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Research Article

Relay cropping of cucurbits in furrows under bed planted wheat for higher profitability

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Abstract

A field experiment was condcuted for four consecutive seasons from 2016-17 to 2019-20 at ICAR- Indian Institute of Wheat and Barley Research, Karnal, Haryana with an objective to increase the profitability through relay crops of cucurbits under bed planted wheat crop. Eight relay crops namely musk melon, water melon, bottle guard, ridge guard, bitter guard, cucumber (kheera), cucumber (tarkakari) were planted under bed planting system with wheat. All the cucurbits were relayed in furrows at milk stage of wheat. Combined over four years analysis revealed that wheat + bottle guard produced maximum and signifiantly higher wheat equivalent yield (WEY), gross return, net return and B: C ratio, which was 80.5%, 80.5%, 227.1% and 80.0% higher than sole wheat crop, respectively. Next best profitable treatment was wheat + cucumber (tarkakari), which also produced 39.8%, 112.3% and 40.0% higher WEY, net return and B: C ratio as compared to sole wheat crop, respectively. All the relayed cucurbits were profitable than sole wheat crop and there was no adverse effect on yield attributes and wheat yield . Thus, small and marginal farmers can adopt this relayed cropping sytem to maximise their profit per unit time and space.

Key words: Bed planting, Cucurbits, Profitability, Relay cropping, Wheat

1. Introduction

The small and marginal farmers are incrseaing rapidly and more than 85 per cent farmers belongs to this category in India (Tripathi *et al.*, 2017) . This situation is much more severe in north eastern plain zone (NEPZ). Keeping in mind the slogan of prime minister regarding the doubling the farmers income, land productivity per unit area per unit time requires immediate attention. This will be possible by adopting multiple cropping which increases the profit per unit area and per unit time (Seran and Brintha, 2010; Khan *et al.*, 2014). The small and marginal farmer of NEPZ practice wheat seeding mainly by broadcasting, which is detrimental to wheat yield, may achieve higher spatial and temporal productivity by adopting Furrow Irrigated Raised Bed (FIRB) technology and relay cropping of cucurbits with wheat. In present circumstances, it is important to reduce the cost of production in systematic manner and to make the produce competitive in the global market. In this endeavor, Furrow Irrigated Raised Bed (FIRB) technology can be a stepping stone in encouraging for enhancing the income of farmers. In this planting system, crops are grown on top of beds 40 cm and furrows are utilized as input management zone. This cost will be further reduced if same beds are reshaped for succeeding crops. This technology saves 25 to 50 % seed, 25 % N and 15 to 40 % water in wheat over recommended level (Chauhan *et al.*, 2001). Besides this, it has additional advantages like intercultural operations in standing crop, N placement between the rows by suitable machinery instead of top dressing, manual weeding, lesser *Phalaris minor* germination on the top of beds and reduction in lodging

(Tripathi *et al.*, 2001). Adoption of bed planting for wheat cultivation provides an opportunity to utilize the furrow for intercropping or relay cropping of suitable crops in order to achieve higher profitability. Many intercropping crops like sugarcane, vegetables, seed spices, mentha etc can be grown in furrows along with wheat under bed planting (Sayre and Moreno Ramos, 1997). Diversifying crop rotation improves system robustness through increasing crop resistance and resilience from biotic-induced disturbances and the most diversified cropping systems had a 14% advantage in system robustness (Li *et al,* 2019).

The aim of researcher should be to maximise the profitabilitry of small and marginal farmers without much increase in cost of cultivation. Even small increase in profit of poor farmers will have an impact on their livelihoods. To utilise furrows for relay cropping of cucurbits in wheat under bed planting is one of the options to explore profit maximisation strategy for poor farmers. Keeping this as preamble, number of cucurbits were tried in furrows during milk stage of wheat to maximise the system profitability.

2. Materials and Methods

A field experiment was conducted during *Rabi s*easons of 2016-17 to 2019-20 at ICAR-Indian Institute of Wheat & Barley Research, Karnal (Latitude 29⁰ 43' N, longitude 76⁰ 58' E and altitude 245 m) in randomized block design with three replications. The soil was moderately well drained coarse textured sandy loam (62.1% sand, 26.6% silt and 11.3% clay) with low to moderate fertility. Baseline soil samples were collected (0–15 cm depth) from each test site (three) at the start of experiment and analyzed for pH (using a soil water solution of 1:2.5 wt/v), soil organic carbon (Walkley and Black, 1934), available N (Jackson, 1958), available P (Olsen, 1954) and available K (Merwin and Peech, 1951). The soil was having 0.3 % organic carbon, 113.9 kg/ha available N, 12.4 kg/ha available P and 154.9 kg/ha available K with an alkaline pH of 8.3 and EC of 0.13 dsm^{-1}. Meteorogical data recorded during experimental period is represented in figure 1. No major weather extremities were observed and all weather parameters were congenial during crop growth period except rainfall during 2019-20. Wheat variety HD 2967 was sown under bed planting method using recommended rate of seed. At milk stage of wheat, seedlings of musk melon (*Cucumis melo*), water melon (*Citrullus lanatus*), bottle guard (*Lagenaria siceraria*), ridge guard (*Luffa acutangula*), bitter guard (*Momordica charantia*), cucumber (*Cucumis sativus*) and armenian cucumber (*Cucumis melo* var. *flexuosus*) were transplanted. Besides, sole wheat was raised for their comparison. These cucrbits were planted at spacing of 1.0 m between the plant to plant and 1.4 m between the rows consiting of four beds. These were picked up to June in each year. Before transplanting, seedlings of all these relayed crops were raised separately in control environment. All the plants of relay crops survived and started spreading over soil surface. However, spreading speed was increased after wheat harvest. After harvesting of preceding rice crop, the field was prepared using cultivator and disk and seeding was done as per the treatments. Recommended dose of fertilizer (150 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha) was applied to the wheat crop. Full dose of phosphorous in the form of diammonium phosphate and potash in the form of muriate of potash and one third dose of nitrogen in the form of urea was applied as basal i.e before sowing. Remaining two third dose of nitrogen was top dressed in two splits at 1st node stage (DC 31) (Zadoks *et al.*, 1974) and at boot stage (DC 41). Other standard agronomic practices were done as per package of practices for the area. Observations were recorded on above ground biomass, yield and yield attributing characters. Grain yield was calculated from net plot area and converted into q/ha. Bearings of musk melon, water melon, bottle guard, ridge guard bitter guard, and cucumber were taken as yield of these crops. In case of wheat, harvest index (HI) was calculated by dividing grain yield with biomass. Number of earhead per meter row length was counted at two places in each plot and converted to per m^2. Thousand grains weight (TGW) was calculated by taking random grain samples and counted by using Contador electronic seed counter (Pfeuffer, Germany) and weighed. Cost of cultivation was calculated by taking into account the prevailing price of inputs like fertilizer, seed, herbicides, irrigations, tillage operations, transportation charges, management charges, rental value of land and depreciation cost of implements. Economic returns were calculated by taking minimum support price of wheat grain and market price of wheat straw and cucurbits. System productivity in terms of wheat equivalent yield (WEY) was calculated by multiplying yield with minimum support price/market price of each crop in a cropping sequence and subsequently adding and thereafter divided by price of one quintal wheat. The experimental data on wheat yield and yield attributing parameters, WEY, cucurbits yield and economics were subjected to standard statistical analysis as outlined by Gomez and Gomez (1984).

3. Results and discussion

3.1 Year effect

In 2018-19, biomass, grain yield, HI, thousand grain weight, grains/earhead, cucurbits yield, WEY, gross return, net return and B:C ratio were maximum whereas number of earhead/m^2 was lowest as compared to other years. However, system productivity in terms of wheat equivalent yield, gross return, net return and B:C ratio of 2018-19 found non significant with 2016-17. Contrarily, year 2018 recorded significantly lower values with respect to all above mentioned parameters when compared to all other experimental years. This yearly variation in yield and yield parameters was might be due to variation in weather parameters like rainfall and minimum and maximum temperatures during crop growth period (Figure 1). More number of rainy events, higher amount of rainfall and lowering of maximum temperatures during March and April of 2018-19 might attributed the higher yield and yield parameters.

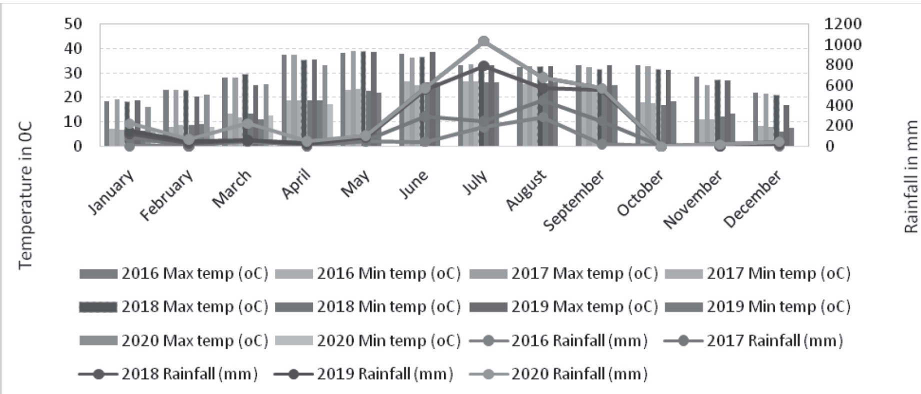

Figure 1. Maximum and minimum temperature and rainfall during the cropping years

3.2 Wheat yield, cucurbits yield and system productivity

Pooled analysis revealed that, relay cropping of cucurbits didn't show any significant effect on wheat yield and yield attributes (Table 1). Among the all cucurbits studied, superior cucurbit yield was obtained under wheat + bottle guard (100.22 q/ha) as compared to other relayed cucurbits. This higher cucurbit yield of bottle guard was mainly attributed to its high yielding potential over other cucurbits. However, wheat + Armenian cucumber was next best combination. On the contrary, the lowest yield was recorded under wheat + cucumber (10.37 q/ha).

Table1. Wheat yield and yield attributes of relayed crops in pooled analysis of four years

Treatments	Biomass (q/ha)	Yield (q/ha)	HI	Earhead/ m^2	1000 grain weight, g	Grains/ earhead
2016-17	146.18	59.55	0.408	450.7	39.19	33.74
2017-18	121.03	50.33	0.416	368.5	41.04	33.37
2018-19	146.15	62.44	0.427	374.0	46.63	36.17
2019-20	130.75	52.56	0.403	479.9	38.83	28.38
CD ($P\leq0.05$)	3.26	1.57	0.006	16.3	0.61	1.74
Relay cropping						
1. Wheat+musk melon	136.17	55.55	0.407	415.0	41.37	32.6
2. Wheat+-water melon	136.14	56.53	0.417	415.4	41.45	33.2
3. Wheat+bottle guard	133.37	54.98	0.413	418.2	41.08	32.4
4. Wheat+ridge guard	135.83	56.33	0.414	421.3	41.19	32.8
5. Wheat+bitter guard	133.17	55.47	0.417	416.3	41.72	32.6
6.Wheat+cucumber	138.34	54.41	0.408	419.4	41.48	32.7

7. Wheat+ Armenian cucumber	136.20	56.82	0.418	423.2	41.62	32.9
8. Wheat sole	138.99	57.65	0.414	417.7	41.47	34.0
CD (P≤0.05)	NS	NS	NS	NS	NS	NS

All the relayed cucurbits produced higher system productivity in terms of wheat equivalent yield (WEY) than wheat sole crop. Maximum and significantly higher WEY was obtained by wheat + bottle guard (131.1 q/ha), which was 80.5% higher than sole wheat crop. Next highest treatment was wheat + Armenian cucumber which also produced 39.8% higher than sole wheat crop. Significantly the lowest yield was obtained with wheat + cucumber, which was at par with sole wheat crop (Table 2). This was mainly because of higher cucurbit yield and its higher market price. In all the four years, this was the trend where wheat + bottle guard produced maximum WEY followed by wheat + Armenian cucumber, both were significantly higher than all other treatments. These findings are in harmony with the results of Dua *et al.* (2007) and Talukder *et al.* (2016). Tripathi *et al.* (2017) also reported 36.37% higher wheat equivalent yield (92.46 q/ha) under intercropping of wheat on bed + radish in furrow over sole wheat crop. Similarly, Sharma *et al.* (2017) also recorded significantly higher rice equivalent yield with relay cropping of pea at 15 days after flowering of *kharif* rice.

Table 2. WEY, cucurbits yield and economics of relayed crops in pooled analysis of four years

Treatments	Wheat Equivalent Yield (q/ha)					Cucurbits yield (q/ha)	Return (Rs/ha)	Net return (Rs/ha)	B:C
	2016-17	2017-18	2018-19	2019-20	Pooled				
2016-17					100.30		162990	86739	2.14
2017-18					77.47		125883	49633	1.65
2018-19					102.65		166815	90565	2.19
2019-20					88.85		144384	68134	1.89
CD (P≤0.05)					2.46		3997	3997	0.29
Relay cropping									
1. Wheat+musk melon	86.4	73.0	87.0	70.7	79.27	14.36	128813	52563	1.69
2. Wheat+-water melon	93.2	76.5	97.7	105.6	93.25	35.78	151532	75282	1.98
3. Wheat+bottle guard	144.3	98.1	145.7	136.4	131.14	100.22	213094	136844	2.79
4. Wheat+ridge guard	106.4	73.2	110.4	85.1	93.78	37.01	152403	76153	2.00
5. Wheat+bitter guard	102.1	75.1	105.9	72.6	88.93	31.05	144512	68262	1.89
6.Wheat+cucumber	82.7	67.7	86.5	74.7	77.92	10.37	126617	50367	1.66
7. Wheat+ Armenian cucumber	110.3	87.4	110.9	97.7	101.59	48.93	16508.	88833	2.17
8. Wheat sole	76.9	68.8	77.0	68.0	72.67	0.0	118090	41840	1.55
CD (P≤0.05)	6.56	8.14	6.06	6.82	3.24	-	5264	5264	0.07

3.3 Economics

Wheat+bottle guard relay cropping recorded significantly the highest gross return (Rs. 213094/ha, net return (Rs. 136844/ha) and B:C ratio (2.79) as compared to other relay systems (Table 2). Increase in gross return, net return and B:C ratio of wheat + bottle guard relay system over sole wheat crop was to the extent of 80.5% 227.1% and 80.0%, respectively. Next best treatment was wheat + Armenian cucumber which recorded 112.3 % of higher net return and 40.0 % of higher B: C ratio over sole wheat crop. In contrast, the lowest economic return among the relayed crops was obtained by wheat + cucumber (kheera) and it was found non significant with sole wheat crop. These results are in accordance with the findings of Ali *et al.* (2015) and Habimana *et al.* (2019). In similar kind of study, Tripathi *et al.* (2017) also reported that growing of radish in furrows and wheat on to top bed was more profitable than sole wheat crop.

In nut shell, this technology is a boon to small and marginal farmers to maximize their profits through relayed cropping of cucurbits under bed planted wheat crop.

Conflict of Interest

Authors declares that they do not have any conflict of interest

Ethical Compliance Statement

NA

Authors Contribution

Conceptualization of research and designing of experiments (SCT), Data collection and analysis (SCT, RPM), Preparation of manuscript (SCT, RPM, SC).

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