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FERTILIZER RECOMMENDATION FOR CHILLI - ONION INTERCROPPING SYSTEM

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Abstract

An experiment was conducted at Central Research Farm, BARI, Gazipur during Rabi season of 2021-22, 2022-23 & 2023-24 to develop a fertilizer recommendation for chilli with onion intercropping system. Six treatment combinations viz. T_1= 100% RDCF of chilli + 0% RDCF of onion, T_2= 100% RDCF of chilli +10% RDCF of onion, T_3= 100% RDCF of chilli + 20% RDCF of onion, T_4= 100% RDCF of chilli +30% RDCF of onion, T_5= 100% RDCF of chilli +40% RDCF of onion and T_6= 100% RDCF of chilli +50% RDCF of onion were tested. The experiment was laid out in randomized complete block design with 3 replications. Both chilli and onion significantly influenced by different treatment combinations. Significantly the highest yield of chilli (12.18 t ha^{-1}) and onion (8.13 t ha^{-1}) were obtained from T_6 treatment (100% RDCF of chilli +50% RDCF of onion) which was statistically similar with T_5 treatment (100% RDCF of chilli +40% RDCF of onion). Chilli equivalent yield (CYI) progressively increases with the increase of inorganic fertilizers. The results showed that T_6 provided the highest CEY (21.93 t ha^{-1}) followed by T_5 (21.88 t ha^{-1}). The highest net return (430005 Tk ha^{-1}) as well as BCR (4.67) were obtained from T_5 treatment (100% RDCF of chilli +40% RDCF of onion) whereas the lowest net return (364411 Tk. ha^{-1}) as well as BCR (4.28) were observed in T_1 treatment (100% RDCF of chilli + 0% RDCF of onion).Though T_6 treatment gave higher yield over all the treatments yet it showed lower BCR compared to T_5 treatment due to higher cost involvement for inorganic fertilizer.

Introduction

In Bangladesh, the majority of farmers practice monoculture rather than intercropping. However, intercropping uses nutrients more efficiently and provides greater yield stability than monoculture (Seran and Brintha, 2010). Furthermore, mixed or intercropping can maximize land utilisation and boost productivity when compared to single crops (Launay *et al.*, 2009; Mucheru-Muna *et al.*, 2010). In highly populated countries with limited per capita land for agricultural production, intercropping is a crucial strategy for increasing productivity per unit area by intensifying the use of land. One of the major spices grown in Bangladesh is chilli, which is often grown as sole crop on char land. Farmers of different region especially char areas grow chilli as a sole or sometimes intercropping with onion. From the previous research findings of Begum *et al.* (2015), chilli with onion intercropping system found very productive and profitable for the char land. For the intercropping system of chillies with onions, there is currently no suggested fertilizer dosage. Fertilizer management is the most logical approach to increase overall productivity in order to obtain the highest return and crop yield. So, it is necessary to find out the optimum fertilizer dose for chilli with onion intercropping system.

Materials and Methods

A field experiment was conducted at Central Research Farm, BARI, Gazipur (AEZ-28) during *Rabi* season of 2020-21, 2021-22 & 2022-23 to develop a fertilizer recommendation for chilli with onion intercropping system. The experiment confined with intercropping where chilli was transplanted as main crop and onion was transplanted as companion crop. The variety of chilli and onion were BARI Morich-4 and BARI Piaj-4, respectively. Before conducting the experiment, initial composite soil samples at a depth of 0-15 cm from the experimental plots were collected and analyzed following standard methods (Table 1).

Table 1. Chemical properties of initial soil (0-15 cm depth) of the experimental field at Central Research farm, BARI, Joydebpur, Gazipur during *Rabi* season

Sample	pH	OM	Total N	K	Ca	Mg	P	S	Zn	B	Cu	Fe	Mn
		(%)	(%)	meq 100 g soil^{-1}			g g^{-1} soil						
Average	6.1	1.36	0.08	0.18	3.8	2.2	12	16	1.6	0.17	4.0	72	8
Critical level	-	-	0.12	0.12	2.0	0.5	7	10	0.6	0.2	0.2	4.0	1.0
Interpretation	Slightly acidic	Low	Very Low	Low	Medium	Very high	Medium	Medium	Optimum	Low	Very high	Very high	Very high

The experiment was laid out in a randomized complete block design with three replicates. The unit plot size was 4.0 m × 3.0 m. Chilli (30 days old seedlings) and onion (40 days old seedlings) transplantation were done on last week of December in all the three consecutive years. One row of onion was sown in between two rows of chilli. Line to line spacing of chilli was 40 cm and chilli to onion spacing was 20 cm. Plant to plant spacing of chilli and onion was 40 cm and 10 cm, respectively.

The experiment was set up with six treatments viz. T_1= 100% recommended dose of chemical fertilizer (RDCF) of chilli + 0% RDCF of onion, T_2= 100% RDCF of chilli +10% RDCF of onion, T_3= 100% RDCF of chilli + 20% RDCF of onion, T_4= 100% RDCF of chilli +30% RDCF of onion, T_5= 100% RDCF of chilli +40% RDCF of onion and T_6= 100% RDCF of chilli +50% RDCF of onion. Recommended fertilizer dose was estimated based on the soil test value. Recommended dose of chemical fertilizer for chilli was $N_{99.5}$ $P_{32.6}$ K_{64} $S_{9.5}$ $Zn_{0.2}$ $B_{0.9}$ kg ha^{-1} and onion was $N_{108.8}P_{28.5}$ $K_{75.2}S_{19.6}$ $B_{1.3}$kg ha^{-1}. Cowdung (5 t ha^{-1}) were applied as a basal in all the plots.

The whole amounts of organic manure, phosphorus, sulphur, zinc, boron, half of nitrogen and potassium were applied as basal during final land preparation. Remaining nitrogen and potassium were applied in two equal installments at 30 and 60 days after transplantation from 10-12 cm away from the base of the plant which could be beneficial for the growth and yield of onion. All the intercultural operations such as irrigation, weeding, insect control etc. were done as and when necessary.

Chilli was harvested five times at 15 days interval starting from 3rd week of March and onion was harvested in its maturity on 1st week of April in all the three years. Ten plants from each plot were tagged at random to take records on different agronomic parameters of chilli and onion. Data on yield and yield contributing parameters were recorded and statistically analyzed with the help of statistical package statistix 10 (Analytical Software. Tallahassee, Fla, USA) and mean separation was tested by Duncan's Multiple Range Test (DMRT) (Steel and Torrie, 1960). Chilli Equivalent Yield (CEY) was calculated after Bandyopadhyay (1984):

$$\text{Chilli Equivalent Yield (kg/ha)} = \frac{\text{Yield of onion (kg/ha)} \times \text{Price of onion (Tk./kg)}}{\text{Price of chilli (Tk./kg)}}$$

Methods of chemical analysis

Soil pH was measured by a combined glass calomel electrode (Jackson, 1958). Organic carbon was determined by wet oxidation method (Walkley and Black, 1934). Total N was determined by modified Kjeldahl method. K, Ca and Mg were determined by NH_4OAc extraction method. Cu, Fe, Mn and Zn were determined by DTPA extraction followed by AAS reading. Boron was determined by $CaCl_2$ extraction method. Phosphorus was determined by Bray and Kurtz method (Acid soils) and S was determined by $CaH_4 (PO_4)_2$. H_2O extraction followed by turbidimetric method with $BaCl_2$.

Results and Discussion

Chilli

The effect of chemical fertilizers on the yield and yield parameters of chilli are summarized in the Table 2. Green chilli yield and yield attributes like plant height, number of branches plant^{-1}, number of fruits plant^{-1} and average fruit weight plant^{-1} of chilli were significantly influenced by different nutrient packages in this study.

The significantly highest plant height (69.5 cm) was obtained from T_6 treatment (100% RDCF of chilli +50% RDCF of onion) which was statistically similar with T_5 treatment whereas the lowest plant height (64.0 cm) was obtained from T_1 treatment (100% RDCF of chilli + 0% RDCF of onion). That similar to all other treatments except T_5 and T_6.

Table 2. Yield and yield components of chilli as influenced by different treatment combinations at Gazipur during *Rabi season* (Pooled data of 3-years)

Treatments	Plant height (cm)	Number of branches plant^{-1}	Number of fruits plant^{-1}	Average fruit weight plant^{-1} (g)	Chilli yield (t ha^{-1})
T_1	64.0c	8.5c	130.0d	181.7e	10.10e
T_2	64.4c	9.3bc	134.6d	204.2d	10.48d
T_3	65.7c	9.6ab	139.5c	211.4c	10.90c
T_4	66.5bc	9.6ab	145.3b	217.3b	11.40b
T_5	69.0ab	10.0ab	157.7a	233.6a	12.15a
T_6	69.5a	10.2a	159.4a	236.2a	12.18a
SE (±)	1.38	1.21	2.98	2.80	0.23
CV (%)	6.37	5.83	3.87	3.26	9.21

Means followed by same letter (s) do not differ significantly at 5% level of significance. T_1= 100% RDCF of chilli + 0% RDCF of onion, T_2= 100% RDCF of chilli + 10% RDCF of onion, T_3= 100% RDCF of chilli + 20% RDCF of onion, T_4= 100% RDCF of chilli + 30% RDCF of onion, T_5= 100% RDCF of chilli + 40% RDCF of onion and T_6= 100% RDCF of chilli + 50% RDCF of onion

Number of branches plant^{-1} positively affected by different fertilizer treatment. Significantly the highest number of branches plant^{-1} (10.2) was obtained from T_6 treatment whereas the lowest number of branches plant^{-1} (8.5) was recorded in T_1 treatment. Number of fruits plant^{-1} progressively increases with the increase of inorganic fertilizers. The maximum number of fruits plant^{-1} (159.4) was obtained from T_6 treatment which was statistically similar with T_5 treatment while the minimum number of fruits plant^{-1} (130.0) was obtained from T_1 treatment. The significantly highest average fruit weight plant^{-1} (236.2 g) was obtained from T_6 treatment which was statistically similar with T_5 and superior to all other treatments. The lowest average fruit weight plant^{-1} (181.7 gm) was recorded in T_1 treatment.

Yield of chilli progressively increases with the increase of inorganic fertilizers. Significantly the highest yield of green chilli (12.18 t ha^{-1}) was obtained from T_6 treatment (100% RDCF of chilli + 50% RDCF of onion) which was statistically similar with T_5 treatment (100% RDCF of chilli +40% RDCF of onion) and superior to all other treatments. The lowest yield of green chilli (10.10 t ha^{-1}) was observed in T_1 treatment (100% RDCF of chilli + 0% RDCF of onion). The result was similar to the findings of Farhad *et al.* (2022) in chill + garlic intercropping system and in maize + potato intercropping system.

Onion

The effect of chemical fertilizers on the yield and yield parameters of onion are summarized in the Table 3. The results indicated that all of the yield attributes of onion were significantly influenced by different treatment combinations. The highest plant height (55.4 cm) was obtained from T_6 treatment (100% RDCF of chilli +50% RDCF of onion**)** which was statistically at par with T_3 and T_4 treatment whereas the lowest plant height (50.3 cm) was obtained from T_1 treatment (100% RDCF of chilli + 0% RDCF of onion), also similar with T2 and T3 treatments.

Table 3. Effect of different treatments on the yield and yield attributes of onion at Gazipur during *Rabi season* (Pooled data of 3-years)

Treatments	Plant height (cm)	Number of leaves $plant^{-1}$	Bulb length (cm)	Bulb diameter (cm)	Individual bulb weight (g)	Bulb yield (t ha^{-1})
T_1	50.3b	8.2e	4.37c	4.10d	36.1c	7.44d
T_2	51.5b	8.5de	4.38c	4.16c	36.4c	7.50d
T_3	52.1b	8.7cd	4.43bc	4.19c	37.6b	7.77c
T_4	54.4a	9.1bc	4.48ab	4.25b	38.7ab	7.93b
T_5	55.3a	9.4ab	4.54a	4.30a	39.5a	8.11a
T_6	55.4a	9.6a	4.56a	4.32a	39.8a	8.13a
SE (±)	1.29	1.13	0.08	0.05	0.72	0.06
CV (%)	5.80	8.72	5.81	3.91	4.81	8.12

Means followed by same letter (s) do not differ significantly at 5% level of significance. T_1= 100% RDCF of chilli + 0% RDCF of onion, T_2= 100% RDCF of chilli + 10% RDCF of onion, T_3= 100% RDCF of chilli + 20% RDCF of onion, T_4= 100% RDCF of chilli + 30% RDCF of onion, T_5= 100% RDCF of chilli + 40% RDCF of onion and T_6= 100% RDCF of chilli + 50% RDCF of onion

The maximum number of leaves $plant^{-1}$ (9.6) was obtained from T_6 treatment which was statistically similar with T_5 treatment whereas the minimum number of leaves $plant^{-1}$ (8.2) was obtained from T_1 treatment (100% RDCF of chilli + 0% RDCF of onion). Both of bulb length and bulb diameter are progressively increases with the increase of fertilizers. The highest bulb length (4.56 cm) and bulb diameter (4.32 cm) were obtained from T_6 treatment (100% RDCF of chilli + 50% RDCF of onion) which was statistically similar with T_5 treatment (100% RDCF of chilli + 40% RDCF of onion**).** The lowest bulb length (4.37 cm) and bulb diameter (4.10 cm) were obtained from T_1 treatment (100% RDCF of chilli + 0% RDCF of onion**).** Individual bulb weight and yield of onion progressively increases with the increase of inorganic fertilizers. Significantly the highest individual bulb weight (39.8 g) and bulb yield (8.13 t ha^{-1}) of onion were obtained from T_6 treatment (100% RDCF of chilli + 50% RDCF of onion) which was statistically similar with T_5 treatment (100% RDCF of chilli + 40% RDCF of onion) and superior to all other treatments.The lowest individual bulb weight (36.1 g) and bulb yield (7.44 t ha^{-1})were obtained from T_1 treatment (100% RDCF of chilli + 0% RDCF of onion).

Chilli Equivalent Yield

Chilli equivalent yield (CEY) was progressively increased with the increase of inorganic fertilizers. The result showed that T_6 provided the highest CEY (21.93 t ha^{-1}) that was15.29% higher over T_1 (Fig. 1). The treatment T_5 also gave higher CEY (21.88 t ha^{-1}) followed by T_4, T_3

and T_2. The higher CEY was mainly attributed due to additional yield advantage resulted from fertilizer effect in chill-onion intercropping. The result was similar to the findings of Farhad *et al.* (2022) who observed that there was a trend of increase in CEY with the increase of inorganic fertilizer level and the CEY was decreased considerably towards lower fertilizer levels in chilli with onion intercropping system. Begum *et al.* (2016) also reported PEY increased towards higher fertilizer rates in potato-hybrid maize intercropping system.

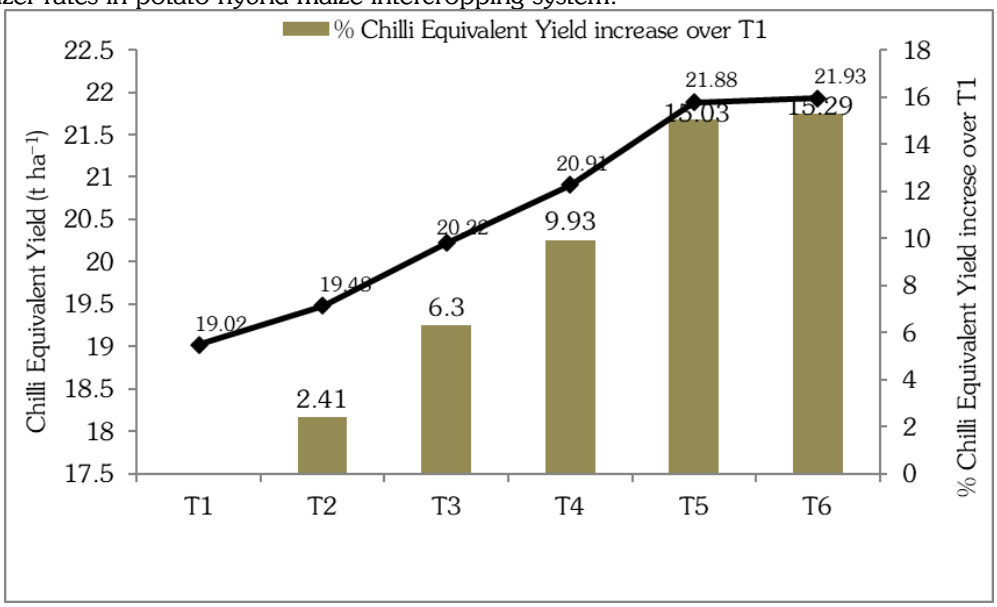

Fig.1. Chilli equivalent yield (CEY) and % CEY increase over T_1 in different treatment combinations

Cost and return analysis

Cost and return of chilli with onion intercropping have been described in the Table 4. Among the treatments, the highest net return (430005 Tk. ha^{-1}) as well as BCR (4.67) were obtained from T_5 treatment (100% RDCF of chilli + 40% RDCF of onion) whereas the lowest net return (364411 Tk. ha^{-1}) as well as BCR (4.28) were observed in T_1 treatment (100% RDCF of chilli + 0% RDCF of onion). Though T_6 treatment gave higher yield over all the treatments yet it showed lower BCR compared to T_5 treatment due to higher cost involvement for inorganic fertilizer.

Table 4. Cost and return analysis of chilli with onion intercropping system as influenced by different fertilizer treatment combinations at Gazipur during *Rabi season* (Pooled data of 3-years)

Treatments	Yield (t ha^{-1})		Chilli equivalent yield (t ha^{-1})	Gross return (Tk. ha^{-1})	Total cost (Tk. ha^{-1})	Net return (Tk. ha^{-1})	Benefit cost ratio (BCR)
	Chilli	Onion					
T_1	10.10	7.44	19.02	475500	111089	364411	4.28
T_2	10.48	7.50	19.48	487000	112566	374434	4.32
T_3	10.90	7.77	20.22	505500	114042	391458	4.43
T_4	11.40	7.93	20.91	522750	115520	407230	4.52
T_5	12.15	8.11	21.88	547000	116995	430005	4.67
T_6	12.18	8.13	21.93	548250	118472	429778	4.62

Input and output price per Kg: Urea = Tk. 16, TSP = Tk. 22, MoP = Tk. 15, Gypsum = Tk. 12, Zinc sulphate =Tk.150, Boric acid Tk. = Tk.220, chilli seed =Tk.600, onion seed =Tk.900, Chilli selling price = Tk. 25 and Onion selling price = Tk. 30

Conclusion

From the present study, it may be concluded that treatment package consists of 100% recommended doses chemical fertilizers of chilli along with 40% recommended doses chemical fertilizers of onion is most profitable for chilli with onion intercropping system in the study area (AEZ-28).

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