Growth, Yield, Quality and Economic Impacts of Intercropping in Potato

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Abstract

A field experiment was conducted at the Instructional Farm of UBKV during rabi seasons of 2008 and 2009 to assess the effect of intercropping on growth, yield, and quality characters of potato with mustard in five different row ratio. The pooled result revealed that sole cropping of potato recorded maximum values for all the growth parameters. Highest potato equivalent yield per hectare (23.61 ton/ha) was obtained from potato and mustard intercropping with 2:1 row ratio. Potato and mustard grown in 1:1 row ratio recorded lowest value for all these yield attributes. The quality parameters namely starch, sucrose and glucose content of potato tuber were not significantly influenced by the different intercropping treatments. Potato and mustard intercropping system with 2:1 row ratio was found best user of biological resources as it recorded maximum values for LER(1.63) ,RCC (8.70) and lower values of aggressivity (-0.39) and competitive ratio (0.53) with highest net return (Rs.75255.25) and maximum B:C ratio (2.43) among all the treatment combinations. Potato + mustard grown in 1:1 ratio was found most competitive and aggressive than all other systems of intercropping.

1. Introduction

India ranks second in vegetable production in the world. In 2012-13 India produced 162.19 million tonnes of vegetables from 9.20 million hectare area in which West Bengal alone supplied 25.47 million tonnes which was nearly 15.7 percent of the country's total vegetable production (Annonymous 2013). Among different vegetables grown, potato is a promising vegetable for the farmers of terai ecological zone of West Bengal. But the productivity of this crop is lower compared to national average. Among different plant production tools, intercropping of compatible crops can be of great value in achieving the improved productivity without requiring significant additional resources. The types of intercrop and spatial arrangement in intercropping have important effects on the balance of competition between component crops and their productivity (Sarkar and Pal,

2004). Considering all these facts the present study has been undertaken to assess the growth, yield, quality and economic impacts of intercropping in potato with mustard in five different row ratio.

2. Material and Methods

The present experiment was carried out during rabi seasons of 2008 and 2009 at the instructional farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal. The climatic condition of terai zone is characterized by high rainfall, high relative humidity, moderate temperature, prolonged winter with high residual soil moisture. The soil was sandy loam in nature, coarse in texture, poor in water holding capacity with low pH. The treatments consisted of sole crop of potato and mustard and five different planting ratio of potato and mustard viz., 1:1,

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2:1, 3:1, 4:1 and 5:1. The treatments were laid out in randomized block design with four replications. The variety used for potato and mustard were Kufri Jyoti and B-9 respectively. A fertilizer dose of 150:100:125 kg/ha and 20:40:20 kg/ha were applied to potato and mustard respectively. Disease free well developed tubers were planted in furrows.Seeds of mustard were sown in between the rows of potato, spaced at 45 cm x 15 cm. The crops were raised under irrigated condition with recommended package of practices. In intercropping situations, mustard received the package of practices as in case of the main crop, potato. The observations on growth and yield and quality characters of potato were recorded by tagging ten randomly selected plants leaving the border rows from each plot of different treatments and their average values were worked out. For the intercrop like mustard only seed yield was recorded. The gross return, cost of cultivation, net return and benefit: cost ratio were calculated for economics of cultivation after computation of yield data and considering the existing rate of the produce in local market. Different crop competition indices were calculated as described by Willey (1979).

3. Results and Discussion

3.1. Growth Parameters

The pooled result, presented in Table 1 and Table 2, revealed that among different treatment combinations, sole cropping of potato recorded maximum values for all the growth parameters of potato like plant height (49.95 cm), number of shoots/hill (4.60), shoot weight/plant (515.71 g), root weight/plant (28.30g), shoot to root ratio (18.21), root length (8.16 cm), root volume/plant (62.90 cc), LAI(4.99) and leaf chlorophyll content (51.05 SPAD value). These values were closely followed by potato + mustard in 2:1 row ratio of intercropping. Higher values for all the growth parameters have been obtained with sole cropping of potato and potato and mustard in 2:1 row ratio of intercropping which might be due to better utilization of resources and less competition between both the component crops for solar radiation, increasing plant height compared to other intercropping treatments. This result is in conformity with the findings of Hussain (2003) and Sharma *et al*. (2009) in pea based and pearlmillet based intercropping systems respectively.

3.2. Yieldand Yield Attributing Parameters

Data presented in Table 3, revealed that as like growth attributing parameters, sole cropping of potato showed maximum tuber yield/ha (20.15 t/ha) which was closely followed by potato + mustard in 5:1 row ratio (18.59 t/ha) and potato + mustard in 2:1 row ratio (17.19 t/ha). This result was in conformity with Koohi and Nasrollahzadeh (2014).

But as per the potato equivalent yield is concerned, potato + mustard in 2:1 row ratio recorded maximum value (23.61 ton/ha) followed by sole cropping of potato (20.15 ton/ha) and potato and mustard in 5:1 (20.13 ton/ha).Potato and mustard in 2:1 row ratio of intercropping also showed maximum production efficiency (248.48 kg/ha/day). Potato + mustard in 1:1 ratio recorded lowest value for this yield attribute (14.30 ton). This result was in conformity with the findings of Meena *et al*. (2008) where they observed that, among different row ratio of clusterbean and sesame intercropping system, growing of these two crops in 2:1 row ratio recorded maximum values for equivalent yield. The maximum value of potato equivalent yield in 2:1 row ratio of potato and mustard was due to increased values of growth parameters. In contrast, potato+ mustard in 1:1 row ratio gave lowest potato equivalent yield which might be due to intense competition effect because of more population pressure of both potato and mustard.

3.3. Quality Parameters

After perusal of the data, presented in Table 3, it was observed that sole cropping of potato recorded maximum values for all the quality parameters but which was statistically at par with all most all the treatments combinations. The higher values of starch content with sole cropping of potato and potato and mustard in 2:1 row ratio of intercropping may be attributed to increased availability of nutrients in the soil that might lead to synthesis and accumulation of more photosynthates which could have mobilized the biosynthesis of starch. These results were in accordance with the findings of Sharma*et al*. (2009) who conducted a field trial at Sabour, Bihar during summer seasons of 2007 and 2008 to assess the productivity and economics of pearlmillet with cowpea, cluster bean and rice bean under different planting proportions and found that highest crude protein yield (1.36t/ha) was observed with intercropping of pearlmillet with cowpea in 2:2 ratio which showed statistical parity with pearlmillet + rice bean (2:1) system. The increase in crude protein yield was mainly because of variation in dry matter content of component crops.

3.4. Competition Functions

The experimental results, related to competition functions, presented in Table 4, showed that LER values were more than one in all the intercropping treatments, except potato + mustard in 1:1 row ratio of intercropping, indicating better utilization of biological resources than monocropping of potato. Potato and mustard in 2:1 row ratio of intercropping recorded maximum value (1.63) of LER which means this model of intercropping was maximum user all the available

resources like light, moisture, etc. On other hand due to more competition effect potato + mustard in 1:1 row ratio of intercropping showed minimum LER value (0.91). Ahlawat *et al* (2005) while studying the performance of chickpea based intercropping system also found that intercropping of barley with chickpea in 2:1 ratio recorded maximum value for LER (1.13) than all other intercropping and sowing proportions. Relative crowding coefficient (RCC) of the system was greater than one in all the treatment combinations, signifying yield advantage over monocropping of potato.Potato grown with mustard in 2:1 ratio recorded maximum relative crowding coefficient value (8.70 as product value) followed by potato and mustard in 3:1 growing combination (3.72 as product value). Higher values ofrelative crowding coefficient in 2:1 row ratio is probably due to better land utilization of the system as it recorded highest values of LER and minimum values for aggressivity. Potato intercropped with mustard in 1:1 row ratio has been found most competitive than all other systems of intercropping as it recorded highest (1.81) competitive ratio (CR) and aggressivity indices (0.26) which might be due to presence of equal number of potato and mustard rows who have competed aggressively for the resources like light, nutrient, moisture, etc. and which ultimately led the highest value for this parameter. Potato grown in association with mustard in 2:1 row ratio was least competitive as it showed minimum competitive ratio(0.42) and aggressivity indices (-0.39).Sharma *etal*.(2009) also found that minimum

aggressivity index (0.13) was recorded with pearlmillet + rice bean, followed by pearlmillet + cowpea both in 2:1 ratio.

3.5. Economics of Production

After perusal of the data, presented in Table 5, related to economics of production of potato and mustard intercropping system, it was found that planting of these two crops in different row ratio has significant effect on economics of production. Maximum net return and benefit cost ratio (Rs 75255.25 and 2.43, net return and B: C ratio respectively) were obtained with potato +mustard in 2:1 intercropping system followed by potato + mustard in 3:1(Rs 50766.40.00 and 1.50 net return and B: C ratio respectively) and 5:1(Rs 52561.10 and 1.38 net return and B: C ratio respectively) row ratio of potato and mustard intercropping systems. It was also found that all the intercropping treatments were more remunerative than sole cropping of potato. Sole cropping of potato recorded minimum values for net return and B: C ratio (Rs 44572.50 and 0.97 respectively). Among different combinations, potato, grown with mustard in 2:1 row ratio was found most remunerative which might be due to maximum potato equivalent yield and comparatively lower cost for cultivation than most of the treatments. This result was in conformity with the findings of Meena *et al*. (2008) who found that intercropping of cluster bean + sesame in 2:1 proportion was most remunerative than all other systems of intercropping as it recorded maximum net return (Rs 2724/ha) and highest B: C ratio (1.79).

Table 1. Effect of intercropping on growth parameters of potato

Treatment	Plant height(cm)	No. of shoots/hill	Shoot weight (g)	Root weight /plant (g)
Sole potato	49.95	4.60	515.71	18.21
Potato + mustard (1:1)	30.76	1.77	335.89	17.33
Potato + mustard (2:1)	44.91	3.46	462.73	17.34
Potato + mustard (3:1)	43.29	3.17	420.79	16.35
Potato + mustard (4:1)	42.24	2.82	408.01	16.78
Potato + mustard (5:1)	37.44	2.24	392.96	17.08
S.Em (±)	1.68	0.49	33.95	1.45
CD at 5%	4.88	1.42	98.89	4.22

Table 2. Effect of intercropping on growth parameters of potato

Treatment	Shoot to root ratio	Root length (cm)	Root volume /plant (cc)	Leaf Area Index(LAI)	Chlorophyll content (SPAD 502value)
Sole potato	18.21	8.16	62.90	4.99	51.05
Potato +mustard (1:1)	17.33	5.71	50.48	2.54	35.73
Potato + mustard (2:1)	17.34	7.07	58.68	4.24	47.43
Potato + mustard (3:1)	16.35	6.78	55.50	3.81	45.01
Potato + mustard (4:1)	16.78	6.68	55.44	3.16	41.89
Potato + mustard (5:1)	17.08	6.29	55.03	3.10	40.34
S.Em (±)	1.45	0.37	1.78	0.39	2.23
CD at 5%	4.22	1.08	5.19	1.15	6.49

Table 3. Effect of intercropping on yield and quality parameters of potato

Treatment	Tuber yield per plot(kg)	Tuber yield /ha (ton)	Potato equivalentyield/ha (ton)	Starch content (%)	Sucrose content (%)	Glucose content (%)
Sole potato	35.70	20.15	20.15	13.52	2.51	0.53
Potato +mustard (1:1)	20.22	11.73	14.30	11.39	1.14	0.23
Potato + mustard (2:1)	29.50	17.19	23.61	13.04	2.32	0.51
Potato + mustard (3:1)	25.12	14.22	18.78	12.09	2.10	0.43
Potato + mustard (4:1)	27.09	15.38	17.41	11.65	1.73	0.34
Potato + mustard (5:1)	31.01	18.59	20.13	11.41	1.56	0.33
S.Em (±)	1.84	1.03	1.37	1.24	0.40	0.08
CD at 5%	5.36	2.99	4.00	3.61	1.16	0.26

Table 4. Effect of intercropping on competition function of potato

Treatment	Land equivalent ratio	Aggressivity		Relative crowding coefficient			Competitive ratio	
		MC	IC	MC	IC	Product	MC	IC
Sole mustard	1.00	-	-	-	-	-	-	-
Sole potato	1.00	-	-	-	-	-	-	-
Potato +mustard (1:1)	1.00	0.26	-0.26	1.51	0.98	1.48	1.81	0.57
Potato + mustard (2:1)	0.91	-0.39	0.39	2.67	3.26	8.70	0.42	2.42
Potato + mustard (3:1)	1.63	-0.34	0.34	2.43	1.53	3.72	0.51	1.99
Potato + mustard (4:1)	1.29	-0.07	0.07	3.22	0.36	1.16	0.76	1.15
Potato + mustard (5:1)	1.02	-0.05	0.05	3.87	0.28	1.08	0.87	1.21

Table 5. Economics of potato based intercropping system

Treatment	yield (t/ha)	Gross income (Rs)	Treatment Cost (Rs.)			Net return (Rs)	Benefit:cost ratio(BCR)
			Fixed cost	Variable cost	Total cost		
Sole potato	20.15	90675.00	37057.50	9045.00	46102.50	44572.50	0.97
Sole mustard	1.02	35700.00	9385.00	6896.00	16281.00	19419.00	1.19
Potato + mustard (1:1)	14.30	64350.00	19479.70	11545.00	31024.70	33325.30	1.07
Potato + mustard (2:1)	23.61	106245.00	20939.75	10050.00	30989.75	75255.25	2.43
Potato + mustard (3:1)	18.78	84510.00	22127.85	11615.75	33743.60	50766.40	1.50
Potato + mustard (4:1)	17.41	78345.00	23916.30	13290.00	37206.30	41138.70	1.11
Potato + mustard (5:1)	20.13	90585.00	24163.90	13860.00	38023.90	52561.10	1.38

Sale price of potato @ Rs 4.50/kg; mustard @ Rs 35/kg

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