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EFFECT OF INTEGRATED CROP MANAGEMENT PRACTICES ON YIELD AND ECONOMICS OF WATERMELON (*Citrullus lanatus* L.) IN KHAMMAM DISTRICT OF TELANGANA

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ABSTRACT
The present investigation was conducted in different villages under Krishi Vigyan Kendra, Wyra, Khammam operational areas during 2016-17 to 2018-19. Total 30 front line demonstrations were laid out on farmers' fields in the district. The result of present study revealed that average highest yield 41.5 t/ha was noted in demonstration plot over control (28.5 t/ha) and 43.31 percent of average yield increase was recorded over control plot. Fruit cracking percentage was high in control plot (20.26%) over demonstration plot *i.e* 10.06 percent. The extension gap ranged from 12.5 t/ha to 13.5 t/ha and technology gap ranged between 5 to 11.5 t/ha respectively, with the technology index of 17 percent during the demonstration years. Besides this, the demonstrated plots gave higher gross returns, net returns with higher benefit cost ratio when compared to farmer's practice. In present study efforts were also made to study the impact of FLD on horizontal spread which has increased by 105 %, if appropriate package and practices were followed. Further, the study was undertaken to do a formative and summative (outcome and impact) evaluation of the frontline demonstration on integrated crop management in watermelon.

INTRODUCTION

Watermelon *Citrullus lanatus* (Thunb.) is one of the important fruit cultivated in the tropics and is consumed throughout the world. Watermelon [*Citrullus vulgaris* L. sin *C. lanatus* (Thlumb) *Mansf.* is also known as tarbuj, tarmuj, kalingad and kalindi in different parts of India. It belongs to *Cucurbitaceae* family (Panigrahi and Sharma, 2017). Melons, as a general term are sweet, juicy and tasty fruits being consumed mainly in the hot season. The crop is native of Africa and in India it is widely grown in Rajasthan, Maharashtra, West Bengal, Uttar Pradesh, Andhra Pradesh and Telangana. In India area under watermelon was 95,520 hectares with a production of 23, 62,160 tonnes. In Telangana, production of watermelon was around 48,970 tonnes in an area of 2,750 ha. (NHB: 2017-18). It is generally grown in summer season in most parts of Telangana state under assured sources of water. It is a warm season crop and requires relatively high temperature for quality fruit production. In some areas it is cultivated throughout the year. Demand for this fruit is mainly in summer. A watermelon fruit contain 95 percent water, 0.2 percent protein, 0.3 percent minerals and 3.3 percent carbohydrates per 100g fresh weight (Edwards *et al*., 2003). The fruits of watermelon are good source of sugar, vitamin A, C, B1, B2 and B6.Watermelon is relished by many people across the world as a fresh fruit. Among all members of cucurbitaceous crops, watermelon is rich in iron content (Adojutelegan *et al*., 2015). Watermelon with red flesh is a significant source of lycopene. Preliminary research indicates the consumption of watermelon may have antihypertensive effects (Lilly, 2013 and Makaepea *et al*., 2019).

In Khammam district, Watermelon crop was raised in the month of January to May. Generally seeds were sowed on the beds without mulching and drip irrigation. During summer, when the rise in temperature leads to increase of staminate flowers, high incidence of sucking pest and viral diseases was increased in watermelon. Plant growth became stunted, fruit cracking and blossom end rot was observed. Finally, these may leads to reduction in fruit quality, yield and increasing in cost of production. In order to overcome these problems, a technology integrated crop management in watermelon was introduced and conducted front line demonstration with an objective to disseminate the technology to farmers and to identify the technology gap, extension gap and technology index.

MATERIALS AND METHODS

Krishi Vigyan Kendra, Wyra carried out front line demonstrations (10 per year) from 2016-17 to 2018-19 to spread the technology to farmers. Each frontline demonstration was laid out on 0.4 ha area which was taken as demo while

adjacent 0.4 ha was taken as control for comparison of farmer's practice. The farmers were selected randomly on the basis of surveys, diagnostic visits and farmer meetings conducted by KVK and trainings imparted on integrated crop management in watermelon. The factors that contribute to low productivity like unavailability of quality seed, gaps in cultivation practices and plant protection measures were identified. Improved method of crop production technology with recommended management practices were applied as an intervention to manage these problems. The recommended practices include- Spraying of Boron @ 3g/lit of water once at 2 to 4 leaf stage and another at flowering stage along with thinning of plants, apical shoot removal, timely irrigations, fertilizer application through drip, mulching and application of need based chemicals and pesticides. The differences in the packages were in line with the findings of Dilip Singh (2017), Morwal *et al*. (2018) and Babu and Rao (2018).

The traditional practices were taken as a control. Field days were also conducted in each cluster to show the results of front line demonstration to the farmers of the same village and neighboring villages. In general, soils of the area under study were sandy to sandy loam with low to medium fertility status and the average annual rainfall of this area is 1036 mm and temperature varies from 24 to 43 ºC with average temperature of 30ºC.

Data on earliness, yield and yield attributing characters, fruit cracking percentage, expenditure incurred by the farmer (Farmer's practice) and expenditure of demonstration plots were collected and analyzed. Gross income was calculated based on local market prices of water melon and net income by subtracting the total cost of cultivation from gross income. B: C ratio was computed by dividing gross returns with cost of cultivation.

To estimate the technology gap, extension gap and technology index the following formula as mentioned below were used as suggested by Samui *et al*. (2000), Sagar and Chandra (2004) and Dayanand *et al*. (2012).

Per cent increase in yield = Demonstration yield - Farmers yield X 100 / Farmers yield

Technology Gap = Pi (Potential yield) – Di (Demonstration yield)

Extension Gap = Di (Demonstration yield) – Fi (Farmers yield)

Technology index = [(Potential yield – Demonstration yield/ Potential yield) X 100].

The data on adoption and horizontal spread of technologies were collected from selected farmers with the help of schedule. Data were subjected to suitable statistical methods. The following formulae were used to assess the impact on different parameters of water melon crop.

Impact of yield = Yield of demonstration plot- yield of control plot/Yield of control plot X 100

Impact on adoption (% change) = No. of adopters after demonstration - No. of adopters before demonstration /No. of adopters before demonstration X 100

Impact on horizontal Spread (% change) = After area (ha) - Before area (ha)/ Before area $\times 100$

RESULTS AND DISCUSSION

The data were pooled on different parameters and the results obtained were discussed accordingly. The demonstrated package and farmers practices details were given in Table1.

Table 1: Difference between demonstrated package of practices and farmers' practice of watermelon cultivation

S.No	Particulars	Water melon	
		Demonstrated package	Farmers practice
1	Sowing time	Jan-Feb	Dec-Jan
2	Seed rate	3 kg per ha	5 kg per ha
3	Preparation of Raised beds along with drip and mulching	Preparation of Raised beds along with drip and mulching -Practiced	Preparation of raised bed along with drip – not practiced
4	Spraying of boron or ethrel at 2-4 leaf stage	Foliar spraying of Boron @ 3g/lit once at 2-4 leaf stage, another at flowering stage (or) 500 mg/lit at 2-4 leaf stage	No boran or ethrel application
5	Thinning of plants at 10-15 days after sowing	Practiced plant thinning	Plant thinning-Not practiced
6	Apical shoot removal	Apical shoot removal practiced	Removal of apical shoot not practiced
7	Application of recommended dose of fertilizers	100: 100: 60 kg per ha NPK fertilizers were applied; Half of the fertilizer as basal dose and remaining half of N& K fertilizers 25 days after planting	Recommended dose of fertilizers were not followed
8	Fertigation along with mulching	Application of soluble fertilizers along with drip irrigation	furrow method of irrigation
9	Spraying of need based pesticides	Need based spray of insecticides and fungicides (Carbendazim 50 WP, Dimethoate, Zineb 68%)	Higher dose of insecticides and pesticides
10	Weed management	Pre plant application of herbicides trifluralin @1.2 kg/ha, use of Black polythene mulch on raised beds	3-4 times Hand weeding
11	Harvesting at proper stage	Fruits are harvested on withering of tendril, change in belly colour or ground spot to yellow and the mature fruit gives dull sound while thumbing	Pre mature harvesting without any thumbing test and ground spot to yellow

Table 2: Effect of Integrated crop management on earliness, yield and yield attributing characters of Water melon

Year	Node from which first female flower emerged		Average fruit weight (Kg)		Number of fruits per plant		Fruit yield per plant (kg)		Total yield per ha (t/ha)		Fruit cracking percentage (%) yield		Percentage increase in
	Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check	
2016-17	12	15	2.8	2.6	6	4	16.8	9.6	42	29	8.4	20.8	45.77
2017-18	13	15	3.3	2.5	5	4	16.5	10.4	38.5	25	11.2	21.5	41.17
2018-19	12	16	3.6	2.8	5	3	17.6	9.8	45	31.5	10.6	18.5	43
Average	12.33	15.33	3.23	2.63	5.33	3.66	16.96	9.93	41.5	28.5	10.06	20.26	43.31

Table 3: Cost economics of FLD on ICM in watermelon

Year	Fruit yield per ha (t/ha)		Gross expenditure per ha (Rs.)		Gross returns per ha (Rs.)		Net Returns (Rs.)		B:C ratio	
	Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check
2016-17	42	29	132750	98000	298000	186000	165250	88000	2.24	1.89
2017-18	38.5	25	163000	135000	331000	254000	168000	119000	2.03	1.88
2018-19	45	31.5	155000	130000	360000	236250	205000	106250	2.32	1.82
Average	41.5	28.5	150250	121000	329666.7	225416.7	179416.7	104416.7	2.2	1.86

Table 4: Fruit yield, extension gap, technology gap and technology index in integrated crop management in watermelon under FLD

Year	Fruit yield per ha (t/ha)		Techno logy gap (t/ha)	Exten sion gap (t/ha)	Tech nology index
	Demo	Check			
2016-17	42	29	8	13	16
2017-18	38.5	25	11.5	12.5	23
2018-19	45	31.5	5	13.5	10
Average	41.5	28.5	8.16	13	17

* potential yield: 50 t/ha

Table 1 show that all the FLD farmers fully adopted the recommended package of practices with slight modifications where as non-FLD farmers were unable to adopt the practices.

Effect of Integrated crop management practices on earliness, yield and yield attributes

Earliness attributes

An average node from which first female flower emerged under demonstrated package was 12.33 whereas it was 15.33 in case of farmers practice over pooled data of three years of demonstrations. It indicates demonstrated package gave earliness over farmers practice.

Yield and yield attributing characters

Integrated Crop Management practices in watermelon lead to marked effect on Water melon fruit yield. The yield performance indicators are presented in Table 2.

The cumulative effect of demonstrated package over three years revealed an average fruit weight of 3.23kg compared to farmers practice 2.63 kg. The number of fruits per plant-under demo recorded was 6, 5 and 5 compared to control 4, 4 and 3 during 2016-17, 2017-18 and 2018-19 respectively. The cumulative effect of demonstrated package over three years, revealed an average number of fruits per plant as 5.33, whereas in control it was 3.66 fruits per plant.

The fruit yield per plant under demonstrated package was 16.8kg, 16.5 kg and 17.6 kg in demonstration plots compared to 9.6 kg, 10.4 kg and 9.8 kg in control plots during 2016-17, 2017-18 and 2018-19 respectively. The cumulative effects of technological interventions over three years revealed an average fruit yield 16.96 kg per plant compared to 9.93 kg in control.

The fruit cracking (%) of Water melon under demo recorded were 8.4 percent, 11.2 percent and 10.6 percent in demo plots compared to 20.8 percent, 21.5 percent and 18.5 percent in control plots during 2016-17, 2017-18 and 2018-19 respectively. The cumulative effect of technological interventions over three years revealed an average fruit cracking (percentage) of 10.06 percent in demo compared 20.26 percent in control.

The total fruit yield per ha under demonstrated package recorded were 42 t, 38.5 t and 45 t in demo compared to 29 t, 25 t and 31.5 t in control plots during 2016-17, 2017-18 and 2018-19 respectively. The cumulative effects of technological intervention over three years revealed an average total fruit yield per ha as 41.5 t in demo compared to 28.5 t in control plots. The average total yield per ha of watermelon is increased by 43.31 percent over the yield obtained under farmer's practice. The year-to-year fluctuations in yield and cost of cultivation can be explained on the basis of variations in prevailing social, economic and microclimatic condition of that particular location. The above findings are in similarity with the findings of Yusuf *et a*l. (2013) in water melon.

Economic parameters

Economic indicators *i.e.* gross expenditure; gross returns, net returns and BC ratio of Front Line Demonstration are presented in Table 3. The data clearly revealed that net returns from the demonstration plot were substantially higher than control plot, *i.e.* farmers practice during all the years of demonstration. Average net returns from demonstration plot were Rs. 1,79,416.7 /ha compared to Rs 1,04,416.7/ha in control.

The average gross expenditure from the demonstration plot was recorded as Rs.1,50,250 per ha compared to Rs. 1,21,000 per ha in control. The average gross returns from the demonstration plot were Rs. 3,29,666.7/ha compared to Rs. 2,25,416.7/ha in control plots.

Economic analysis of the yield performance revealed that

Table 5: Impact of Front Line Demonstration (FLDs) on horizontal spread of integrated crop management in Watermelon

Name of the technology	Area (ha)		Change in area	Impact (% change)
	Before demonstration	After demonstration		
Integrated crop management in watermelon	16	32.8	16.8	105

benefit cost ratio of demonstration plots was observed to be significantly higher than control plot *i.e.*, farmer practice. The benefit cost ratio of demonstrated and control plots were recorded as 2.24, 2.03 and 2.32 and 1.89, 1.88 and 1.82 during 2016-17, 2017-18 and 2018-19 respectively. The cumulative effect of technological interventions over three years, revealed an average benefit cost ratio of 2.20 in demonstration plots compared to 1.86 in control plots.

Technology gap

The technology gap, the difference between potential yield and yield of demonstration plots was 8, 11.5 and 5 t /ha during 2016-17, 2017-18 and 2018-19, respectively (Table 4). On an average technology gap under three year FLD programme was 8.16 t/ha. This may be due to the soil fertility, managerial skills of individual farmer's and climatic conditions of the selected area. Hence, location specific recommendations are necessary to bridge these gaps. These findings are similar to Mishra *et al*. (2009), Kansara and Sabalpara (2015) and Babu and Rao (2018).

Extension gap

Extension gap of 13, 12.5 and 13.5 t/ha was observed during 2016-17, 2017-18 and 2018-19 respectively. On an average extension gap under three year FLD programme was 13t/ha. This emphasized the need to educate the farmers through various techniques for the adoption of improved agricultural production technologies to reverse this trend of wide extension gap. More and more use of latest production technologies along with high yielding variety/hybrid will subsequently change this alarming trend of galloping extension gap.

Technology Index

The technology index shows the feasibility of the demonstrated technology at the farmer's field. The technology index varied from 10 to 23 (Table 4). On an average technology index of 17 per cent was observed during the three years of FLD programme, which shows the effectiveness of technical interventions. This accelerates the adoption of demonstrated technical interventions to increase the yield performance of watermelon.

Data in Table 5 showed that FLD organized on watermelon crop helped to increase area under integrated crop management of watermelon. There was significant increase in area under horizontal spread of the technology from 16 ha to 32.8 ha, an increase of 105 percent under integrated crop management in watermelon.

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