of Jat *et al.,* (2012) in green gram. Nitrogen availability depends more or less on phosphorus. Phosphorus enhanced the symbiotic nitrogen fixation in legumes and ultimately improves the uptake of nutrients. Our results are in conformity with those reported by Verma *et al.,* (2014) in cowpea.

Effect of levels of biofertilizer

Significantly higher plant height (28.12 cm) and number of branches/plant (7.75) was recorded with an inoculation of *Azospirillum* + PSB. The growth regulators like NAA and cytokinnins released by biofertilizers might have resulted in breaking of apical dominance and accelerated higher number of branches. These findings are in accordance with the results of Gudadhe *et al.,* (2005) in brown sarson.

An inoculation of *Azospirillum* + PSB recorded significantly more yield attributes *viz*., number of umbels/plant (30.50), number of umbellates/umbel (5.75) and number of seeds/umbellate (6.06); seed yield (433 kg/ha) and straw yield (750 kg/ha). Significantly higher harvest index (37.19 %) was observed under inoculation of *Azotobacter* + PSB. The seed inoculation with bacterial mixtures provided more nutrition for the plants and the improvement in root uptake of both nitrogen and phosphorus as a balance result of mechanism of interaction between nitrogen fixing and phosphate solubilising bacteria, which ultimately contributed into higher yield and yield attributing characters. Similar results were observed by Aishwath *et al.,* (2012) in coriander. The increase in seed yield might be attributed to the fixation of atmospheric nitrogen production of biologically active compounds like organic siderophores which regulate the availability of nutrients to the crop. The positive influences as recorded in yield contributing characters under these treatments were manifested in the seed yield. Similar findings were reported by Gudadhe *et al.,* (2005) in brown sarson.

Table.1 Treatment details

Varieties (V) :
V_1 = GC 3
V_2 = GC 4
Levels of fertilizer (F) :
F_1 = 100% RDF (40:15:0, N:P_2O_5:K_2O,kg/ha)
F_2 = 50% RDF (20:7.5:0, N:P_2O_5:K_2O,kg/ha)
Biofertilizers (B) :
B_1 = *Azotobacter* + PSB
B_2 = *Azospirillum* + PSB
B_3 = NPK consortium

Table.2 Effect of variety, levels of fertilizer and biofertilizers on growth and yield of cumin

Treatments			Plant height at harvest (cm)	Number of branches /plant	Number of umbels / plant	Number of umbellates / umbel	Number of seeds/ umbellate	Test weight (g)	Seed yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)
Varieties (V) :											
V_1	:	GC 3	25.26	6.58	27.83	4.79	5.29	4.205	356	640	35.72
V_2	:	GC 4	28.66	7.79	30.04	5.79	5.96	4.667	437	716	37.92
S.Em. ±			0.44	0.18	0.60	0.15	0.60	0.138	12.1	21.1	12.1
C.D. at 5 %			1.26	0.51	1.72	0.43	1.72	0.397	34.7	60.7	34.7
Levels of fertilizer (F) :											
F_1	:	100% RDF	27.95	7.67	30.29	5.54	6.13	4.634	424	714	37.19
F_2	:	50% RDF	25.97	6.71	27.58	5.04	5.13	4.238	370	643	36.45
S.Em. ±			0.44	0.18	0.60	0.15	0.60	0.138	12.1	21.1	12.1
C.D. at 5 %			1.26	0.51	1.72	0.43	1.72	NS	34.7	60.7	34.7
Biofertilizers (B) :											
B_1	:	*Azotobacter*+ PSB	27.03	7.13	29.00	5.25	5.50	4.467	395	657	37.44
B_2	:	*Azospirillum*+ PSB	28.12	7.75	30.50	5.75	6.06	4.518	433	750	36.54
B_3	:	NPK consortium	25.72	6.69	27.31	4.88	5.31	4.323	362	628	36.47
S.Em. ±			0.54	0.22	0.73	0.18	0.73	0.169	14.8	25.9	14.8
C.D. at 5 %			1.55	0.63	2.11	0.53	2.11	NS	42.5	74.4	42.5
Interaction :											
V × F			NS	NS	NS	NS	NS	NS	NS	NS	NS
V × B			NS	NS	NS	NS	NS	NS	NS	NS	NS
F × B			NS	NS	Sig.	Sig.	NS	NS	**Sig.**	**Sig.**	**Sig.**
V × F × B			NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %			8.0	12.1	10.1	13.9	13.0	17.2	14.9	15.2	1.6

Table.3 Interaction effect of levels of fertilizer and biofertilizers on seed yield of cumin

Treatments	F_1 : 100% RDF (40:15:00 $N:P_2O_5:K_2O$ kg/ha)	F_2 : 50% RDF (20:7.5:00 $N:P_2O_5:K_2O$ kg/ha)
B_1 : *Azotobacter*+ PSB	422	367
B_2 : *Azospirillum*+ PSB	493	373
B_3 : NPK consortium	356	368
S.Em. ±	20.9	
C.D. at 5 %	60.1	

Table.4 Interaction effect of levels of fertilizer and biofertilizers on straw yield of cumin

Treatments	F_1 : 100% RDF (40:15:00 $N:P_2O_5:K_2O$ kg/ha)	F_2 : 50% RDF (20:7.5:00 $N:P_2O_5:K_2O$ kg/ha)
B_1 : *Azotobacter* + PSB	651	663
B_2 : *Azospirillum*+ PSB	851	648
B_3 : NPK consortium	639	617
S.Em. ±	36.6	
C.D. at 5 %	105.2	

Table.5 Interaction effect of levels of fertilizer and biofertilizers on harvest index of cumin

Treatments	F_1 : 100% RDF (40:15:00 $N:P_2O_5:K_2O$ kg/ha)	F_2 : 50% RDF (20:7.5:00 $N:P_2O_5:K_2O$ kg/ha)
B_1 : *Azotobacter* + PSB	39.32	35.57
B_2 : *Azospirillum* + PSB	36.59	36.49
B_3 : NPK consortium	35.66	37.29
S.Em. ±	0.21	
C.D. at 5 %	0.61	

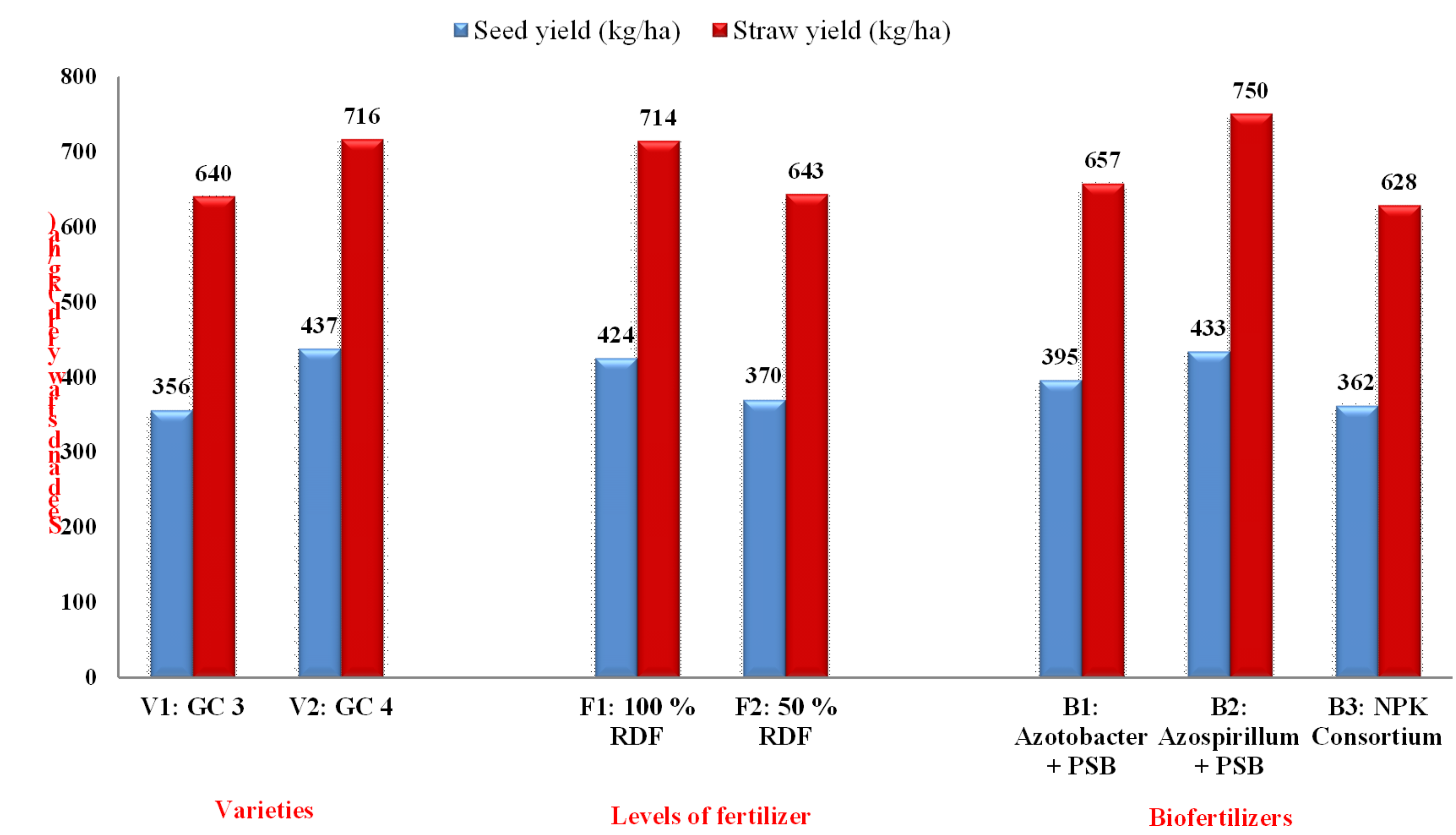

Fig. 1 : Effect of varieties, levels of fertilizer and biofertilizers on seed and straw yield (kg/ha)

Interaction effect

Data presented in Table 3 and 4, Significantly higher seed yield (493 kg/ha) and straw yield (851 kg/ha) were obtained under 100% RDF and seeds inoculated with *Azospirillum* + PSB. The profound influence of nitrogen and phosphorus fertilization and inoculation with *Rhizobium* + PSB biofertilizers on biological yield mediated via increased photosynthetic efficiency and nutrient accumulation might have ultimately led to the production of higher yield under its application. The interactive advantages of combining fertility levels and bio-fertilizers generally proved superior. This might be due to synergistic effects of both and enhanced plant growth by promoting the merismatic activity, which favours plant growth and finally leaf and seed yield. Similar results were reported by Mehta *et al.*, (2012) in fenugreek and Singh *et al.*, (2012) in kasuri methi.

Significantly higher harvest index (39.32 %) was recorded under 100% RDF and seeds inoculated with *Azotobacter* + PSB (Table 5). An application of 100% RDF with *Rhizobium* + PSB inoculation in combination under kasuri methi crop recorded significantly higher harvest index over control and rest of treatments. This is in close accordance with the findings of Singh *et al.*, (2012) in kasuri methi and Mehta *et al.,* (2012) in fenugreek.

In the view of the results obtained from the present investigation, it can be concluded that for securing higher seed yield from cumin (*Cuminum cyminum* L.) raised on loamy sand soil, the cumin variety GC 4 should be fertilized with 100% RDF (*i.e.* 40:15:00 kg NPK/ha) along with seed inoculation with *Azospirillum* + PSB @ 25 ml/kg seed each.

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