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Impact of herbicides and their combination on economics of onion cultivation (*Allium cepa* L.)

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Abstract
An investigation in the field named "Effect of Herbicides and their Combination on Economics of Onion Cultivation (*Allium cepa* L.)" was conducted in 2020–2021 and 2021–2022 at the Horticultural Research and Instructional Farm, Indira Gandhi Agriculture University, Raipur (C.G.). Ten treatments were reproduced three times, and the experiment was set up using a randomized block design. Hand weeding and five herbicide combinations of Oxyfluorefen, Oxdiargyl, Pendimethalin, Fluazifop-p-butyl, and Quizalofop-p-ethyl were evaluated in comparison to a weedy control (untreated) plot. The herbicide treatment (T_7), consisted of Oxyfluorfen 23.5% at 0.25 kg a.i./ha, Quizalofop-p-ethyl 5% EC at 75 g a.i./ha, Pendimethalin 30% EC at 1 kg a.i./ha, and manual weeding 40 days after transplanting, were considerably superior to other treatments. The results showed that treatment T_7 produced the highest income (gross and net) and b:c ratio.

Keywords: *Allium cepa* L., herbicides, combination, economics, onion, cultivation

Introduction
An major vegetable and spice crop in India, the onion (*Allium cepa* L.) is a member of the Alliaceae family and the genus Allium. All year long, people all across the world consume onions, a bulbous, biennial herb. Due to the presence of phytochemicals and flavonoids including quercetin, trisulfide, and vinyl dithins, it aids in appetite stimulation and helps to prevent high blood pressure, heart attack, and cancer. A wide range of physiological conditions, including cough, obesity, sleeplessness, hemorrhoids, and constipation, are also treated with it (Ibrahim *et al.*, 2011) [5].

India is one of the leading producer in the world regarding production and export. It is one of the most important cash crops grown for vegetables in the green stage as well as for mature bulbs. It is highly pursued by the processing industry for dehydration in the form of onion flakes and powder, which are in great demand in the world market among bulb crops with increasingly market demand as well as price due to their culinary, dietary, and medicinal values (Anon., 2021) [1]. Onion contains carbohydrates (11.0 g), protein (1.2 g), fiber (0.6 g), moisture (86.8 g), and several vitamins like vitamin A (0.012 mg), vitamin C (11 mg), thiamin (0.08 mg), riboflavin (0.01 mg) and niacin (90.2 mg) and also some minerals like phosphorus (39 mg), calcium (27 mg), sodium (1.0 mg), iron (0.7 mg) and potassium (157 mg) per 100 g.

One of the most important issues with onions is weed management, which lowers crop output and decreases revenues. Weeds are a serious problem that can have a dramatic impact on bulb production, decreasing it by as much as 40–80% (Vishnu *et al.*, 2014) [12]. Regular irrigation fosters weed growth because of onions' natural characteristics, such as their short height, sparse foliage, Close planting to transplants, shallow root systems, and extremely slow initial development. According to Kour *et al.* (2014) [6], it typically competes with crops for nutrients and 30-40% depletion of soil-applied nutrients; Therefore, in crucial times of the growth period, it is imperative to preserve the area weed-free. But it has generally been understood that forty days of manual weeding is an additional step.

Materials and Methods

At the Horticultural Research and Instructional Farm, Indira Gandhi Agriculture University, Raipur (C.G.), during the Rabi seasons of 2020-21 and 2021-22, a field experiment was conducted. Ten different treatments in a randomized block design with three replications. T_1 (Oxyfluorfen 23.5% EC @ 0.25 kg a.i./ha + at 40 days after transplanting), T_2 (Oxyfluorfen 23.5% @ 0.25 kg a.i./ha + Fluazifop-p-butyl 11.1% SL @ 0.25 kg a. i./ha), T_3 (Oxyfluorfen 23.5% @ 0.25 kg a.i./ha + Fluazifop-p-butyl 11.1% SL @ 0.25 kg a. i./ha + HW at 40 days after transplanting), T_4 (Oxydiargyl 80% WP @ 0.09 kg a.i./ha + Fluazifop-p-butyl 11.1% SL @ 0.25 kg a.i./ha), T_5 (Oxydiargyl 80% WP @ 0.09 kg a.i./ha + Fluazifop-p-butyl 11.1% SL @ 0.25 kg a.i./ha+ HW at 40 days after transplanting), T_6 (Oxyfluorfen 23.5% @ 0.25 kg a.i./ha + Quizalofop-p-ethyl 5% EC @ 75 g a.i./ha + Pendimethalin 30% EC @ 1kg a.i./ha), T_7 (Oxyfluorfen 23.5% @ 0.25 kg a.i./ha + Quizalofop-p-ethyl 5% EC @ 75 g a.i./ha + Pendimethalin 30% EC @ 1kg a.i./ha + HW at 40 days after transplanting), T_8 (Oxydiargyl 80% WP @ 0.09 kg a.i./ha + Quizalofop-p-ethyl 5% EC @ 75 g a.i./ha + Pendimethalin 30% EC @ 1kg a.i./ha), T_9 (Oxydiargyl 80% WP @ 0.09 kg a.i./ha + Quizalofop-p-ethyl 5% EC @ 75 g a.i./ha + Pendimethalin 30% EC @ 1kg a.i./ha + HW at 40 days after transplanting), T_{10} (Control plot).

Results and Discussion

The result and discussion recorded from the present investigation are summarized below:

Effect of herbicides on economics in onion cultivation

The economics of different treatments as influenced by various herbicides applied in onion on an average of two years combined data are given in Table-1 and present in Fig.1 & 2.

First-year statistical data revealed that the net profit per ha ranged from Rs. 159153.98/ha to Rs. 240312.56/ha. The highest net profit per ha was recorded under treatment T_7 Rs. 240312.56/ha. While lowest net profit per ha was recorded in treatment T_{10} Rs. 159153.98/ha. The gross profit per ha ranged from Rs. 222951.56/ha to Rs. 310744.89/ha. The highest gross profit/ha was recorded in T_7 Rs. 310744.89/ha. Whereas, the lowest gross profit/ha was recorded in T_{10} Rs. 222951.56/ha. Thus, the highest income (both gross and net) was obtained with treatment T_7 and the lowest income including gross and net was obtained with treatment T_{10}. The benefit-cost ratio from 2.49 to 3.45 is based on different treatments. It was found to be maximum 3.45 under T_6 and the minimum 2.49 under the treatment T_{10}.

During the second year of investigation that the net profit/ha increased from Rs. 158194.42 to Rs. 250098.34/ha. The highest net profit per ha was observed with treatment T_7 Rs. 250098.34/ha. Whereas the lowest net profit/ha was recorded with T_{10} Rs. 158194.42/ha. The gross profit/ha was ranged from Rs. 221992.00/ha to Rs. 320530.67/ha. The maximum gross profit/ha was recorded in T_7 320530.67/ha. While the minimum gross profit/ha was recorded under control treatment T_{10} Rs. 221992.00/ha. The benefit-cost ratio ranges from 2.48 to 3.72 depending on different herbicidal treatments. It was found to be highest at 3.72 under treatment T_6 and lowest at 2.48 under treatment T_{10}.

Similarly, in the case of pooled data analysis, the net profit per ha ranges from Rs. 15867.20/ha to Rs. 245205.45/ha. The highest net profit per ha was noticed with treatment T_7 Rs. 245205.45/ha. Whereas the lowest net profit/ha was recorded with T_{10} Rs. 15867.20/ha. The gross profit/ha ranges from Rs. 222471.78/ha to Rs. 315637.78/ha. The maximum gross profit/ha was recorded in T_7 315637.78/ha. While the minimum gross profit per ha was recorded under treatment T_{10} Rs. 222471.78/ha. The benefit-cost ratio ranges from 2.49 to 3.59 depending on various herbicidal treatments. It was found to be highest at 3.59 under T_6 and lowest at 2.49 under treatment T_{10}.

Herbicide delivery and trim effectiveness account for the differences in the B:C ratio. all provided extensive analyses of the financial viability of adopting herbicidal treatment.

These studies have also observed similar trends in the economic outcomes of different herbicidal treatments in agricultural settings.

Table 1: Effect of different herbicides on the economics of onion cultivation.

Treatments	Gross profit (Rs./ha)			Net profit (Rs./ha)			B:C Ratio		
	1st year	2nd year	Pooled	1st dear	2nd year	Pooled	1st year	2nd year	Pooled
T_1	243968	255500	249700	174274.86	185806.42	180006.42	2.50	2.67	2.58
T_2	244655	260700	252700	179494.56	195538.92	187538.92	2.75	3.00	2.88
T_3	248536	270700	259600	178375.81	200538.92	189438.92	2.54	2.86	2.70
T_4	245424	263200	254300	178960.48	196735.59	187835.59	2.69	2.96	2.83
T_5	255690	276800	266300	185543.59	206652.92	196152.92	2.65	2.95	2.80
T_6	291360	308900	300100	225928.11	243467.67	234667.67	3.45	3.72	3.59
T_7	310744	320500	315600	240312.56	250067.67	245167.67	3.41	3.55	3.48
T_8	272425	287400	279900	207007.45	221981.67	214481.67	3.16	3.39	3.28
T_9	276555	292200	284400	206136.78	221781.67	213981.67	2.93	3.15	3.04
T_{10}	222951	222000	222500	159153.98	158202.42	158702.42	2.49	2.48	2.49

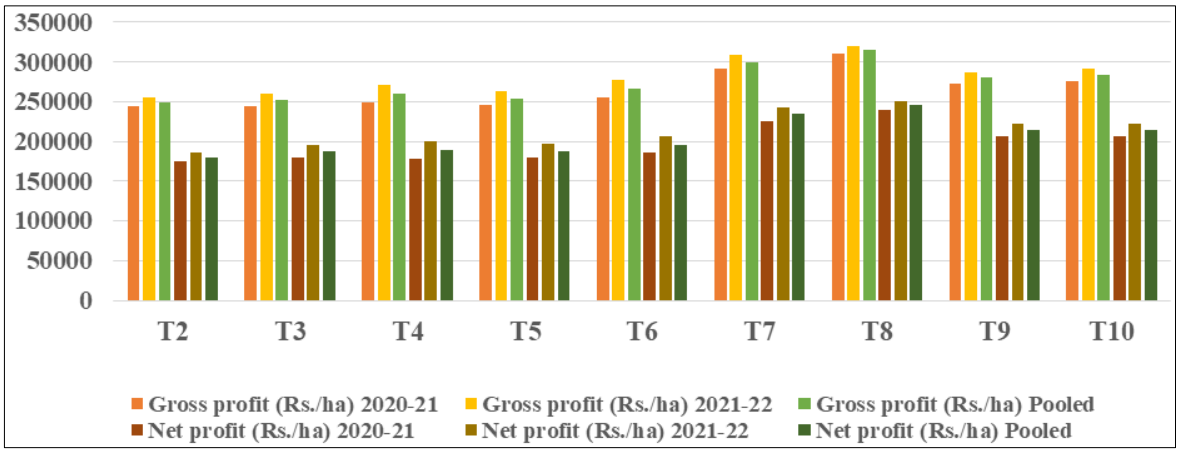

Fig 1: Effect of different herbicides on economics of onion cultivation

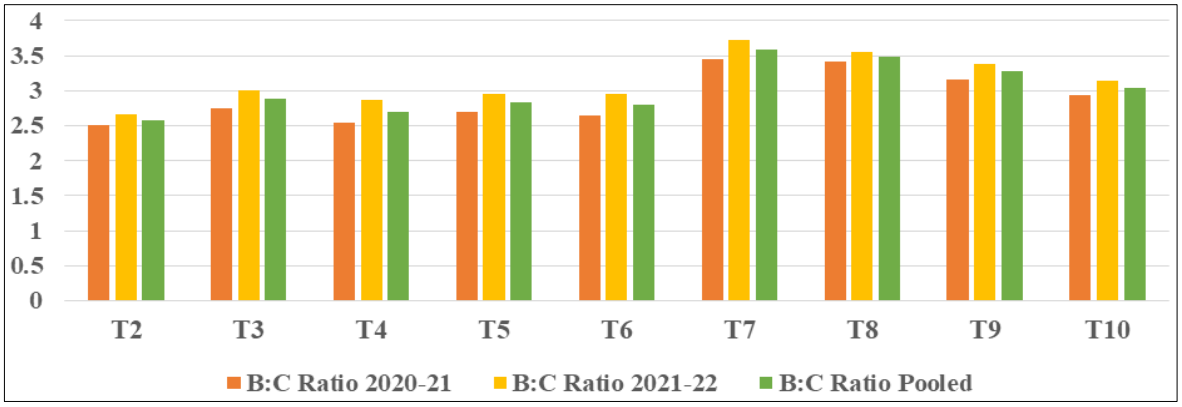

Fig 2: Effect of different herbicides on economics of onion cultivation

Conclusion

The economic analysis of various herbicidal treatments applied in onion cultivation over two years revealed significant differences in net profit, gross profit, and benefit-cost ratio. Treatment T7 consistently yielded the highest income and benefit-cost ratio across both years, while treatment T10 consistently resulted in the lowest financial returns. These findings underscore the importance of herbicide selection and efficacy in optimizing economic outcomes in agricultural practices. Moreover, the consistency of these results with previous research by Singh et al., (2009) [10] Mandeep Kaur Saini and Walia, Jangre et al., and others, highlights the robustness of the observed trends. Ultimately, informed decision-making regarding herbicide usage can significantly impact the profitability of onion cultivation.

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