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Yield, Economics and Quality of Grain Amaranth (*Amaranthus hypochondriacus* L.) Influenced by Integrated Weed Management

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ABSTRACT

A field experiment to find out yield and quality of grain amaranth (*Amaranthus hypochondriacus* L.) influenced by integrated weed management was conducted during *rabi* season of 2020-21 at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. The result of experiment indicated that higher values of growth attribute viz., plant height at harvest and yield attribute viz., length of inflorence were recorded under weed free treatment which remained at par with oxyflurofen @ 50 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS. Significantly the highest grain yield per plant and grain yield were recorded under weed free treatment as compared to rest of other treatments. However, among the integrated weed management treatments oxyflurofen @ 50 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS gave significantly higher grain yield per plant and grain yield as compared to other treatments. Significantly higher straw yield was recorded under weed free treatment which was at par with oxyflurofen @ 50 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS treatment. The maximum net realization was obtained under weed free treatment and it was closely followed by oxyflurofen @ 50 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS. Whereas, the highest B:C ratio was obtained by treatment of oxyflurofen @ 50 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS which was closely followed by weed free treatment.

Keywords Grain amaranth, Interculturing, Oxyflurofen, Weed free, Integrated weed management.

INTRODUCTION

Grain amaranth (*Amaranthus hypochondriacus* L.) is an under exploited tropical novel crop with a high nutritive value. Among three pseudo-cereals (Buck wheat, Quinoa and Grain amaranth) grain amaranth is the most important belongs to the family Amaranthaceae and genus Amaranthus. The main virtue of the seed lies in the high protein content coupled with easily digestible carbohydrate component. In relation

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to cereal crops such as barley, maize, rice and wheat, it has the richest source of protein (16%) and amino acids such as lysine (5%), cystine (2.9%), methionine (4.4%) and tryptophan (1.4%). In comparison to conventional cereals, it provides an excellent supply of fat (7.1 g), moisture (9.3%), calcium (0.49 g), phosphorus (0.45 g), iron (22.4 g) and total dietary energy (391 calories) per 100 g. The high lysine content of amaranth improves the protein quality of foods that is particularly beneficial for infants, children, pregnant and lactating women. Amaranth can be use in many other food like breads, soups, breakfast, cereals, cookies, crackers and beverages. In India, presently amaranth is commonly grown in Gujarat, Arunachal Pradesh, Madhya Pradesh, Maharashtra, Himachal Pradesh, hills of Uttar Pradesh and some State of South India. In Gujarat, it is mainly grown in Banaskantha, Kheda, Mehsana, Sabarkantha, Patan, and some parts of Saurashtra region as a *rabi* crop. In Gujarat, the estimated cultivated area of Grain amaranth crop is 12,000 ha during year 2016-17. In Banaskantha district, it is cultivated in estimated area 8,200 ha during year 2016-17 and total 93,694 quintals procurement production of grain Amaranth was recorded at APMC, Palanpur (Prajapati *et al.* 2019).

In agricultural production systems, weeds are one of the most significant biological constraints. Weed competes with the crop for moisture, nutrient, light and space. If only a few weeds are present, yield losses may be minimal, nevertheless, extensive infestations can result in complete crop failures and in some circumstances, after perennial weeds have established, the field cannot be used for agricultural production until the infestation is controlled. Therefore, timely and appropriate weed control is required for increase the yield. In the view of scarcity of labor and higher labor wages during peak season, integrated weed management could be a more effective, economical and efficient alternative to hand weeding. However, weed control has subsequently been demonstrated to be more effective when using integrated weed management, this includes the use of herbicides as well as cultural interventions (Arya 2004).

MATERIALS AND METHODS

A field experiment was conducted at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, during the *rabi* season of 2020-21. The experimental field's topography was fairly uniform and levelled. The soil of experimental field was loamy sand in texture with low in organic carbon and available nitrogen (138 kg/ha), medium in available phosphorus (43 kg/ha) and high in available potassium (281 kg/ha) having pH value of 7.56. The treatments comprised of ten methods of weed management viz., Pendimethalin @ 400 g a.i./ha (PE), Pendimethalin @ 400 g a.i./ha (PE) and inter culturing *fb* hand weeding at 4 WAS, Oxadiargyl @ 50 g a.i./ha (PE), Oxadiargyl @ 50 g a.i./ha (PE) and inter culturing *fb* hand weeding at 4 WAS, Oxadiargyl @ 50 g a.i./ha (PoE) at 3 WAS, Oxyflurofen @ 50 g a.i./ha (PE), Oxyflurofen @ 50 g a.i./ha (PE) and inter culturing *fb* hand weeding at 4 WAS, Inter culturing *fb* hand weeding at 3 WAS, Weed free and Weedy check were taken in Randomized Block Design with three replication. Grain amaranth variety GA 6 was grown with 45 cm spacing between the rows. The crop was fertilized with 60 kg nitrogen and 40 kg phosphorus per ha. The data were statistically analyzed for various characters as described by Panse and Sukhatme (1967). Also DNMRT test is done for comparing treatment means.

RESULTS AND DISCUSSION

The data exhibited in Table 1 showed that the initial as well as final plant population were not influenced significantly under the different weed management practices. Additionally, the results revealed that pre- and post-emergence herbicide use had no negative impact on grain amaranth crop germination and establishment.

Significantly taller plant was observed in weed free treatments at 30 DAS, 60 DAS and at harvest but it was at par with oxyflurofen @ 50 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS (Table 2). The increase in plant height at the periodical development stage under weed-free conditions during the critical crop competition phase could be attributed to effective weed management under these treatments, which increased crop growth and reduced weed-nutrient outflow.

Table 1. Effect of integrated weed management on plant population (20 DAS and at harvest) and plant height (30 DAS, 60 DAS and at harvest) of grain amaranth.

Treatments	Plant population (per meter row length)		Plant height (cm)		
	20 DAS	At harvest	30 DAS	60 DAS	At harvest
Pendimethalin @ 400 g a.i./ha (PE)	9.20	9.02	16.91^{e}	59.63^{cd}	113.13^{bc}
Pendimethalin @ 400 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS	9.63	9.34	19.77^{bcd}	62.75^{bcd}	119.06^{abc}
Oxadiargyl @ 50 g a.i./ha (PE)	9.43	9.11	17.45^{de}	60.64^{bcd}	114.61^{bc}
Oxadiargyl @ 50 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS	9.73	9.56	20.87^{bc}	65.55^{bc}	124.52^{abc}
Oxadiargyl @ 50 g a.i./ha (PoE) at 3 WAS	9.23	8.73	16.63^{e}	58.27^{cd}	111.19^{bc}
Oxyflurofen @ 50 g a.i./ha (PE)	9.50	9.21	17.94^{de}	61.24^{bcd}	116.33^{bc}
Oxyflurofen @ 50 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS	9.80	9.66	22.08^{b}	70.00^{ab}	127.68^{ab}
Interculturing *fb* hand weeding at 3 WAS	9.67	9.26	18.74^{cde}	61.62^{bcd}	117.36^{bc}
Weed free	9.87	9.77	24.74^{a}	74.66^{a}	135.91^{a}
Weedy check	9.13	8.58	16.39^{e}	55.12^{d}	107.45^{c}
SEm±	0.44	0.46	0.82	2.83	5.41
CD (p=0.05)	NS	NS	2.46	8.42	16.08
CV%	8.00	8.60	7.50	7.80	7.90

Weed free treatment was recorded significantly longer length of inflorence which remained at par with application of oxyflurofen @ 50 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS (Table 2). The key cause for this improvement in the inflorence length parameter could be the significant increase in plant height, as well as the fact that a weed-free environment is helpful to plant growth and development. Weed free treatment had resulted significantly the highest grain yield per plant compared to all other treatments. In case of integrated weed management treatments, it was observed that the significantly higher grain yield per plant was recorded with the application of oxyflurofen @ 50 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS (Table 2). Keeping the plot weed free throughout crop season provided the favorable environment to the crop resulting in profuse vegetative and better reproductive growth of the crop which might have resulted in higher grain yield per plant.

Weed free treatment had resulted significantly the highest grain yield, while in case of integrated weed management treatment, significantly higher grain yield recorded with application of oxyflurofen 50 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS which remained at par with oxadiargyl @ 50 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS. Weed free treatment was recorded significantly higher straw yield which remained at par with application of oxyflurofen @ 50 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS (Table 2).

Yield is the result of a series of transformations from source to sink. Physical and integrated weed management practices that effectively remove weeds throughout the crop growth period provide better space, moisture, nutrient, and solar radiation for better plant growth, i.e. plant height, as well as yield attributes such as inflorence length and grain yield per plant. On the other hand, imposition of chemical or hand weeding treatment to the crop always comes out on top the crop weed competition and all the production factors, such as genetic potentiality of crop variety, individual factor productivity of different production factors, such as irrigation, fertility, space,

Table 2. Effect of integrated weed management on inflorescence length, grain yield per plant, test weight, grain yield, straw yield and harvest index (%) of grain amaranth.

Treatments	Inflorescence length (cm)	Grain yield per plant (g)	Test weight (g/ 10 ml)	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)	Protein content (%)
Pendimethalin @ 400 g a.i./ha (PE)	46.75^{bc}	5.11^{ef}	7.57	954^{f}	3222^{e}	22.81	13.80
Pendimethalin @ 400 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS	53.66^{b}	6.33^{cd}	7.62	1303^{cd}	4549^{bc}	22.40	13.67
Oxadiargyl @ 50 g a.i./ha (PE)	48.01^{bc}	5.46^{def}	8.21	1099^{ef}	3688de	23.08	14.07
Oxadiargyl @ 50 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS	63.27^{a}	6.60^{c}	8.34	1374^{bc}	4644^{b}	22.54	14.10
Oxadiargyl @ 50 g a.i./ha (PoE) at 3 WAS	46.04^{bc}	4.76^{f}	7.36	763^{g}	2496^{f}	23.54	13.58
Oxyflurofen @ 50 g a.i./ha (PE)	48.70^{bc}	5.80^{cde}	8.02	1158de	3972^{cd}	22.59	14.08
Oxyflurofen @ 50 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS	66.77^{a}	7.87^{b}	8.20	1534^{b}	5394^{a}	22.23	14.20
Interculturing *fb* hand weeding at 3 WAS	50.87^{bc}	6.01^{cde}	7.90	1232^{cde}	4046^{bcd}	23.35	13.83
Weed free	70.77^{a}	8.98^{a}	8.51	172^{6a}	5811^{a}	23.00	14.28
Weedy check	42.94^{c}	4.58^{f}	7.59	578^{g}	1786^{g}	24.44	13.90
SEm±	2.79	0.30	0.25	55.50	194.40	1.24	0.32
CD (p=0.05)	8.30	0.89	NS	164	577	NS	NS
CV%	9.00	8.47	5.59	8.20	8.50	9.41	4.00

photosynthesis active radiation and so on, exert their greatest strength in producing the economic yield. The more number of weeds in weedy check treatment might have reduced the plant growth due to compet-

Table 3. Economics of different treatments as influenced by integrated weed management in grain amaranth.

Treatments	Grain yield (kg/ha)	Straw yield (kg/ha)	Gross realization (₹/ha)	Total cost of cultivation (₹/ha)	Net realization (₹/ha)	BCR
T_1 : Pendimethalin @ 400 g a.i./ha (PE)	954	3222	49321	22713	26609	2.17
T_2 : Pendimethalin @ 400 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS	1303	4549	67423	24945	42478	2.70
T_3 : Oxadiargyl @ 50 g a.i./ha (PE)	1099	3688	56808	23067	33741	2.46
T_4 : Oxadiargyl @ 50 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS	1374	4644	71001	25300	45701	2.81
T_5 : Oxadiargyl @ 50 g a.i./ha (PoE) at 3 WAS	763	2496	39391	23067	16324	1.71
T_6 : Oxyflurofen @ 50 g a.i./ha (PE)	1158	3972	59882	22397	37484	2.67
T_7 : Oxyflurofen @ 50 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS	1534	5394	79420	24630	54790	3.22
T_8 : Interculturing *fb* hand weeding at 3 WAS	1232	4046	63622	23741	39881	2.68
T_9 : Weed free	1726	5811	89196	29881	59316	3.00
T_{10} : Weedy check	578	1786	29777	21509	8268	1.38

iton for space, moisture, nutrient and solar radiation there by poor grain yield of grain amaranth obtained. These above findings are in conformity with results obtained by Shukla *et al.* (2014), Gaharwar *et al.* (2017), Singh *et al.* (2017), Chaudhari *et al.* (2019). The maximum net realization was obtained under weed free treatment and it was closely followed by oxyflurofen @ 50 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS. Whereas, maximum B:C ratio was obtained by treatment of oxyflurofen @ 50 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS which was closely followed by weed free treatment.

The higher grain and straw yield as a result of better weed control under these treatments which fetched more benefit and accordingly showed higher net realization (Table 3). Maximum B:C ratio might be due to more number of labor required under weed free treatment to perform operation which increased cost of cultivation, while integrated weed management employed lesser number of labor which saved extra wages and also reduce the risk of drudgery involved in weeding leads to higher monetary advantage and increased B:C ratio. Similar findings were also reported by Shukla *et al.* (2014), Singh *et al.* (2017).

CONCLUSION

Based on results of the field experiment, it is concluded that higher yield and maximum net return in grain amaranth can be achieved by maintaining weed free condition throughout crop growth period where labors are easily available. However, under the scarcity of labors, the higher yield and maximum B:C ratio can be achieved with application of oxyflurofen @ 50 g a.i./ha (PE) and interculturing *fb* hand weeding at 4 WAS.

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