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Mixed Cropping Onion with Different Plant Population of Sweet Gourd

A.H.M.M.R. Talukder[1], J. Rahman[2], L. Nahar[3], M. M. Rahman[2] & N.Kaisar[4]
[1]*Scientific Officer, Bangladesh Agricultural Research Institute, Gazipur-1701, Bangladesh.*
[2]*Scientific Officer, Regional Agricultural Research Station, Jamalpur-2000, Bangladesh.* [3]*Scientific Officer, Bangladesh Rice Research Institute,Gazipur-1701,Bangladesh.*
[4]*MS students department of soil science Bangladesh Agricultural University, Mymensingh- 2202,Bangladesh.*

Abstract: *An experiment was conducted at the Regional Agricultural Research Station, Jamalpur during rabi 2012-2013and 2013-2014 to find out the optimum plant population of sweet gourd in Sweet gourd onion mixed cropping systems(s). The treatments were : T_1=Sole onion (BARI Peaj-1) (Broadcast), T_2=Sole sweet gourd (2m × 2m), T_3= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (1 plant plot^{-1}) (8m × 8m) (625 number plant population ha^{-1}), T_4= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (2 plant plot^{-1}) (4m × 4m) (1250 number plant population ha^{-1}), T_5= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (3plant plot^{-1}) (2.67m × 2.67m) (1875 number plant population ha^{-1}), T_6= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (4 plant plot^{-1}) (2m × 2m) (2500 number plant population ha^{-1}). The result obtained from the experiment revealed that bulb yield of onion reduced significantly in all combination of onion-sweet gourd mixed cropping system and the bulb yield of onion was drastically reduced when the maximum number of sweet gourd (4 plant plot^{-1}) (2m ×2m)(2500 number of plant population ha^{-1}) was prevailed with onion. During the both years among the mixed cropping systems100% onion broadcast + 3 plant plot^{-1}(2.67m × 2.67m) (1875 number plant population ha^{-1}) gave the maximum gross margin (Tk. 2,44,596 ha^{-1}and Tk. 2,92,796 ha^{-1}) followed by 100% onion broadcast + 4 plant plot^{-1}) (2m × 2m) (2500 number plant population ha^{-1}) (Tk. 2,06,682 ha^{-1} and Tk. 2,43,482 ha^{-1}) respectively. During the both years the maximum onion equivalent yield (16.79 and 19.5) was obtained from the treatment combination of 100% onion broadcast + 3 plant plot^{-1} (2.67m × 2.67m) (1875 number plant population ha^{-1}) followed by 100% onion broadcast + 4 plant plot^{-1} (2m × 2m) (2500 number plant population ha^{-1}) (15.81 and 17.7) respectively.*

Keywords- *mixed cropping, onion, optimum plant population, sweet gourd*

I. Introduction

Intercropping can be explained as a system where two or more crop species are grown in the same field at the same time during a growing season [1]. It is a simple and inexpensive strategy and has been recognized as a potentially befitted technology to increase crop production due to its substantial yield advantage than sole cropping [2]. The purpose of intercropping is to generate beneficial biological interactions between the crops. Intercropping can increase yields, more efficiently use available resources, reduce weed, insect and disease pressures and provide greater biological and economic stability [3]. Intercropping has been an essential production method in tropical regions for hundreds of years [3], and to a lesser extent in temperate regions [4]. Intercropping was once common in temperate regions, but has been largely replaced in the last 150 years by monocultures [5]. Intercropping is the most common practice to the farmers of Bangladesh, because it increases the total productivity per unit area through the maximum utilization of land, labour and growth resources [6]. The most common goal of intercropping is to produce a greater yield on a given piece of land by making use of resources that would other wise not be utilized by a single crop. Better intercrop production could be achieved with the choice of appropriate crops [7], population density and planting geometry of component species/crops [8]. Greater productivity in intercropping system is commonly achieved by minimizing inter-specific competition and maximizing complementary use of growth resources [9]. Among the intercropping practices sweet gourd onion intercropping is a common practice to the farmers of char areas. Sweet gourd is creeper type species that covers the maximum areas of land and good source of vitamin and also used as vegetable. On the other hand, onion is a herb type species and it has a preservative and medicine uses [10]. It has been compared cropping systems over three successive seasons (monsoon, winter and summer) in India [11]. In another study, intercropping of pearl millet with cowpea or groundnut showed their significant effects on soil and crop productivity after either sole or intercrop system [12]. To optimize the planting density, the seedling rate of each crop on the mixture has been suggested to adjust below the full rate to reduce competition from overcrowding. Thus, intercrops yield was found to be increased in the mixture stand compared to sole stand [13]. plant architecture allows one intercrop to capture sunlight that would not otherwise be available to others. This phonological character is particularly important to growth and yield of cereals and legume crops [14], [15].

Depending on the crops to be intercropped, competition for water, light and nutrients may results in lower yields. In this case changes in the spatial arrangement of the intercrops will reduce resource competition [14]. Due to decreasing cultivable land, some farmers of char areas (river flood plain) under greater Mymensingh district (together five district) in Bangladesh have been practicing sweet gourd onion intercropping system instead of sole cropping. But the farmers do not follow proper ratio of components crop especially for sweet gourd. As a result they deprived of from obtaining good yield from intercropping systems. Moreover, little information is available for planting geometry of components crops. Hence, this experiment was undertaken to find out the optimum plant population of sweet gourd for intercropping with onion for higher productivity and economic return. Intercropping also reduces pests attack because the non host crop act as physical barriers to the movement of insect pests [16].

II. Methods And Materials

The experiment was conducted at the Regional Agricultural Research Station, Jamalpur during rabi 2012-2013 and 2013-2014 to find out the optimum population of sweet gourd mixed cropped with onion and to maximize the land utilization and benefit of the growers in the char areas. The experiment was arranged following randomized complete block design with three replications. The experimental unit plot size was 4m × 4m. Onion variety BARI Peaj-1 and sweet gourd variety BARI Misti kumra-2 were used as test varieties in this experiment. The seed rate and seedling populations were calculated from recommended dose for onion and sweet gourd. Fifteen days old seedlings of sweet gourd were transplanted on 13 November, 2012 and 2013 while on the same day's onion seeds were broadcasted in the plot at the rate of 7.0 kg ha^{-1}. Treatments included in the experiment were: T_1=Sole onion (BARI Peaj-1) (Broadcast), T_2=Sole sweet gourd (2m × 2m), T_3= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (1 plant $plot^{-1}$) (8m × 8m) (625 number plant population ha^{-1}), T_4= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (2 plant $plot^{-1}$) (4m × 4m) (1250 number plant population ha^{-1}), T_5= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (3plant $plot^{-1}$) (2.67m × 2.67m) (1875 number plant population ha^{-1}), T_6= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (4 plant $plot^{-1}$) (2m × 2m) (2500 number plant population ha^{-1}). Fertilizers were applied for sweet gourd at the rate of 60-27-75-18-1.4-1.2 g N-P-K-S-Zn-B per pit and for onion fertilizers were applied at the rate of 90-45-120-30-3.0-1.4 kg ha^{-1} of N-P-K-S-Zn-B in the form of Urea, triple super phosphate, Muriate of potash, Zypsum, Zinc Sulphate and Boric acid respectively. In case of sweet gourd all phosphorus, potassium, Sulphur, Zinc, boron and organic manure was applied in pit prior 5-7 days prior to planting while full amount of nitrogenous fertilizer was applied in to two equal installment around the plant by side dressing at 30 and 50 days after planting and mixed with soil followed by irrigation. In case of onion half nitrogenous fertilizer and all amounts of other fertilizers were applied during the final land preparation while half nitrogenous fertilizer was applied at 25 and 50 days after sowing respectively. Intercultural operations like watering, weeding and spraying insecticides were followed as and when necessary. One pheromone trap was used for every one decimal land to control of fruit fly of cucumber. Irrigation was applied two times during the whole crop growing period. Fruit yield for sweet gourd and bulb yield of onion was calculated in t ha^{-1} considering the whole plot harvest area. Five plants of onion in each plot were selected randomly to collect data on yield contributing such as bulb length, bulb width, and 10-bulb wt. and yield. Similarly five sweet gourd fruits were selected randomly to collect data on number of fruit $plant^{-1}$, fruit length, fruit breath and yield. Yield data was recorded considering the whole plot in case of both crops. Collected data were analyzed statistically with the help of MSTAT-C programme and mean separation was done as per LSD test at 5% level of significance. Economic analysis was performed considering the price of sweet gourd and onion prevailed at the harvesting period in the local market. Onion equivalent yield was also calculated considering the local market price at the harvesting time following the formula as stated by [17].

Onion Equivalent Yield (t ha^{-1}) = Yield of sweet gourd (t ha^{-1}) × Price of sweet gourd (Tk. kg^{-1})/price of onion (Tk. kg^{-1})

Land Equivalent Ratio (LER) was calculated following the formula of [18].

LER= Yield of intercrop onion (t ha^{-1})/Yield of sole onion (t ha^{-1}) + Yield of intercrop sweet gourd (t ha^{-1})/ Yield of sole sweet gourd (t ha^{-1})

III. Results And Discussion

Yield and Yield Attributes of Onion under Sweet gourd Intercropping

Two years of the experiment sweet gourd intercropping revealed significant influence on the growth and yield characters of onion (Table 1). Result indicated that during the both years plant height of onion did not differ significantly due to the different plant population of sweet gourd but numerically the tallest plant was found in sole onion. Similar result was also obtained by [19] During the both years the numerically dwarf stature onion plant height was found in T6 treatment. Bulb length of onion also did not differ significantly due to the different plant population of sweet gourd but during the both years numerically sole onion gave the maximum

bulb length compare to the other mixture stands while the during the both years the T6 treatment gave the minimum bulb length. During the first year bulb diameter of onion differ significantly due to the different plant population of sweet gourd but in second it did not. During the first year the sole onion treatment produced the maximum bulb diameter that was statistically similar to the treatment T3, T4 and T5 while the treatment T6 produced the minimum bulb diameter. During the second year numerically the sole onion treatment produced the maximum bulb width while the T6 treatment produced the minimum bulb diameter. It might be due to the more interring plant competition of sweet gourd and onion. Ten bulb weight of onion differ significantly during the both years under different plant population of sweet gourd. During the both years sole onion seeding produced the maximum ten bulb weights that was statistically similar to the treatment T3, T4 and T5 while the treatment T6 produced the minimum ten bulbs compare to the other mixed cropping combinations. Ten bulb weights were mainly influenced by the variation of bulb width and diameter. During the both years bulb yield of onion differ significantly under different plant population of sweet gourd and the sole onion treatment produced the significantly maximum bulb yield. Quayyum and Maniruzzaman [20], [21], and [22] also reported that seed yield was higher in monoculture as compared to their corresponding intercropped yield. Among the mixed cropping system bulb yield of onion decreased gradually with the increasing of sweet gourd population. The minimum bulb yield of onion was obtained from the T_6 treatment. Bulb yield of onion was mainly varied due to the variation of bulb length, bulb width and ten bulb weights. The yield of onion in the mixed cropping system decreased compare to the sole cropping system ranged from 25.3% to 66.6% (Average of two years). The yield of in the mixed cropping system was gradually decreased with the increasing of sweet gourd population.

Yield and Yield Attributes of Sweet gourd under Intercropped with Onion

The two years independent field experiment it was found that, all the growth and yield variables of sweet gourd except height of fruit during the first year and fruit yield during the both years did not differ significantly under mixed cropped with onion (Table 2). During the first year the sole sweet gourd (2m × 2m) (T_2) treatment produced the maximum height of fruit that was statistically similar to the Onion (BARI Peaj-1) (Broadcast) + sweet gourd (1 plant plot^{-1}) (8m × 8m) (625 number plant population ha^{-1}) (T_3), Onion (BARI Peaj-1) (Broadcast) + sweet gourd (2 plant plot^{-1}) (4m × 4m) (1250 number plant population ha^{-1}) (T_4) & Onion (BARI Peaj-1) (Broadcast) + sweet gourd (3plant plot^{-1}) (2.67m × 2.67m) (1875 number plant population ha^{-1}) (T_5) treatments. The lowest height of fruit was obtained from the Onion (BARI Peaj-1) (Broadcast) + sweet gourd (4 plant plot^{-1}) (2m × 2m) (2500 number plant population ha^{-1}) (T_6) treatment. The Sole onion (T_2) treatment produced the highest fruit yield that was statistically similar to the Onion (BARI Peaj-1) (Broadcast) + sweet gourd (4 plant plot^{-1}) (2m × 2m) (2500 number plant population ha^{-1}) (T_6) & Onion (BARI Peaj-1) (Broadcast) + sweet gourd (3plant plot^{-1}) (2.67m × 2.67m) (1875 number plant population ha^{-1}) (T_5) treatment. The lowest fruit yield was obtained from the Onion (BARI Peaj-1) (Broadcast) + sweet gourd (1 plant plot^{-1}) (8m × 8m) (625 number plant population ha^{-1}) (T_3) treatment. Fruit yield of sweet gourd was mainly influenced due to the variation of sweet gourd population. The yield of sweet gourd in the mixed crop system was decreased compare to the sole cropping system ranged from 0.75% to 62.9% (average of two years).

Table 1. Yield and yield components of onion in onion-sweet gourd mixed system during rabi 2012-2013 and 2013-2014

Treatment	Plant height (cm)		Bulb length (cm)		Bulb width (cm)		10-bulb wt. (gm)		Bulb yield (t ha^{-1})		Yield of mixed cropped (%) decreased than sole		OEY (t ha^{-1})	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
T_1	51.3	51.6	2.90	3.30	3.11	3.60	170.0	188.3	11.9	12.5	100	100	11.9	12.5
T_2	-	-	-	-	-	-	-	-	-	-	-	-	12.3	12.95
T_3	50.7	50.1	2.82	3.20	3.02	3.55	160.0	183.3	8.51	9.73	28.5	22.2	13.0	14.68
T_4	47.7	50.3	2.72	3.10	3.03	3.42	159.0	176.7	6.50	7.20	45.4	42.4	13.9	15.65
T_5	49.3	50.3	2.74	3.10	2.95	3.40	158.3	165.0	6.24	6.51	47.6	47.9	16.8	19.46
T_6	48.3	49.8	2.70	2.98	2.73	3.21	128.3	165.0	3.56	4.60	70.1	63.2	15.8	17.7
CV (%)	9.08	3.65	6.15	3.57	3.29	3.97	8.57	3.64	9.11	10.7	-	-	-	-
$LSD_{0.05}$	-	-	-	-	0.19	-	25.02	12.03	1.26	3.50	-	-	-	-
F- test	NS	NS	NS	NS	*	NS	*	**	**	**	-	-	-	-

Note: OEY= Onion Equivalent Yield, Y_1= 2012-2013, Y_2= 2013-2014**;** T_1=Sole onion (BARI Peaj-1) (Broadcast), T_2=Sole sweet gourd (2m x 2m), T_3= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (1 plant plot^{-1}) (8m × 8m) (625 number plant population ha^{-1}), T_4= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (2 plant plot^{-1}) (4m × 4m) (1250 number plant population ha^{-1}), T_5= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (3plant plot^{-1}) (2.67m × 2.67m) (1875 number plant population ha^{-1}), T_6= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (4 plant plot^{-1}) (2m × 2m) (2500 number plant population ha^{-1})

Table 2. Yield and yield components of sweet gourd in onion - sweet gourd intercropping system during rabi 2012-2013 and 2013-2014

Treatment	No. of fruit plant^{-1}		Breath of fruit (cm)		Height of fruit(cm)		Fruit yield (t ha^{-1})		Yield of mixed cropped (%) decreased than sole		LER	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
T_1	-	-	-	-	-	-	-	-	-	-	1.00	1.00
T_2	7.6	8.0	4.70	5.45	12.8	14.9	24.6	26.2	100	100	1.00	1.00
T_3	7.3	8.0	4.41	5.59	12.3	14.5	8.93	9.90	63.7	62.2	1.10	1.20
T_4	7.1	8.0	4.60	5.45	11.7	14.9	14.8	16.9	39.8	35.5	1.15	1.22
T_5	6.4	9.0	4.60	5.26	11.9	14.2	21.1	25.9	14.2	1.1	1.40	1.51
T_6	6.9	7.0	4.81	5.03	10.7	14.5	24.5	25.9	0.4	1.1	1.30	1.40
CV (%)	10.9	9.66	3.15	4.74	5.78	7.54	10.3	9.22	-	-	-	-
$LSD_{0.05}$	-	-	-	-	1.29	-	3.64	2.45	-	-	-	-
F- test	NS	NS	NS	NS	*	NS	**	**	-	-	-	-

Note: LER= Land Equivalent Ratio, Y_1= 2012-2013, Y_2= 2013-2014; T_1=Sole onion (BARI Peaj-1) (Broadcast), T_2=Sole sweet gourd (2m x 2m), T_3= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (1 plant plot^{-1}) (8m × 8m) (625 number plant population ha^{-1}), T_4= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (2 plant plot^{-1}) (4m × 4m) (1250 number plant population ha^{-1}), T_5= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (3plant plot^{-1}) (2.67m × 2.67m) (1875 number plant population ha^{-1}), T_6= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (4 plant plot^{-1}) (2m × 2m) (2500 number plant population ha^{-1})

Onion Equivalent Yield (OEY) under sweet gourd Mixed cropped with onion

During the both years among the mixed cropping systems, maximum Onion equivalent yield was found in combination Sole onion (100% broadcast) + Sweet gourd (3 plant plot^{-1}) (2.67m × 2.67m) (1875 number plant population ha^{-1}) (Table 1). While the lowest OEY was obtained in Sole onion (100% broadcast). Onion Equivalent yield in treatment T_5= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (3plant plot^{-1}) (2.67m × 2.67m) (1875 number plant population ha^{-1}) was 41.2% higher during the first year and 56% higher during the second year over the sole onion. Similar results were recorded by [22], [23] and [24] in different intercropping system.

Land Equivalent Ratio (LER) under sweet gourd mixed cropped with Onion

Land equivalent ratio (LER) value more than one (1.00) indicates yield advantages of mixed cropping. LER values in the mixed cropping range from 1.10 to 1.40 during the first year trial while during the second year it was from 1.20 to 1.51 which indicated 10% to 40% and 20% to 51% yield advantages respectively (Table 2). During the both years the maximum LER 1.40 and 1.51 was obtained from the Onion (BARI Peaj-1) (Broadcast) + sweet gourd (3plant plot^{-1}) (2.67m × 2.67m) (1875 number plant population ha^{-1}) (T_5) treatment.

Economic performances of sweet gourd mixed cropping with onion

During the both years maximum cost of cultivation (Tk. 1,10,5185 ha^{-1}) was found in the combination of Sole onion (100% broadcast) + Sweet gourd (4 plant plot^{-1}) and minimum was (Tk. 54,245 ha^{-1}) in Sole onion (100% broadcast) (Table 3). The highest gross return (Tk. 3,41,000 ha^{-1} and Tk. 3,89,200 ha^{-1}) was obtained from the combination of Sole onion (100% broadcast) + Sweet gourd (3 plant plot^{-1}). The highest gross margin (Tk. 2,44,596 ha^{-1} and Tk. 2,92796 ha^{-1}) was obtained from the combination of Sole onion (100% broadcast) + Sweet gourd (3 plant plot^{-1}) followed by Sole onion (100% broadcast) + Sweet gourd (2 plant plot^{-1}). During the both years minimum gross return (Tk. 2,38,000 ha^{-1} and Tk. 2,50,000 ha^{-1}) and gross margin (Tk. 1,83,755 ha^{-1} and Tk. 1,95,755 ha^{-1}) was obtained from the sole onion treatment.

Table 3. Economic performances of sweet gourd onion intercropping system during rabi 2012-2013 and 2013-2014

Treatment	Yield t ha^{-1}				Total cost of cultivation (Tk ha^{-1})		Gross return (Tk. ha^{-1})		Gross Margin (Tk. ha^{-1})	
	Onion		Sweet gourd							
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
T_1	11.90	12.5	-	-	54,245	54,245	2,38,000	2,50,000	1,83,755	1,95,755
T_2	-	-	24.5	25.9	59,273	59,273	2,45,000	2,59,000	1,85,727	1,99,727
T_3	8.51	9.73	8.93	9.90	68,314	68,314	2,59,500	2,93,600	1,91,186	2,25,286
T_4	6.24	7.20	14.8	16.9	82,382	82,382	2,72,800	3,13,000	1,90,418	2,30,618
T_5	6.50	6.51	21.1	25.9	96,404	96,404	3,41,000	3,89,200	2,44,596	2,92,796
T_6	3.56	4.60	24.6	26.2	1,10,518	1,10,518	3,17,200	3,54,000	2,06,682	2,43482

Selling price: Onion Tk. 20/- kg^{-1}; Sweet gourd Tk. 10/- kg^{-1}

Note: Y_1= 2012-2013, Y_2= 2013-2014; T_1=Sole onion (BARI Peaj-1) (Broadcast), T_2=Sole sweet gourd (2m x 2m), T_3= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (1 plant $plot^{-1}$) (8m × 8m) (625 number plant population ha^{-1}), T_4= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (2 plant $plot^{-1}$) (4m × 4m) (1250 number plant population ha^{-1}), T_5= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (3plant $plot^{-1}$) (2.67m × 2.67m) (1875 number plant population ha^{-1}), T_6= Onion (BARI Peaj-1) (Broadcast) + sweet gourd (4 plant $plot^{-1}$) (2m × 2m) (2500 number plant population ha^{-1})

IV. Conclusion

The aforesaid results indicated that during the both years sweet gourd with onion was found profitable than sole cropping of onion. The broadcasting of onion (100%) + sweet gourd (3 plant plot-1) gave the maximum gross return and gross margin followed by the Sole onion (100% broadcast) + Sweet gourd (4 plants $plot^{-1}$). Therefore, from the two years result it may be concluded that broadcasting of 100% onion + sweet gourd (3 plant $plot^{-1}$) (2.67m × 2.67m) (1875 number plant population ha^{-1}) and onion broadcast (100%) + sweet gourd (4 plants $plot^{-1}$) (2m × 2m) (2500 number plant population ha^{-1}) may be recommended for the char areas in study region of Bangladesh.

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