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Studies on correlation between weed dynamics, growth parameters, yield attributes and bulb yield of onion as influenced by pre and post emergence herbicides

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Abstract
During the Rabi season, an experiment was conducted at the Horticultural College and Research Institute, Dr. Y.S.R Horticultural University, Venkataramannagudem, Tadepalligudem, West Godavari District, A.P. on the effects of pre-and post-emergence herbicides on weed dynamics, growth parameters, yield attributes, and onion bulb yield. The experiment consisted of ten pre- and post-emergence herbicide treatments (Pendimethalin, Oxyflourfen, Imazethapyr, and Quizalofop-ethyle) and their mixtures, replicated in a random block design. Pendimethalin and oxyflourfen applied as pre-emergence along with 75 g of Quizalofop ethyl as post emergence were shown to be just as effective in increasing bulb production as hand weeding three times. Onion bulb output was inversely linked with weed dynamics, including overall weed density, weed dry weight, and weed nutrient uptake at onion harvest. While the mean bulb weight, length, and diameter of the bulb showed positive correlations with bulb output, as did the number of leaves per plant, leaf and bulb dry matter at harvest, and plant height.

Keywords: Pendimethalin, oxyflourfen, imazethapyr, quizalofop-ethyle onion

Introduction
The onion (*Allium cepa* L.) is an important member of the Alliaceae family. Every kitchen must have it because it is a staple ingredient and condiment used to flavour a variety of foods. As a result, the onion is referred to as the "Queen of the Kitchen." Next to the tomato, onions are regarded as the second-most significant vegetable crop produced worldwide. India leads the globe in both area and production; during the 2012–2013 growing season, 10.51 lakh hectares of the country's land were planted with onions, yielding 168.13 lakh tonnes and a productivity of 16 t ha^{-1} (Tiwary, 2014) [10].

In addition to other factors that contribute to low productivity, onions are more susceptible to weed competition than other crops because of their natural traits, including slow germination, extremely slow initial growth, short stature, non-branching habit, sparse foliage, and shallow root systems. In the beginning, this encourages weeds to grow quickly, which makes competition more difficult. Additionally, using excessive amounts of FYM, fertiliser, and irrigation frequently encourages the growth of weeds (Rajendra Singh *et al*., 1986) [7]. Weeds compete with crop plants for resources like space, nutrients, moisture, and light, which lowers the yield's quality and quantity (Moolani and Sachan, 1966) [4]. When onion seedlings are transplanted, weeds also appear and develop alongside them. As a result, the crop and weed face intense competition (Bhan *et al*., 1976) [2]. If the weeds are present throughout the entire crop growing period, the marketable yield may completely disappear. Depending on the length, rate of growth, and competition from weeds, the drop in bulb output can range from 48 to 85 percent (Bhalla, 1978) [1]. In India, hand weeding onions is a widespread practise, however because of their close spacing and shallow root systems, it is an expensive and time-consuming task. Hand weeding becomes challenging during the crop's vital phase due to a lack of labourers, which results in significant output losses. Between 15 and 60 days after transplanting, the onion crop-weed competition crucial period occurs (Singh and Singh, 1986) [7]. Therefore, careful weed management in the early phases is a crucial duty to achieve increased weed control efficiency and bulb production. Herbicides used prior to emergence remain active for roughly a month following application. Onion digging operations are complicated by late-emerging weeds, which impede bulb growth (Warade *et al*., 2008) [12]. Therefore, weed management is required throughout the later stages of onion crop growth.

Post-emergence herbicides are used at later stages to keep the weed population below the economic threshold level and to lower the cost of weeding during the crop growth period. The way a herbicide behaves in a particular soil type, as well as how much organic matter it contains and how the weather is, soil moisture, etc., all affect how effective it is. In order to effectively manage weeds, it is crucial to test a number of recently released herbicides under certain agro-climatic conditions. Agriculture innovation adoption is influenced by economic factors, primarily profit (Pannell *et al.*, 2006) [13]. It's likely that the techniques generating the highest yield won't always result in the highest financial gain. Smallholder farmers lack sufficient knowledge about weed control techniques that could increase output and have trade-off effects on onion production's economics. The goal of the experiment was to evaluate how well pre- and post-emergence herbicides affected the relationship between weed dynamics, growth factors, yield attributes, and onion bulb yield.

Material and Methods

During the 2011–12 and 2012–13 Rabi seasons, an experiment was carried out at the Horticultural College and Research Institute, Dr. Y.S.R Horticultural University, Venkataramannagudem, Tadepalligudem, West Godavari District, A.P. The soil had a middling availability of NPK and an acidic response. The soil has a sandy loam texture. The experiment's design used a randomised block layout with three replications on a 4X3 m2 plot. Onion cultivar "N-53" seeds were planted for nursery rearing, and transplanting was carried out using a ridge and furrow technique with a spacing of 30 x 10 cm. The ten treatments consists of T_1-Pendimethalin @ 0.75 Kg a.i / ha as pre emergence application, T_2-Oxyfluorfen @ 0.125 Kg a.i / ha as pre emergence application, T_3-Imazethapyr @ 100 g a.i / ha as post emergence application (20 DAT), T_4-Quizalofop ethyl @ 75 g a.i / ha as post emergence application (20 DAT), T_5-Pendimethalin @ 0.75 Kg a.i / ha as pre emergence application + Imazethapyr @ 100 g a.i / ha as post emergence application (20 DAT), T_6-Pendimethalin @ 0.75 Kg a.i / ha as pre emergence application+ Imazethapyr @ 100 g a.i / ha as post emergence application (20 DAT), T_7-Oxyfluorfen @ 0.125 Kg a.i / ha as pre emergence application + Quizalofop ethyl @ 75 g a.i / ha as post emergence application (20 DAT), T_8-Oxyfluorfen @ 0.125 Kg a.i / ha as pre emergence application + Quizalofop ethyl @ 75 g a.i / ha as post emergence application (20 DAT), T_9-Weed free (Hand weeding) and T_{10}-Weedy check.

For transplanting, seedlings that were 45 days old were employed. To reduce transpiration loss and improve crop establishment, the upper third of the seedlings were cut off at the time of transplanting. In the experimental field, the full set of procedures for growing a successful crop was carried out, and weed control treatments were performed in accordance with the protocols. The correlation coefficient between the variables is calculated by using the following formula:

$$r = \frac{\text{cov}\,(x, y)}{\sqrt{\text{var}\,(x)}, . \sqrt{\text{var}\,(y)}}$$

Results and Discussion

Bulb yield (t/ha)

The bulb yield was considerably affected by each weed management strategy in both the experimentation years, and the statistics are shown in Table 1. In the first and second years, respectively, Treatment T_9 (Weed free hand weeding at 20, 40, and 60 DAT) generated the highest bulb production of 18.89 tonnes/ha and 19.19 t/ha. The highest yield was generated in both years by T_9 (manual weeding at 20, 40, and 60 DAT), followed by T_6 (pendimethalin at 0.75 kg a.i./ha (PE) + quizalofop ethyl at 75 g a.i./ha as POE). T_1 (Pendimethalin @ 0.75 kg a.i/ha) and T_2 (Oxyfluorfen @ 0.125 kg a.i/ha) treatments applied aspre emergence herbicides were comparable to each other, but were inferior to T_6 (Pendimethalin @ 0.75 kg a.i/ha (PE) + Quizalofop ethyl @ 75 g a.i/ha as POE) and T_8 (Oxyfluorfen @ 0.125 kg a.i/ha+ Quizalofop ethyl @ 75 g a.i/ha as POE).

Imazethapyr at 60 g a.i/ha (T_3), pendimethalin at 0.75 kg a.i /ha as PE + Imazethapyr at 60 g a.i /ha as POE (T_5), and oxyfluorfen at 0.125 kg a.i /ha as PE + Imazethapyr at 60 g a.i /ha as POE (T_7) produced the lowest bulb yield of onion due to their phytotoxic effects. Because T_9 (weed free-hand weeding at 20, 40, and 60 DAT), which has a greater weed population and weed growth from the beginning of the crop, produces more bulbs than T_{10} (weedy check), which has a lower weed population and weed growth.

The less crop-weed competition creates a better environment for healthy growth, development, and bulb production. This might be the result of proper weed management practises that effectively managed weeds, reduced weed competition to a greater extent, and helped the onion bulb crop grow and develop more quickly, leading to higher values for all yield-attributing characters that are positively correlated with yield. The results concur strongly with those published by Warade *et al*. (2006) [12], Saraf (2007) [9], Vashi *et al*. (2011) [11], Patel *et al*. (2012) [5], and Sangeetha Kumari and Singh (2012) [8].

Correlation coefficient between growth parameters, yield attributes and Yield of Onion

Correlation coefficients were worked out between growth parameters, yield attributes and yield to study their relation at harvest. Data are presented in the Table 2A and 3A. Distinguishable positive correlation was witnessed between plant height, number of leaves per plant, leaf and bulb dry matter at harvest, bulb height, length and diameter of the bulb and bulb yield. Bulb yield displayed statistically measurable positive correlation with plant height, number of leaves per plant, leaf and bulb dry matter at harvest, mean bulb weight, length and diameter of the bulb.

Correlation Coefficients between weed parameters and bulb yield at harvest of onion. Correlation coefficients were worked out between weed parameters and bulb yield to study their relation at harvest. Data are presented in the Table 2B and 3B. Bulb yield of onion was negatively correlated with total weed density, weed dry weight and nutrient uptake by weeds at harvest of onion. Total weed density was strongly and positively correlated with weed dry weight and nutrient uptake by weeds at harvest of onion. Similar findings have been reported by Rajalingam and Haripriya (2000) [6] and Mahanthesh (2002) [3].

Table 1: Bulb yield (t/ha) of Onion as influenced by weed management practices

	Treatment	Bulb yield (t/ha)	
		I year	II year
T_1	Pendimethalin @ 0.75 kg a.i / ha as PE	14.42	15.78
T_2	Oxyfluorfen @ 0.125 kg a.i / ha as PE	13.64	14.92
T_3	Imazethapyr @ 60 g a.i / ha as POE (20 DAT)	0.54	0.63
T_4	Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT)	11.50	12.63
T_5	Pendimethalin @ 0.75 kg a.i / ha as PE +Imazethapyr @ 60 g a.i / ha as POE (20 DAT)	0.70	0.77
T_6	Pendimethalin @ 0.75 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT)	17.75	18.29
T_7	Oxyfluorfen @ 0.125 kg a.i / ha as PEImazethapyr @ 60 g a.i / ha as POE (20 DAT)	1.04	0.88
T_8	Oxyfluorfen @ 0.125 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT)	16.87	17.64
T_9	Weed free (Hand weeding at 20, 40 and 60 DAT)	18.89	19.67
T_{10}	Weedy Check	6.65	7.92
	S.Em±	1.00	1.06
	CD (P=0.05)	2.99	3.17

Table 2a: Correlation coefficient between growth parameters, yield attributes and Yield of Onion

	Onion-1 year							
	Plant height	**No. of leaves plant^{-1}**	**Leaf dry weight**	**Bulb dry wt**	**Average Bulb weight**	**Bulb height**	**Bulb diameter**	**Bulb Yield**
Plant height	1.00000	0.67163*	0.89952*	0.89172*	0.89445*	0.84621*	0.90583*	0.83170*
No. of leaves plant^{-1}		1.00000	0.91057*	0.90600*	0.90061*	0.87157*	0.87771*	0.92396*
Leaf dry weight			1.00000	0.99012*	0.98359*	0.91824*	0.97606*	0.97912*
Bulb dry wt				1.00000	0.99604*	0.90858*	0.98496*	0.98993*
Average Bulb weight					1.00000	0.90920*	0.99106*	0.98406*
Bulb height						1.00000	0.92778*	0.88536*
Bulb diameter							1.00000	0.97466*
Bulb yield								1.00000

*significant at P=0.05
** Significant at p=0.01

Table 2b: Correlation coeffecient between weed parameters and Bulb yield at harvest of Onion

Onion-1 year						
	Total weed density	**Weed dry matter**	**Nitrogen depletion**	**Phosphorus depletion**	**Potassium depletion**	**Bulb Yield**
Total weed density	1.00000	0.99160*	0.69588*	0.70056*	0.67866*	-0.65448*
Weed dry matter		1.00000	0.67978*	0.68627*	0.66895*	-0.62172**
Nitrogen depletion			1.00000	0.98727*	0.99728*	-0.98476*
Phosphorus depletion				1.00000	0.98240*	-0.96126*
Potassium depletion					1.00000	-0.98056*
Bulb yield						1.00000

*significant at P=0.05
** Significant at p=0.01

Table 3a: Correlation coefficient between growth parameters, yield attributes and Yield of Onion

Onion-II year								
	Plant height	**No. of leaves plant $^{-1}$**	**Leaf Dry wt**	**Bulb dry wt**	**Average Bulb wt**	**Bulb height**	**Bulb Diamater**	**Bulb Yield**
Plant height	1.00000	0.72372*	0.83420*	0.92257*	0.91656*	0.84759*	0.92395*	0.88073*
No. of leaves plant^{-1}		1.00000	0.96747*	0.90494*	0.90218*	0.79546*	0.90024*	0.90611*
Leaf Dry wt			1.00000	0.92444*	0.91179*	0.82555*	0.91845*	0.90308*
Bulb dry wt				1.00000	0.99467*	0.90690*	0.98055*	0.98709*
Average Bulb wt					1.00000	0.92291*	0.98669*	0.98694*
Bulb height						1.00000	0.89361*	0.92594*
Bulb diameter							1.00000	0.97791*
Bulb yield								1.00000

*significant at P=0.05
** Significant at p=0.01

Table 3b: Correlation coefficient between weed parameters and Bulb yield at harvest of Onion

Onion-II year						
	Total weed density	**Weed dry matter**	**Nitrogen depletion**	**Phosphorus depletion**	**Potassium depletion**	**Bulb Yield**
Total weed density	1.00000	0.98680*	0.76137*	0.58615**	0.61597**	-0.55605**
Weed dry matter		1.00000	0.72190*	0.53998**	0.58722**	-0.49889**
Nitrogen depletion			1.00000	0.86665*	0.90137*	-0.92683*
Phosphorus depeltion				1.00000	0.98538*	-0.95085*
Potassium depletion					1.00000	-0.95055*
Bulb yield						1.00000

*significant at P=0.05
** Significant at p=0.01

Conclusion

Pendimethalin and oxyflourfen applied as pre-emergence along with 75 g of Quizalofop ethyl as post emergence were shown to be just as effective in increasing bulb production as hand weeding three times. Onion bulb output was inversely linked with weed dynamics, including overall weed density, weed dry weight, and weed nutrient uptake at onion harvest. While the mean bulb weight, length, and diameter of the bulb showed positive correlations with bulb output, as did the number of leaves per plant, leaf and bulb dry matter at harvest, and plant height.

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