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RESPONSE OF FERTILIZER AND WEED MANAGEMENT ON BLACK CUMIN

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Abstract

The experiment was conducted at Agronomy research field of Bangladesh Agricultural Research Institute, Gazipur during 2018-2019 and 2019-20 to find out the optimum fertilizer dose and appropriate weed management method for getting higher yield and economic return of black cumin. The treatments were T_1= STB (Soil test basis fertilizer dose, FRG, 2018) 60-24-49-13-0-1 kg ha^{-1} of N- P- K- S- Zn- B and two hand weeding at 30 days after emergence (DAE) and 50 DAE of black cumin, T_2= STB + 25% of N-P-K kg ha^{-1} and two hand weeding at 30 DAE and 50 DAE of black cumin, T_3= STB + 50% of N-P-K kg ha^{-1} and two hand weeding at 30 DAE and 50 DAE of black cumin, T_4= STB and two hand spading at 30 DAE and 50 DAE of black cumin, T_5= STB + 25% of N-P-K kg ha^{-1} and two hand spading at 30 DAE and 50 DAE of black cumin ,T_6= STB + 50% of N-P-K kg ha^{-1} and two hand spading at 30 DAE and 50 DAE of black cumin and T_7 = Native nutrient and no weeding (Control). The highest weed control efficiency % (WCE) 83.68 and 85.23% at 30 DAE of black cumin and 93.62% and 92.57% at 50 DAE of black cumin was found in T_3 treatment (Two hand weeding at 30 DAE of black cumin and 50 DAE of black cumin with STB + 50% of NPK kg ha^{-1} fertilizer dose) in 2018-2019 and 2019-2020, respectively followed by T_2 (82,35 to 82.74% and 92.24 to 91.24%) treatment at 30 and 50 DAE of black cumin and in 2018-19 and 2019-20 respectively. Results showed that treatment T_3 (STB + 50% of N-P-K kg ha^{-1} and two hand weeding at 30 and 50 DAE of black cumin) produced the highest seed yield 953.75 kg ha^{-1} but in case of higher benefit cost ratio 2.69 was obtained from T_4 treatment (soil test basis fertilizer dose: 60-24-49-13-0-1 kg ha^{-1} of N-P-K-S-Zn-B kg ha^{-1} and two hand spading at 30 and 50 DAE of black cumin) due to lower cost of production.

Introduction

Black cumin (*Nigella sativa*), known as Kalozira, is one of the important spice crops (Abadi *et al.*, 2015) in Bangladesh, it is popular among the people for serving a wide range of medicinal purposes. It is widely cultivated throughout South Europe, Syria, Egypt, Saudi Arabia, Iran, Pakistan, India and Turkey (Riaz *et al.*, 1996). The seed contain 30-35% of oil which has several uses for pharmaceutical and food industries (Ustun *et al.*, 1990). The ripe seed contains 23% protein, 0.39% fat, 4.99% starch and 5.44% raw fiber (Zargari, 1990). Among the seed spices grown, black cumin or *Nigella* is considered as a miraculous spice having very important medicinal values apart from its intrinsic flavor (Aliyu, 2003). It is also appreciated as magical herb for its ability to treat allergies, asthma, and immune disorders (Naz, 2011). For these reasons, there is a great demand of black cumin in consumer level. In Bangladesh, winter season is the favorable environment for the black cumin cultivation. Crop management factors such as fertilizer and weed management are essential to increase yield and quality of seed (Singh and Goswami, 2000). Weed control reduce potential environmental contamination and will reduce crop weed completion and ultimately increase the yield as well as black cumin yield (Nadeem *et al.*, 2013). Now a day, people become conscious about their health and as a result this type of ayurvedic medicinal and rare condiments is in great demand and has thus become a paying cash crop. To meet its increasing demand the productivity must be increased. Hence, the experiment was conducted to find out optimum fertilizer dose and appropriate weed management practice for obtaining higher yield and economic return.

Materials and Methods

The experiment was conducted at the research field of Agronomy Division BARI, Joydebpur, Gazipur during *rabi* season of 2018-19 and 2019-20, respectively. The soil of the research area belongs to AEZ-28. The soil was clay loam with pH 6.3. Soil samples of the experimental plots were collected and analyzed. The chemical properties of experimental soil are presented in Table 1.

Table 1. Chemical properties of experimental soil (initial)

pH	OM (%)	Total N (%)	Available P (g mL^{-1})	Exchangeable K (meq 100g^{-1} soil)	Available S (g mL^{-1})	Available Zn (g mL^{-1})	Available B (g mL^{-1})
6.3	1.910	0.092	7.750	0.079	8.400	1.620	0.175
	VL	L	L	VL	L	O	L
Critical levels		-	7.0	0.12	10.00	0.60	0.20

L= Low, VL= Very low, O = Optimum

Seven treatments viz., T_1= STB (Soil test basis fertilizer dose, FRG, 2018) 60-24-49-13-0-1 kg ha^{-1} of N- P- K- S- Zn- B and two hand weeding at 30 days after emergence (DAE) and 50 DAE of black cumin, T_2= STB + 25% of N-P-K kg ha^{-1} and two hand weeding at 30 DAE and 50 DAE of black cumin, T_3= STB + 50% of N-P-K kg ha^{-1} and two hand weeding at 30 DAE and 50 DAE of black cumin, T_4= STB and two hand spading at 30 DAE and 50 DAE of black cumin, T_5= STB + 25% of N-P-K kg ha^{-1} and two hand spading at 30 DAE and 50 DAE of black cumin ,T_6= STB + 50% of N-P-K kg ha^{-1} and two hand spading at 30 DAE and 50 DAE of black cumin and T_7 = Native nutrient and no weeding (Control) were used in the study as treatment variable. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The unit plot size was 3 m × 4 m. Seeds of BARI Kalijira-1 were sown on 25 November, 2018 and 23 November, 2019 with maintaining spacing 30 cm × 5 cm. Full amount of Triple super phosphate (TSP), Muriate of potash (MOP), Gypsum, Zinc sulphate and Boric acid were applied at the time of final land preparation. The remaining N (Urea) was top dressed in two equal splits at 30 and 50 days after sowing (DAS). In addition, 5 t ha^{-1} of cowdung were applied before land preparation. A light irrigation was given after sowing of seeds for germination. Four irrigations were given to crop at 15, 30, 45 and 60 DAE. Thinning was done at 10 DAE and weeding was done as per treatments. For dry matter estimation, 10 plants were sampled at 30, 45, 60, 75 DAE and at harvest. Weed samples were collected using 50 cm × 50 cm quadrate, from randomly selected four places from each plot at 30 and 50 DAE of black cumin. Number and dry weight of weeds were recorded carefully. Weed control efficiency (WCE) was calculated according to following formula:

$$\text{WCE (\%)} = \left(\frac{A - B}{A}\right) \times 100;$$

where, A = Dry weight of weeds in no weeding plots and B = Dry weight of weeds in treated plots.

BARI Kalijira-1 was harvested on 29 May, 2019 and 28 May, 2020 respectively. The yield component data was taken from 10 randomly selected plants prior to harvest from each plot.

At harvest, the yield data was recorded plot wise. Yield and yield contributing characters were recorded and pooled data analyzed statistically and means separations were done by LSD test at 5% level of significance.

Results and Discussion

Number of weeds m^{-2}, weed dry weight and weed control efficiency

In both the year (2018-19 and 2019-2020, respectively) number of weeds m^{-2}, weed dry weight (g m^{-2}) and WCE (%) were affected by different fertilizer dose and weed management practices are presented in Table 2.

Table 2. Effect of different doses of fertilizer and weed management practice on number of weeds m^{-2} in 2018-19 and 2019-20

Treatments	30 DAE		50 DAE	
	Weed m^{-2} (no.)		Weed m^{-2} (no.)	
	2018-19	2019-20	2018-19	2019-2020
T_1	91	102	46	61
T_2	98	105	70	82
T_3	104	108	59	70
T_4	120	134	60	75
T_5	120	134	60	75
T_6	109	116	67	77
T_7	127	178	211	276

Anguli (*Digitaria* spp), Durba (*Cynodon dactylon*), Helencha (*Enhydra fluctuans*), Mutha (*Cyperus rotundus*) and Shama (*Echinochola crusgali*) were found the most dominant weed in the black cumin field. The number of weeds m^{-2} ranged from 91 to 127 m^{-2} during 2018-19 and 102 to 178 m^{-2} during 2019-20 at 30 DAEs of black cumin. At 50 DAEs of black cumin number of weeds m^{-2} ranged from 46 to 211 m^{-2} during 2018-19 and 61 to 276 m^{-2} during 2019-20, respectively in different fertilizer dose and weed management practice.

Table 3. Effect of different doses of fertilizer and weed management practice on weed dry weight and weed control efficiency over time in black cumin field during *rabi* season of 2018-2019 and 2019-20.

Treatments	Weed dry weight (g m^{-2})				Weed control efficiency (%)			
	30 DAE		50 DAE		30 DAE		50 DAE	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
T_1	7.95	8.78	5.80	6.84	81.17	81.01	91.21	90.30
T_2	7.45	7.98	5.12	6.13	82.35	82.74	92.24	91.30
T_3	6.92	6.83	4.20	5.24	83.61	85.23	93.62	92.57
T_4	9.92	10.78	7.90	8.45	76.50	76.68	88.02	88.01
T_5	8.82	9.78	7.00	8.98	79.10	78.84	89.38	87.26
T_6	8.12	8.65	6.89	7.35	80.76	81.29	89.55	89.57
T_7	42.41	46.23	65.93	70.48				

Note: T_1= STB (Soil test basis fertilizer dose, FRG, 2018) 60-24-49-13-0-1 kg ha^{-1} of N- P- K- S- Zn- B and two hand weeding at 30 DAE and 50 DAE of black cumin, T_2= STB + 25% of N- P- K kg ha^{-1} and two hand weeding at 30 DAE and 50 DAE of black cumin, T_3= STB + 50% of N-P-K kg ha^{-1} and two hand weeding at 30 DAE and 50 DAE of black cumin, T_4= STB and two hand spading at 30 DAE and 50 DAE of black cumin, T_5= STB + 25% of N- P- K kg ha^{-1} and two hand spading at 30 DAE and 50 DAE of black cumin ,T_6= STB + 50% of N- P- K kg ha^{-1} and two hand spading at 30 DAE and 50 DAE of black cumin and T_7 = Native nutrient and no weeding (Control).

Among the treatments the lowest number of weed m^{-2} (91 and 102 m^{-2}) was found in the treatment T_1 followed by T_2 (98 and 105 m^{-2}) at 30 DAE of black cumin during 2018-19 and 2019-20, respectively. At 50 DAE of black cumin the lowest number of weeds m^{-2} was obtained from T_1 treatment (46 and 61 m^{-2}) followed by T_3 (59 and 70 m^{-2}). The highest number of weeds m^{-2} (127 and 178 m^{-2} at 30 DAE and 211 and 276 m^{-2} at 50 DAE was recorded in T_7 (Native nutrient and no weeding, control plots) during 2018-19 and 2019-20, respectively. The maximum weed dry weight was 42.41 and 46.23 g m^{-2} at 30 DAE of black cumin and 65.93 g m^{-2} and 70.48 g m^{-2} at 50 DAE of black cumin was recorded in treatment T_7 treatment (Native nutrient and no weeding: control plots) in 2018-19 and 2019-20, respectively (Table. 3).

The minimum weed dry weight (6.92 g m^{-2} and 6.83 g m^{-2}) was recorded in T_3 treatment at 30 DAE of black cumin in 2018-19 and 2019-20, respectively. Similarly at 50 DAE of black cumin the minimum weed dry weight 4.20 g m^{-2} and 5.24 g m^{-2} was obtained from T_3 treatment during 2018-19 and 2019-20, respectively. Higher weed density and dry weight decrease the seed yield of black cumin. Similar findings were observed by Sarandon *et al.* (2002). The variation in WCE was observed among the different treatments. The highest WCE 83.61 85.23% at 30 DAE of black cumin and 93.62 and 92.57% at 50 DAE of black cumin was found in T_3 treatment (Two hand weeding at 30 and 50 DAE of black cumin with STB + 50% of N-P-K kg ha^{-1} fertilizer dose) respectively followed by T_2 and T_1 and treatments during 2018-19 and 2019-20, respectively (Table 3).

First flower bud initiation, capsule setting and capsule ripening days in 50% plant

Different fertilizer levels and weed management slightly influence the first flower bud initiation day in 50% plants of black cumin in both the year (Table 4).

Table 4. Effect of fertilizer and weed management on first flower bud initiation, capsule setting and capsule ripening days in 50% plant of black cumin in 2018-19 and 2019-20

Treatments	First flower bud initiation days in 50% plant (DAS)		Capsule setting days in 50% plant (DAS)		Capsule ripening days in 50% plant (DAS)	
	2018-19	201920	2018-19	201920	2018-19	201920
T_1	79	78	83	83	132	131
T_2	78	78	84	83	133	131
T_3	82	81	86	85	134	133
T_4	77	76	83	83	132	131
T_5	77	76	83	83	133	132
T_6	78	77	86	84	134	132
T_7	76	75	76	76	128	126

Among the treatments T_3 took the maximum days (82 and 81 DAS) for first flower bud initiation in 50% plants, whereas T_7 (Native nutrient and no weeding: control) treatment took the minimum days (76 and 75 DAS) during 2018-19 and 2019-29, respectively. Capsule setting days in 50% plant influence among the different treatments (Table 4). T_3 treatment took the longest time (86 and 85 DAS) for capsule setting in 50% plant, whereas, control treatment T_7 took the shortest time 76 DAS in both the years. Capsule ripening time in 50% plant among the treatment combinations, T_3 treatment took maximum time 134 DAS and 133 DAS whereas T_7 treatment (Native nutrient and no weeding: control) expressed the minimum time 128 DAS and 126 DAS during 2018-19 and 2019-20, respectively.

Total dry matter

The yield of a crop is mainly determined by the accumulation of dry matter and its partitioning into the economic sink. The pattern of dry matter accumulation in black cumin over time was influenced by different fertilizer dose and weed management practice (Fig. 1). Total dry matter g m^{-2} of black cumin influenced by the different dose of fertilizer and weed management method. Total dry matter was increased gradually with the different level of applied fertilizer and weed management method in both years. Total dry matter increased slowly up to 60 DAE there after dry matter accumulation increased rapidly up to harvest. Among the treatment combinations T_3 treatment (STB + 50% of NPK) produced the maximum total dry matter 26.40 g m^{-2} and 23.40 g m^{-2} at 30 DAE of black cumin and T_7 treatment (Native nutrient and no weeding: control) produced the minimum TDM 19.2 g m^{-2} and 16.20 during 2018-19 and 2019-20, respectively. At 45 DAE of black cumin T_3 treatment similarly produced the maximum TDM (41.40 g m^{-2} and 36.00 g m^{-2}), whereas T_7 Treatment (Control) produced minimum total dry matter weight (24.60 and 23.98 g m^{-2}) during 2018-19 and 2019-20, respectively. At 60 DAE of black cumin maximum total dry matter weight (73.40 and 70.80 g m^{-2}) was recorded in T_3 treatment and minimum total dry matter weight (40.80 and 37.40 g m^{-2}) was recorded in T_7 treatment with no fertilizer and no weeding. Similar trend also observed at 75 DAE of black cumin. Higher total dry matter weight 196.40 g m^{-2} in 2018-19 and 186.43 g m^{-2} in 2019-2020, respectively was obtained from in T_3 treatment at harvest with STB + 50% of NPK fertilizer dose and two hand weeding at 30 and 50 DAE of black cumin. No fertilizer and no weeding showed the minimum dry matter weight 131.20 g m^{-2} and 116.23 g m^{-2} during 2018-19 and 2019-2020, respectively. Similar findings were also observed by Ali *et al.* (2015) in black cumin.

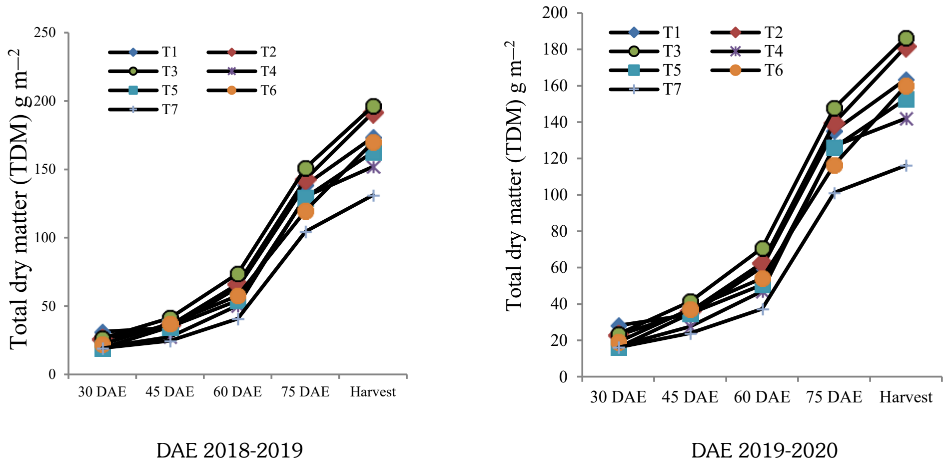
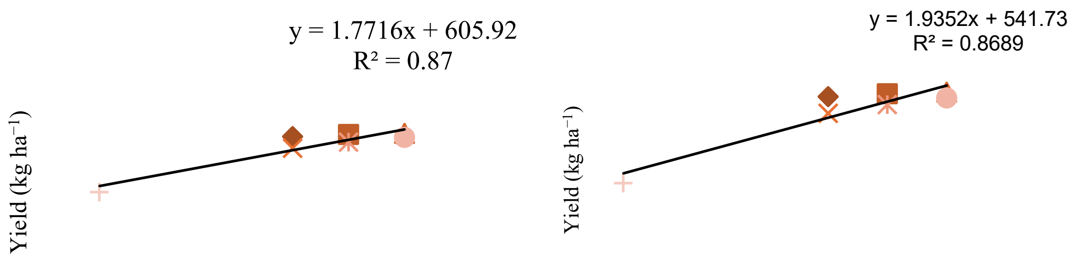


Fig. 1. Total dry matter (TDM g m^{-2}) of black cumin as influenced by different fertilizer dose and weeding method.

Relationship between seed yield of black cumin with fertilizer dose

There was a positive linear correlation between seed yield of black cumin with different fertilizer doses (Fig. 2).The regression line ($y = 1.771x + 605.9$, $R^2 = 0.87$) that means the correlation of coefficient (x) was 1.771 stated that seed yield of black cumin increase at the rate of 1.771 kg ha^{-1} for per unit change of fertilizer levels during 2018-19 and 2019-20 also found the similar results that means there was a positive linear correlation between seed yield of black cumin with different fertilizer doses (Fig. 2). The regression line ($y = 1.935x + 541.7$, $R^2 = 0.868$) that means the correlation of coefficient (x) was 1.935 stated that seed yield of black cumin increases at the rate of 1.935 kg ha^{-1} for per unit change of fertilizer levels during 2019-20. The coefficient of determination ($R^2 = 0.87$) and ($R^2 =0.867$) value indicated that 0.87 and 0.867% during 2018-19 and 2019-20 respectively on seed yield of black cumin was attributed due to different doses of fertilizer. Thus, the result indicated that increasing fertilizer dose increase the seed yield of black cumin. These findings are in agreement with those of Tuncturk *et al.* (2012).

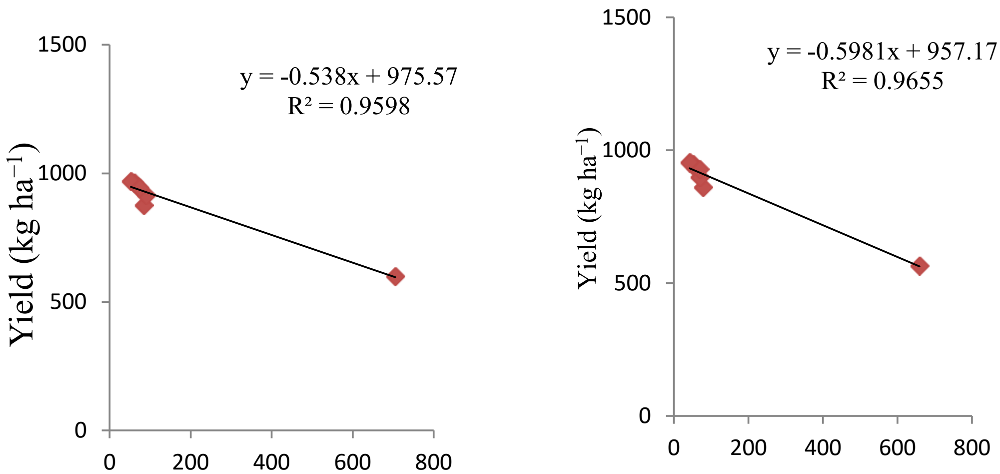


Total applied nutrient (kg ha^{-1}) in 2018-19. **Total applied nutrient (kg ha^{-1}) in 2019-20.**

Fig. 2. Functional relationship between applied different fertilizer dose and seed yield of black cumin in 2018-19 and 2019-20.

Relationship between seed yield of black cumin with weed dry weight at harvest

There was a negative linear correlation between seed yield of black cumin with weed dry weight at harvest (Fig. 3). In 2018-19 the regression line ($y = -0.538x + 975.57$, $R^2 = 0.9598$) that means the correlation of coefficient (x) was –0.538 stated that seed yield decrease at the rate of –0.538 kg ha^{-1} for per kg increase of weed dry weight at harvest and in 2019-20 and the regression line ($y = -0.5981x + 957.17$, $R^2 = 0.9655$) that means the correlation of coefficient (x) was –0.5981 stated that seed yield decrease at the rate of –0.5981 kg ha^{-1} for per kg increase of weed dry weight at harvest. The coefficient of determination ($R^2 = 0.9598$) and (R^2= 0.9655) value indicated that 0.9598% and 0.9655% seed yield of black cumin was attributed due to dry weight of weed during 2018-19 and 2019-20, respectively. Thus, the results indicated that increasing dry weight of weeds decreasing the seed yield of black cumin. These findings were in agreement with those of Sarandon *et al.* (2002), Ciuberkis *et al.* (2004) and Mubeen *et al.* (2009).



Weed dry weight at harvest in 2018-19. **Weed dry weight at harvest in 2019-20.**

Fig. 3. Functional relationship between seed yield of black cumin and weed dry weight at harvest in 2018-19 and 2019-20.

Effect on yield and yield contributing characters of black cumin

Yield and yield components of black cumin were statistically influenced by different doses of fertilizer and weed management method (Table 5).

Table 5. Yield attributes of BARI Kalijira-1 as influenced by different doses of fertilizer and weed management

Treatments	Plant height (cm)	Branch plant^{-1} (no.)	Capsule plant^{-1} (no.)	Seed capsule^{-1} (no.)	Length of capsule (cm)	Diameter of capsule (cm)	1000 Seed weight (g)	Seed yield (Kg ha^{-1})
T_1	52.30	6.67	18.57	77.30	0.32	0.14	3.24	933.32
T_2	53.32	7.11	19.64	82.23	0.33	0.17	3.27	946.41
T_3	56.47	7.31	21.27	89.03	0.34	0.20	3.31	953.75
T_4	45.10	6.23	16.55	61.53	0.30	0.11	2.52	859.87
T_5	54.93	6.31	16.86	65.23	0.30	0.13	2.70	898.25
T_6	50.63	6.38	17.76	71.90	0.31	0.13	2.75	928.04
T_7	33.06	3.69	11.70	42.38	0.19	0.09	1.72	565.54
LSD (0.05)	12.64	0.78	1.83	8.97	0.06	0.06	0.48	114.50
CV (%)	14.17	7.01	5.87	7.21	3.27	11.31	9.73	7.41

The tallest plant at harvest (56.47 cm) was observed in T_3 treatment which was statistically similar with that of T_5 (54.93 cm), T_2 (53.32 cm), T_1 (52.30) treatments and the shortest plant (33.06 cm) in T_7 treatment (No fertilizer and no weeding). Valadabadi and Aliabadi (2011) found plant height of black cumin to range from be 58 to 82 cm. Plant heights might be controlled genetically, and/or environmental factors. The reason may be due to higher doses of fertilizer application which itself increases plant growth by promoting processes such as cell division, cell enlargement, metabolic processes. T_3 treatment produced the maximum number of branches plant^{-1} (7.31) which was statically similar with T_2 (7.11) and T_1 (6.67) treatments. T_7 treatment gave the minimum branches plant^{-1} (3.69). Tuncturk *et al.* (2012) found significant influence of fertilizer levels and weed management on the number of branches plant^{-1} in black cumin. At harvest T_3 treatment gave the maximum number of capsule plant^{-1} (21.27) which was statistically identical with that of T_2 (19.64) treatment. Hammo and Al-Atrakchii (2006) and Tuncturk *et al.* (2012) also reported increased number of capsule plant^{-1} of black cumin with increased of fertilizer levels. The lowest number of capsule plant^{-1} of black cumin was obtained from control T_7 (11.70) treatment. The maximum number of capsule plant^{-1} at harvest (89.03) was obtained from T_3 treatment which was statistically identical with that of T_2 (82.23) treatment. Among the treatments T_7 treatment (control) gave the minimum number of capsule plant^{-1} (42.38). This result was correlated was in agreement with the findings of Toncer and Kizil (2004) who reported that, number of capsule plant^{-1} varied from 85.7 to 92.8. The maximum capsule length at harvest (0. 4 cm) was recorded from T_3 treatment which was statistically similar with that of T_2 (0.33 cm), T_1 (0.32), T_6 (0.31 cm), and T_5 (30 cm) and T_4 (30 cm) treatments whereas the lowest capsule length was obtained from (0.19 cm) from T_7 treatment (Control). The highest capsule diameter also follows the similar trend of capsule length. The highest capsule diameter (0.20 cm) was obtained from T_3 treatment and it was at par with that of T_2 and T_1 treatments. Treatment T_7 (control) showed the minimum capsule diameter (0.09 cm). 1000 seed weight is an important yield contributing character. The 1000 seed weight of black cumin significantly influenced by different fertilizer dose and weed management practices. Significantly the highest 1000 seed weight (3.31g) was obtained from T_3 treatment which was at par with that of T_2 (3.27 g) and T_1 (3.24 g) treatments. The lowest 1000 seed weight 1.72 g was obtained from T_7 treatment (control). Kaheni *et al.* (2013) also found significant effect of different fertilizer levels on thousand seed weight of black cumin. Seed yield (kg ha^{-1}) of black cumin significantly influenced by different dose of fertilizer and weed management method. The maximum yield (953.75 kg ha^{-1}) was obtained from T_3 treatment (STB + 50% of NPK along with two hand weeding at 30 and 60 DAE of black cumin) followed by T_2 (946.41 kg ha^{-1}), T_1 (933.32 kg ha^{-1}), T_6 (928.04 kg ha^{-1}), T_5 (898.25 kg ha^{-1}) and T_4 (859.87 kg ha^{-1}) treatments. The lowest yield (565.54 kg ha^{-1}) was obtained from control treatment T_7 (No fertilizer and no weeding). Tuncturk *et al.* (2012) and (Valadabadi and Aliabadi, 2011) reported that increasing fertilizer doses and properly weed management positively influenced seed yields in black cumin.

Economic performance

From the cost-benefit analysis it was found that the maximum gross return (Tk. 2,38,437 ha^{-1}) was obtained from T_3 treatment followed by treatments T_2 (Tk. 2,36,603 ha^{-1}) and T_1 (Tk. 2,33,330 ha^{-1}) (Table. 6). The highest cost of production was recorded in T_3 treatment (Tk. 94,000 ha^{-1}) due to high labour and fertilizer cost. The highest gross margin of (Tk. 1,44,603 ha^{-1}) was obtained from T_2 treatment followed by T_3 (Tk. 1,44,437 ha^{-1}) and T_6 (Tk. 1,44,010 ha^{-1}) treatments. The highest BCR 2.69 was obtained from T_4 treatment (STB fertilizer dose along with two hand spading at 30 and 50 DAE of black cumin) due to lower cost of cultivation (Table. 6) followed by T_5 (2.67) and T_6 (2.64). The lowest BCR (1.89) was recorded in T_7 (No fertilizer and no weeding) treatment.

Table 6. Economic performance of different doses of fertilizer and weed management on black cumin in 2018-2019 and 2019-2020 (Average data of two years)

Treatments	Black cumin yield (kg ha^{-1})	Gross return (Tk. ha^{-1})	Total cost of production (TK. ha^{-1})	Gross margin (TK. ha^{-1})	Benefit cost ratio (BCR)
T_1	933.32	2,33,330	90,000	1,43,330	2.59
T_2	946.41	2,36,603	92,000	1,44,603	2.57
T_3	953.75	2,38,437	94,000	1,44,437	2.54
T_4	859.87	2,14,967	80,000	1,34,967	2.69
T_5	898.25	2,24,563	84,000	1,40,563	2.67
T_6	928.04	2,32,010	88,000	1,44,010	2.64
T_7	565.54	1,41,386	75,000	66,386	1.89

Note: Urea- Tk. 16 kg^{-1}, TSP- Tk. 25 kg^{-1}, MoP- Tk. 15 kg^{-1}, Gypsum- Tk. 12 kg^{-1}, Zinc Sulphate- Tk. 175 kg^{-1}, Boric acid- Tk. 200 kg^{-1}, Labour- Tk. 500 man^{-1} day^{-1}, Irrigation- Tk. 3,000 ha^{-1} $irrigation^{-1}$, Seed- Tk. 400 kg^{-1} and sale price of seed Tk. 250 kg^{-1}.

Conclusion

Fertilizer dose @ 90-36-73-13-0-1 kg ha^{-1} of N-P-K-S-Zn-B and two hand weeding at 30 and 50 DAE of black cumin produced higher seed yield (953.75 kg ha^{-1}) of black cumin but highest marginal BCR 2.69 was obtained from fertilizer dose @ 60-24-49-13-0-1 kg ha^{-1} of N-P- K- S- Zn- B (Soil test basis fertilizer dose) and two hand spading at 30 and 50 DAE of black cumin due to lower cost of production.

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